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Financial exchange rates and international currency exposures

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Discussion Paper
Series 1: Economic Studies
No 22/2008

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Internet http://www.bundesbank.de

ISBN 978-3–86558–458–8 (Printversion)
ISBN 978-3–86558–459–5 (Internetversion)

This paper was presented at the 10th Bundesbank spring conference (May 2008) on “Central Banks and Globalisation“. The views expressed in the paper are those of the authors and not necessarily those of the Bundesbank.

Central Banks and Globalisation

10th Bundesbank Spring Conference
(in cooperation with the IMFS)

22-23 May 2008

Thursday, 22 May 2008

9.00 – 9.30 **Introduction**

Axel Weber *(Deutsche Bundesbank)*

Chair: Axel Weber *(Deutsche Bundesbank)*

9.30 - 10.30 **Global business cycles: convergence or decoupling?**

Speaker: Ayhan Kose *(IMF)*
Christopher Otrok *(IMF)*
Esward Prasad *(IMF)*

Discussant: Massimiliano Marcellino *(Bocconi University)*

10.30 – 10.45 **Coffee break**

10.45 – 11.45 **Absorbing German immigration: wages and employment**

Speaker: Gabriel Felbermayer *(University of Tübingen)*
Wido Geis *(ifo)*
Wilhelm Kohler *(University of Tübingen)*

Discussant: Michael Burda *(Humboldt University)*

11.45 – 13.15 **Lunch**

Chair: Stefan Gerlach *(IMFS)*

13.15 – 14.15 **Financial exchange rates and international currency**

Speaker: Philip Lane *(Trinity College Dublin)*
Jay Shambrough *(Dartmouth College)*

Discussant: Frank Warnock *(University of Virginia)*

14.15 – 14.30 **Coffee break**

14.30 – 15.30 **International Portfolios and Current Account Dynamics: The Role of Capital Accumulation**

Speaker: Robert Kollmann *(ECARES, Universite Libre de Bruxelles, University Paris XII and CEPR*)
Nicolas Coeurdacier (*London Business School*)

Discussant: Mathias Hoffmann (*University Zurich*)

15.30 – 15.45 **Coffee break**

15.45 – 16.45 **Financial globalisation and monetary policy**

Speaker: Michael Devereux *(University of British Columbia)*
Alan Sutherland *(University of St Andrews)*

Discussant: John Rogers *(Federal Reserve Board)*

16.45 – 17.00 **Coffee break**

17.00 – 18.00 **Globalization and inflation – evidence from factor augmented Phillips curve regressions**

Speaker: Sandra Eickmeier *(Deutsche Bundesbank)*
Katharina Moll *(Frankfurt University)*

Discussant: Matteo Ciccarelli (ECB)

19.30 **Dinner**

Speaker: Harold James *(Princeton University)*

Friday, 23 May 2008

Chair: Lars Jonung *(European Commission)*

10.00 – 11.00 **Globalisation of banking and the effectiveness of monetary policy**

Speaker: Linda Goldberg *(Federal Reserve Bank of New York)*
Nicolla Cetorelli *(Federal Reserve Bank of New York)*

Discussant: Claudia Buch *(University of Tübingen)*

11.00 – 11.15 **Coffee break**

11.15 – 12.15 **Foreign capital and economic growth in the first era of globalisation**

Speaker: Michael Bordo *(Rutgers University)*
Chris Meissner *(University of Cambridge)*

Discussant: Albrecht Ritschl *(London School of Economics)*

12.15 – 14.00 **Lunch**

Chair: Beatrice Weder di Mauro *(University Mainz)*

14.00 – 15.00 **Money, liquidity and financial stability**

Speaker: Franklin Allen *(University of Pennsylvania)*
Elena Carletti *(Frankfurt University)*

Discussant: Wolf Wagner *(Tilburg University)*

15.00 – 15.15 **Coffee break**

15.15 – 16.15 **International linkages and financial fragility**

Speaker: Falko Fecht *(Deutsche Bundesbank)*
Hans Peter Grüner *(University of Mannheim)*
Phillip Hartmann *(ECB)*

Discussant: Roman Inderst *(Frankfurt University & IMFS)*

16.15 – 16.30 **Coffee break**

Chair Heinz Herrmann *(Deutsche Bundesbank)*

16.30 – 17.30 **Financial globalisation and regulation**

Speaker: Xavier Freixas *(Pompeu Fabra)*

Discussant: Arnoud Boot *(University of Amsterdam)*

Financial Exchange Rates and International Currency Exposures*

Philip R. Lane
IIIS, Trinity College Dublin
and CEPR

Jay C. Shambaugh
Dartmouth College
and NBER

September 2008

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. We show that our currency measure has high explanatory power for the valuation term in net foreign asset dynamics: exchange rate valuation shocks are sizable, not quickly reversed and may entail substantial wealth redistributions. 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.

JEL Classification Numbers: F31, F32

Keywords: Financial integration, capital flows, external assets and liabilities

*We thank the participants in the Bundesbank Annual Research Conference, especially our discussant Frank Warnock. In addition, we thank the journal referees, Patrick Honohan, Philippe Martin, Roberto Rigobon, Ted Truman, Pinar Yesin and the participants in conferences and seminars including CGFS-BIS, CEPR, NBER IFM Lunch Group, Bank of England, Dartmouth College, ECB, Federal Reserve Board, Georgetown, Pompeu Fabra, MIT, NBER IFM, UC Davis, UC Santa Cruz, Siena and Wisconsin. We are grateful to Philippe Mesny and Dennis Petre for the provision of data from the BIS and Ted Truman for generously sharing his data on reserves. Agustín Bénétrix, 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

Non-technical summary

It has been shown that the foreign liabilities of the United States are mostly denominated in dollars whereas 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 countries have historically issued significant amounts of foreign-currency debt. Remarkably little is known about the currency composition of foreign assets and liabilities of most countries. A major contribution of our project is to address this data deficit by building an empirical profile of the international currency exposure of a large number of countries. We then exploit the estimated currency positions to create financially-weighted exchange rate indices (instead of trade-weighted) and capture the valuation impact of currency movements on net foreign asset positions. We show that trade-weighted exchange rate indices are insufficient to understand the financial impact of currency movements. Our financially-weighted indices have 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 redistributions. 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. Shifts to equity-type liabilities and large increases in reserves play a more important role than changes in the currency denomination of external debt.

Nichttechnische Zusammenfassung

Es ist früher gezeigt worden, dass die Auslandsverbindlichkeiten der USA meist in Dollar denominiert sind während ihre Auslandsaktiva zu einem erheblichen Teil aus Anlagen in anderen Währungen bestehen. Dementsprechend verbessert eine unvorhergesehene Dollarabwertung die Auslandsposition der USA, wenn man in Dollar rechnet. Im Gegensatz dazu haben sich viele Entwicklungsländer in der Vergangenheit in hohem Umfang in Fremdwährung verschuldet. Für viele Länder ist erstaunlich wenig darüber bekannt, in welchen Währungen ihre Auslandsforderungen und Verbindlichkeiten denominiert sind. Ein wichtiger Beitrag unseres Projektes besteht darin, dieses Defizit zu beseitigen, indem wir für eine große Zahl von Ländern ein Profil ihrer Währungszusammensetzung erstellen. Diese Schätzungen verwenden wir dann um „finanzgewichtete“ Indizes (statt handelsgewichtete) zu erstellen und so die Bewertungseffekte von Wechselkursbewegungen auf die Nettowährungspositionen eines Landes zu ermitteln. Wir zeigen, dass handelsgewichtete Indizes die Effekte von Wechselkursveränderungen nur ungenügend widergeben. Unsere finanzgewichtete Indizes haben einen hohen Erklärungswert für die Dynamik der Nettoauslandsposition: die Bewertungseffekte von Wechselkursschocks sind beachtlich, sie kehren sich nicht schnell um und können die Vermögenspositionen zwischen den Ländern erheblich verschieben. Viele Entwicklungsländer sind per Saldo in fremder Währung verschuldet, was sie verletzlich macht, wenn ihre Währung abwertet. Wir zeigen aber auch, dass viele dieser Länder in der letzten Dekade ihre Verschuldung in Auslandswährung deutlich verringert haben. Dabei spielen Verschiebungen zu aktienähnlichen Verschuldungsarten und der Aufbau von Währungsreserven eine wichtigere Rolle als Veränderungen in der Währungszusammensetzung ihrer Auslandsverschuldung selbst.

1 Introduction

A recent wave of research has emphasized that exchange rate movements operate through a valuation channel, in addition to their traditional impact on real 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]

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, 2007b) and Lane and Milesi-Ferretti (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, an extensive literature has highlighted that currency depreciation has induced adverse balance sheet effects.[2]

Remarkably little is known about the currency composition of the foreign assets and liabilities of most countries: 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 then exploit the estimated currency positions to create financially-weighted exchange rate indices, while the interaction of the financial exchange rate indices and the gross scale of the international balance sheet allows 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 endogenize the composition of international portfolios and analyzing the 'wealth' channel of monetary policy in open economies. Accordingly, the analysis of currency exposure data may provide new insights on the interaction between financial globalization and macroeconomic behavior.

Our analysis yields three important findings. First, we compare asset- and liability-weighted exchange rate indices to the conventional trade-weighted exchange rate index. While we find that there are on average high correlations across the indices, we also highlight that these indices can diverge in important ways. This is especially true for the liability-weighted index, in view of the importance of domestic-currency liabilities which are extensive for advanced economies and growing rapidly for developing and emerging economies.

Second, we combine the asset- and liability-weighted indices to create a net financial

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

[2] See the contributions to Eichengreen and Hausmann (2005) and Devereux, Lane and Xu (2006).

index that attaches a positive weight to currencies in which a country holds a long position and a negative weight to currencies in which it is short. Accordingly, the net financial index captures the directional exposure of a country's international balance sheet to exchange rate movements. We find that there is tremendous heterogeneity in the comovement between the trade-weighted index and the net financial index. While 20 percent of countries have a strong positive correlation (above 0.7) most countries (63 percent) show a negative correlation: for these countries, depreciation of the trade-weighted index may boost net exports but is associated with a decline in the net financial index that damages the external balance sheet through a negative valuation effect. Moreover, we quantify the scale of these currency-induced valuation shocks and find that these shocks can be substantial, are not quickly reversed and explain a significant fraction of aggregate valuation shocks, especially for developing countries.

Third, we construct a summary measure of aggregate foreign currency exposure that captures the sensitivity of the external balance sheet to a uniform exchange rate movement against all foreign currencies. We find that the majority of countries have a net negative exposure, where they have more foreign currency liabilities than foreign currency assets. These net negative positions are quite large in many cases and leave countries exposed to substantial valuation losses in the event of a uniform depreciation. However, we also find that, over the last decade, many countries have shifted their exposure to foreign currencies in a positive direction, with a shift to equity-type liabilities and large increases in reserves playing a more important role than any change in the currency denomination of external debt.

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 affect 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.[3]

Our work is related to several previous empirical 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 their analysis by constructing estimates of net foreign-currency debt assets. However, these contributions did 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 (2007b) calculate dollar exposures for China, Japan and a set of European countries. 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 im-

[3] There has been a flurry of recent theoretical work that seeks to calculate optimal international portfolios within the framework of dynamic stochastic general equilibrium macroeconomic models (including Engel and Matsumoto 2005, Devereux and Saito 2006, Devereux and Sutherland 2006, Tille and van Wincoop 2007).

portant 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 describing 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 online appendix provides a detailed description of the methods by which we construct our data set 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 analyzing the role of the exchange rate in the international adjustment process has been its impact on variables such as the trade balance. However, in recent years, there has been a resurgence in interest in the balance sheet impact of currency movements. While this valuation channel was recognized in the portfolio balance literature that developed during the 1970s, the increase in the scale of gross holding of foreign assets and liabilities means that its quantitative importance has grown.

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. 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. Although the relation between currency movements and the current account has been much studied, there is less empirical evidence on the role of the exchange rate in influencing net capital gains. 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 emphasized 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 (2007b) have emphasized that the 'finance' currency weights for the United States are quite different to the 'trade' currency weights, 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 data sets, augmented by 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 or the interest/dividend payments on these assets could be negatively correlated with the exchange rate, such that investor-currency returns might be insulated from currency movements. To see this, we can also write the change in the net foreign asset position as

$$NFA_t - NFA_{t-1} = TB_t + FC_t = TB_t + NETINVINC_t + VAL_t^{MV} + VAL_t^{XR} \quad (2)$$

where TB_t is the trade balance and FC_t is the aggregate net financial return on the external investment position (since, ignoring transfers and cross-border labor income, the current account is just the sum of the trade balance and net investment income). In turn, the FC_t term is the sum of net investment income ($NETINVINC_t$), the component of net capital gains that relates to shifts in local-currency asset prices (VAL_t^{MV}) and the component of net capital gains that relates to currency movements (VAL_t^{XR}). Accordingly, an increase in VAL_t^{XR} may have no impact on the overall net financial return, if it is offset by a decline in local-currency asset prices or a decline in net investment income. Indeed, if all foreign assets were single-period foreign-currency bonds and all foreign liabilities were single-period domestic-currency bonds, uncovered interest rate parity would mean that all predictable movements in exchange rates would be exactly offset by shifts in net investment income. However, the general failure of uncovered interest parity, plus the fact that most countries have few domestic-currency foreign debt liabilities, means that this polar case is not empirically relevant.

More generally, 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 success of financial trades such as the carry trade shows 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 of the foreign currency could be accompanied by an improvement in export performance, boosting the local-currency returns on holdings in export-orientated firms. However, in the other direction, a depreciation is also frequently accompanied by a slowing of the economy, such that local-currency returns on domestically-orientated assets 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. In related fashion, Pavlova and Rigobon (2007) 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 currency-based valuation effects, so there is no offset for these asset classes. In summary, 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. 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). We return to these issues in the analysis section, where we find that VAL^{XR} is positively correlated with VAL and has a significant impact on the direction of VAL as well as on the aggregate net financial return on the external investment position.

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 derivative trade is very large, much of this is between domestic residents, which does not alter the aggregate net exposure of the economy.[4] [5] Hau and Rey (2006) estimate that only 10 percent of foreign equity positions are hedged, often due to institutional restrictions on the use of derivative contracts. Furthermore, as noted above, if the counterparty in derivative contract is another domestic resident, the currency risk still resides within the same country. In addition, any hedging that comes through balancing of assets and liability exposure (e.g. simultaneously holding dollar assets and liabilities) is captured in our weights: it is only the more complex derivative contracts that will be missed. Finally, it is not clear that an optimizing 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).

3 Data

We follow a two-step procedure in estimating currency positions. First, we determine the currency composition of assets and liabilities within individual categories, using a variety of methods and data sources. Second, we weight the categories by their shares in the international balance sheet in order to construct aggregate currency exposures. 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 2008).

Our sample includes 117 countries and we generate estimated currency positions for the years 1990 to 2004. In constructing financially-weighted exchange rate indices, 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

[4] 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.

[5] 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.

dropped). Many results examine the change in positions from 1994 to 2004. These results use a smaller 102 country sample that has full data from 1994 through 2004.[6] The online appendix provides a detailed description of the methods employed to construct estimates of the currency composition of international balance sheets.

3.1 Foreign Assets

The asset side of a country's international balance sheet is divided into five categories: portfolio equity, direct investment, portfolio debt, other debt (generally bank-related), and reserves.

Since 2001, the IMF's Coordinated Portfolio Investment Survey (CPIS) data set annually provides the geographical location of portfolio equity asset holdings for 68 reporter countries across 220 host countries.[7] In order to provide estimates for country pairs that are missing from the data set, we employ a gravity-based model of bilateral equity holdings to construct estimated positions in these cases.[8] We make the key assumption that equity issued by country j carries exposure to the currency of country j. 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 equity holdings. (See also the discussion in section 2 regarding the lack of correlation between returns and exchange rate changes). Accordingly, we generate the currency composition of equity holdings by combining the actual and synthetic data on the geography of equity positions together with the currency arrangements for each destination country. For non-reporter countries, we use synthetic data for their weights. As it turns out, these do not play a major role in our overall index creation, since countries that are not CPIS reporters typically hold fairly small equity portfolios.[9]

For 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-a-vis up to 196 partner countries over 1970-2004. 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

[6] When a gap in years is present, we average across adjacent years to fill in the missing weights.

[7] We also make use of the 1997 CPIS trial survey which included a smaller set of reporting countries (27 countries). Since the geographical pattern of portfolio investment is highly persistent, we also use the 1997 weights for the years 1990 through 1996. However, we note that this risks overweighting currencies in the earlier years that subsequently appreciated, to the extent that portfolio rebalancing across currencies did not take place.

[8] See Martin and Rey (2004) and Lane and Milesi-Ferretti (2008) for theoretical and empirical support for such a procedure. Following Lane and Milesi-Ferretti (2008), we eliminate holdings listed in offshore financial centers. Countries report very large holdings in these offshore centers (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 centers eventually wind up in the same pattern as those that go directly to other countries. After eliminating offshore centers, we are left with 50 reporting countries and 180 hosts. We follow Lane and Milesi-Ferretti (2008) and primarily use the IMF Background Paper, "Offshore Financial Centers" (2000), as our guide to labelling countries as offshore centers.

[9] 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.

reporters. Since most major destinations are reporters, this process gives us a reasonable gauge of the currency distribution of the non-reporter countries. We follow our process for portfolio equity and assume that direct investment in country j carries exposure to the currency of the host country.[10]

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). 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.[11] This dataset contains information on the currency denomination of international bonds for 113 issuing countries.[12] 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.

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 from the US Treasury, Bank of Japan and the European Central Bank). 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 to allocate a higher portion of major currency denominated debt to investors from each currency's country.

In relation to other non-portfolio debt assets, we obtained BIS data on the breakdown between 'domestic currency' and 'foreign currency' components for the bilateral foreign assets and liabilities of the banks residents in twenty reporter countries vis-à -vis a large number of counterpart countries (on a locational basis).[13]The reporters are the dominant banking centers and, despite the small number, capture the bulk of world bank holdings.

Finally, the IMF tracks the currency composition of reserves for its member countries, in its COFER (Currency Composition of Official Foreign Exchange Reserves) database. However, for confidentiality reasons, the only reported COFER data are for major aggregates (world, industrial country group, developing country group). However, the country-level data have been used on a few occasions in research by IMF-affiliated economists to analyze

[10] 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.

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

[12] Where the BIS data set 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 BIS data make up a small fraction of internationally held debt assets. Our dataset focuses on international bond issues - while foreign investors have become active in the domestic bonds markets of developing countries in very recent years, the international bond issues are more important for the vast bulk of our sample period.

[13] 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).

the determinants of cross-country and time series variation in the currency composition of reserves. We exploit the results from these papers, especially Eichengreen and Mathieson (2000), to model currency composition. We take the coefficients from these regressions and use them to predict the share for each of the major currencies (the dollar, the DM (euro after 1999), the Swiss Franc, the Yen, and the Pound). Once we have predicted values for each currency, we impose an adding up constraint and re-normalize the results, so that each country has totals that add up to 100 percent.

We merge this generated data with actual data on reserves for 2000-2004 for twenty 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 (US, Canada, UK) and blend our model generated data with 2000 actual data. We can further confirm that our predictions are sensible by drawing on two additional sources of information. First, some countries occasionally report their reserves 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) reserves shares. Our results perform quite well on this measure. Second, Ewe-Hhee Lim (2006) studies the changing international role of the euro and dollar and gives some regional information on the currency composition of reserves.

3.2 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. Consistent with our treatment on the assets side, portfolio equity and direct investment liabilities are assumed to carry exposure to the domestic currency, such that no foreign-currency exposure is generated by equity-type liabilities.

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 percent 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).[14] 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.

[14] 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.

4 Index Creation

The dataset allows us to build a number of 'financially-weighted' effective exchange rate indices for a large number of countries. 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.

4.1 Asset, Liability, and Trade Indices

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. 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

$$\omega^A_{ijt} = \sum_{k=1}^{k=N} \lambda^{Ak}_{it} * \omega^{Ak}_{ijt}; \quad \omega^L_{ijt} = \sum_{k=1}^{k=N} \lambda^{Lk}_{it} * \omega^{Lk}_{ijt} \tag{3}$$

where $\omega^A_{ijt}, \omega^L_{ijt}$ are the weights for currency j in period t in country i's assets- and liabilities-exchange rate indices, $\lambda^{Ak}_{it}, \lambda^{Lk}_{it}$ are the relative importance of category k (portfolio equity, FDI, debt, reserves) in country i's assets and liabilities in period t and $\omega^{Ak}_{ijt}, \omega^{Lk}_{ijt}$ 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^k_{it}).

Our indices use these weights to average the percentage changes of bilateral exchange rates. Since the currency weights are based on end-of-year data, we use the period t values to weight the changes in bilateral exchange rates during period $t+1$. Accordingly, the index formulae are given by

$$I^A_{it+1} = I^A_{it} * \left(1 + \sum \omega^A_{ijt} * \%\Delta E_{ijt+1}\right); \quad I^L_{it+1} = I^L_{it} * \left(1 + \sum \omega^L_{ijt} * \%\Delta E_{ijt+1}\right) \tag{4}$$

where I^A_{it+1} and I^A_{it+1} are the asset- and liability-weighted indices for country i, ω^A_{ijt} and ω^L_{ijt} are the asset and liability weights attached to currency j in period t and $\%\Delta E_{ijt+1}$ is the percentage change in the end-of-period nominal exchange between i and j during period $t+1$. Trade indices are made in the same manner using weights that add exports and imports together. Since our currency position data runs from 1990 to 2004, we can use these weights to create exchange rate indices for 1991 to 2005.

Our index is an 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.[15] It will move similarly to a portfolio that uses these weights to define shares of the portfolio.[16] 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 will 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.[17]

4.2 Net Indices and Valuation Effects

It is also useful to define aggregate net financial weights

$$\omega^F_{ijt} = \omega^A_{ijt} s^A_{it} - \omega^L_{ijt} s^L_{it} \tag{5}$$

where $s^A_{it} = A_{it}/(A_{it} + L_{it})$ and $s^L_{it} = L_{it}/(A_{it} + L_{it})$ are the shares of foreign assets and foreign liabilities in total cross-border holdings. These weights indicate the direction of the valuation impact of a movement in currency j. If the net foreign asset position is zero, 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.

We define the aggregate net financial index by[18]

$$I^F_{it+1} = I^F_{it} * \left(1 + \%\Delta I^A_{it+1} * s^A_{it} - \%\Delta I^L_{it+1} * s^L_{it}\right) \tag{6}$$

(The index could equivalently be written in the same form as the asset and liability

[15] 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. See Lane and Shambaugh (2007) for more details on the index method.

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

[17] 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. In our case, if the exchange rate for all countries were constant, and the weights change, our index is unchanged, 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.

[18] The index could equivalently be written in the same form as the asset and liability indices using the net financial weights.

indices using the net financial weights defined in equation (5).) This net financial exchange rate index is conceptually different from a trade-weighted index since it has currencies entering both positively and negatively. More importantly, the weights do not need to add up to one. In the extreme, if net positions and currency compositions are balanced, there is no movement in the index regardless of bilateral exchange rate movements. Thus, movements in this index can tell us about the impact of currency movements on the balance sheet, but it is not a typical exchange rate index.

In turn, this allows us to write

$$VAL^{XR}_{it+1} = \%\Delta I^{F}_{it+1} * IFI_{it} \tag{7}$$

where the superscript XR indicates currency-induced valuation changes and the gross scale of the international balance sheet is measured by $IFI_{it} = A_{it} + L_{it}$. Equation (7) highlights 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.

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 look at role played by financial-weighted exchange rate indices in driving the valuation component of the dynamics of net foreign asset positions. Finally, we explore the variation in aggregate foreign currency exposures across countries and over time.

5.1 Case Studies

It is useful to begin with some case studies. We show a selection of four countries in Figures 1a-1d. The most striking feature of Figure 1a is that the liability index for the United States is essentially flat, since (as is well established) the foreign-currency component in its external liabilities is very low. While the asset- and trade-weighted indices are qualitatively similar, Figure 1a also highlights that the asset-weighted index has depreciated more sharply than the trade-weighted index since 2001. This is consistent with the findings of Tille (2003) and others: the asset index gives a higher weight to European currencies (against which the dollar has fallen sharply), while the trade index places a substantial weighting on Asian countries that track the dollar, are important as trading partners but are not major destinations for US outward investment.

We show the Brazilian indices in Figure 1b as representative of the typical emerging market economy. While the asset, liability and trade indices show a high degree of co-movement, the liability index is substantially less volatile (especially in the latter part of the sample period), which reflects the importance of the domestic-currency component in total liabilities.

China and Benin present interesting contrasts in Figures 1c and 1d of countries that followed pegged exchange rate regimes during the sample period. The Chinese peg to the

dollar stabilized its financially-weighted indices but its trade index was quite volatile, since industrial countries that float against the dollar are important trading partners for China. In contrast, the trade index for Benin is much less volatile than its financial indices. As a member of the CFA zone that pegged to the French Franc during the 1990s (with a one-off step devaluation in 1994) and subsequently to the euro, Benin's exchange rate has been relatively stable against its major European and regional trading partners. In contrast, Benin has significant dollar financial liabilities and fluctuations in the euro-dollar rate map into volatile financial indices for Benin. Moreover, the sharp fluctuations in the franc/euro against the dollar has meant that Benin's trade and financial indices have moved in opposite directions for much of the post-1994 period.

In summary, the message from Figures 1a-1d is that there is a diverse range of patterns in the behavior of financially-weighted exchange rates, with the trade index not generally informative about the financial impact of currency movements.

5.2 Comparison of Exchange Rate Indices

We turn to a quantitative comparison of exchange rate indices in Tables 1 and 2. Tables 1 reports the the mean and median within-country correlation of the annual percentage changes in different indices as well as the mean within quartiles, while Table 2 reports the second moments. [19] 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). In relation to the correlations between the financial indices and the trade index, the mean and median correlations are high but there are many cases in which the correlations are much lower. In particular, the mean correlation between the asset-weighted and trade-weighted indices is only 0.60 for the first quartile of countries, while the correlation between the liability-weighted and the trade-weighted indices is only 0.52 for the first quartile.

Table 2 shows that the liability index is much more stable than the asset index, especially for industrial countries. 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.

We also examine a number of alternatives to the main indices. First, we examine an asset index that looks only at the debt portion of the balance sheet, and it behaves very similarly to the general asset index. We also examine only the foreign currency portion of the external portfolios. While a large domestic currency share of liabilities may stabilize that index, it is also interesting to see to what extent excluding those liabilities changes the

[19] This table, and many others, breaks countries into advanced, emerging, and developing groups. The advanced countries are the group typically known as industrialized 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.

index. We see from columns (5) of Table 1 that the impact is negligible. The direction of the index is not altered by including the domestic-currency portions of the balance sheet in the weights. Likewise, Table 2 shows the exclusion of domestic-currency components leads to more volatile indices, especially for the liabilities of industrial countries.

5.3 The Net Financial Index

The net financial index captures the directional sensitivity of the external balance sheet to currency movements. While a depreciation of the domestic currency against some currency j should over time improve net exports by raising exports and reducing imports, the valuation impact depends on whether the country is long or short in currency j and currency j's relative importance in the aggregate external portfolio.[20] Aggregating across all bilateral currency movements, a country will enjoy a valuation gain if there is an increase in its net financial index and a valuation loss if the net financial index falls. Accordingly, a country receives a double boost to its external position if it experiences a simultaneous improvement in its trade-weighted index (where an improvement means a depreciation) and in its net financial index, since both the current account and the valuation term will improve. In contrast, there will be an ambiguous response of the external position in the case of a country that sees its trade-weighted index and its net financial index move in opposite directions, since an improvement in the trade balance may be offset by the negative valuation impact. Accordingly, it is interesting to consider the comovement between these indices.

Figure 1 shows the cross-country distribution of this correlation. About 63 percent of countries show a negative correlation, with a cluster of countries concentrated near minus 1: these countries typically had very large depreciations at some point during the sample period, while maintaining negative foreign-currency positions. There is considerable heterogeneity even among the advanced economies (marked by their country abbreviation), even if most of these countries show a positive correlation. Table 3 shows a strongly negative average correlation between the net financial index and the trade-weighted index for emerging and developing economies. When compared to the results in Table 2, Table 3 also shows that net financial indices are far more stable than any other index for all types of countries.[21] This again represents 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.[22]

[20] Since a depreciation boosts net exports by both increasing exports and reducing imports, it is appropriate that the trade-weighted index sums across exports and imports. However, the financial impact of a depreciation is ambiguous since the boost to the domestic-currency value of foreign-currency assets may be offset by the increase in the domestic-currency value of foreign-currency liabilities. Accordingly, foreign-currency assets enter positively into the net financial index but foreign-currency liabilities enter negatively.

[21] We can also examine a foreign currency only net index. Just as the percentage change in the net index shows the change in the external balance sheet, the percentage change in a net foreign currency index would tell us about the change in the foreign currency portion of the balance sheet. The two will always move almost perfectly together because all movement comes from the foreign currency portion, but the overall net index's movements may be dampened by sizeable portions of domestic currency assets or liabilities. As Table 3 shows, the foreign currency only index is slightly more volatile, but the two are nearly indistinguishable.

[22] The pattern is the same if one instead examines the average absolute value of the percentage change of

5.4 Valuation Effects

As noted in section 4, the net financial index tells us the directional impact of currency movements on the external position, but to know the total impact on the economy, we need to combine this information with the scale of the international balance sheet. The total effect, VAL_{it}^{XR} becomes the object of interest. We consider three aspects of this term. First, the extent to which exchange rate based valuation effects drive the overall valuation term, the persistence of these terms, and finally the size.

All three results are shown in Table 4. We report indicators of the impact of the exchange rate on the overall valuation term. where VAL_{it} is the aggregate valuation term defined in equation (1) and VAL_{it}^{XR} is the currency valuation term defined in equation (7), with both scaled by GDP. Since VAL_{it}^{XR} and VAL_{it}^{MV} are not orthogonal, we cannot do a pure variance decomposition. Instead, we rely on a series of statistics that demonstrate the importance of VAL_{it}^{XR} for the overall valuation term. On the most basic level, Table 4 shows that the two are positively correlated: the mean and median within-country correlations are 0.46 and 0.51 respectively. The advanced sample has a weaker connection, but it is still positive. When VAL_{it}^{XR} moves, VAL_{it} tends to move in the same direction.

Next we show that VAL_{it}^{XR} has sufficient variance to be an important part of VAL_{it}. The mean country variance ratio is 0.47. Furthermore, the movements in VAL_{it}^{XR} are not simply offset by changes in VAL_{it}^{MV}. There is only a mildly negative correlation between VAL_{it}^{XR} and VAL_{it}^{MV} for the advanced countries, while the correlation is close to zero for the full sample and weakly positive for developing countries. In order to provide an additional quantitative measure of the comovement between the currency valuation term and the overall valuation term, Table 4 also reports the β and R^2 from a simple regression of VAL_{it} on VAL_{it}^{XR}. 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 $\beta = 0$. 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).

The results 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 related 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 0.2 and 0.6). The pattern is quite different for the advanced countries. While the currency valuation term is significant in the pooled sample, the explanatory power of the regression is much lower at $0.08-0.14$. The estimated $\hat{\beta}$ is also much lower at roughly 0.5, which again 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.

Panel B of the next table shows the size relative to GDP of a number of components. The first two columns demonstrate that these currency-induced wealth effects are non-trivial. The table shows means and medians across the sample. The 75th percentile of

the index instead of the standard deviation of the changes.

absolute movements in VAL_{it}^{XR} is 3.1 percent of GDP for advanced countries, 3.4 percent for emerging countries, and 4.9 percent for developing countries. These effects are sizable enough to dominate current account balances in some years and, depending on the market capitalization of a country, may rival the wealth effects of stock market booms and busts.[23] In addition, since these represent cross-border wealth transfers, these may matter more for the international transmission mechanism than price shifts that also cause large transfers across agents within an economy.

Importantly, these wealth shocks are not reversed quickly. Table 4 also shows the average within country autocorrelation coefficients for VAL_{it}^{XR} and VAL_{it} are nearly zero. Individual country coefficients are 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} are persistent, reinforcing the potential impact on the real economy.

As noted in section 2, we may also worry that VAL^{XR} is simply offsetting expected returns and the total financial impact on NFA (valuation plus investment income) is not materially affected by VAL^{XR}. Table 5 demonstrates that, while an important theoretical concern, this is not the empirically relevant scenario. Columns (1) through (5) examine the extent to which VAL^{XR} contributes to movements in the financial component FC that was defined in equation (2). We see very similar results to those in Table 4. VAL^{XR} has a significant share of the variance of the total financial component and VAL^{XR} and FC have a strongly positive correlation. Finally, bivariate regressions yield similar results to those in Table 4. This is not to argue that $NETINVINC$ is unimportant in the balance of payments, since panel B shows its size is not trivial (an average share of GDP of 2-3 percent). Rather, $NETINVINC$ is not particularly variable and its variance explains little of the overall financial components variance. Thus, net investment income cannot be offsetting the swings in VAL^{XR} or VAL. In addition, it has a weakly positive correlation with VAL^{XR}. Thus, we see that the valuation term is fairly sizeable and, while shifts in market asset prices explain some of its movements, shifts in currencies explain an important part of the overall financial impact on the NFA position.

5.5 Aggregate Foreign-Currency Exposure

It is useful to develop a measure of aggregate foreign-currency exposure, which captures the sensitivity of a country to a uniform movement of its domestic currency against all foreign currencies. We define aggregate foreign currency exposure at the end of period t by

$$FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L} \tag{8}$$

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

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

foreign currencies. In turn, the net impact of a uniform shift in the value of the domestic currency against all foreign currencies is given by

$$NETFX_{it} = FX_{it}^{AGG} * IFI_{it} \tag{9}$$

Figure 3 and Table 6 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 -23 percent. Roughly 25 percent have below -50 percent weight, leaving them with a considerable short position in foreign currencies. On the other hand, industrial countries are 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 the end of 2004, 19 percent more of the sample had taken a positive position against the rest of the world. The mean and median position have both moved close to zero (-3 percent) and less than 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.

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 (new number) shows 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.[24]

The middle portion of Table 6 shows the shift in financial globalization over the sample period. In general, the external balance sheet as a share of GDP has gone up 60 percent, but this growth has not been evenly distributed. The IFI ratio for advanced countries is up over 200 percent (for EMU countries, even more). The scale of financial globalization for emerging markets has gone up 60 percent, but developing countries have actually receded from the global financial system on average, with a small decline in the size of their external balance sheets.

[24] 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 percent), and the euro (28 percent) along with 16 other currencies which are the largest long position for somewhere between 1 and 3 other countries. The more minor currencies become important due to a large FDI holding in the country and no off-setting liabilities in that currency. Thus, even countries with roughly balanced net positions tend to have considerable exposure to movements across bilateral rates.

The bottom half of Table 6 puts these two features together to show 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 positions has increased even more by this measure. While many industrial countries have not shifted FX_{it}^{AGG} dramatically, their scale of financial globalization (IFI) has increased considerably, so their overall net long exposure against 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. During the recent appreciation of the euro against the dollar, euro area countries long the dollar have faced steep losses.

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 changing the share of assets relative to liabilities in IFI (s_{it}^{A}), or changing the foreign currency weight of liabilities (ω_{ijt}^{L}) or assets (ω_{ijt}^{A}). Table 7 shows the driving factors underlying the changes in FX_{it}^{AGG}. [25] There is a considerable range of behavior of FX_{it}^{AGG} over the decade. To understand why positions have changed we can divide the sample into quartiles by the extent that FX_{it}^{AGG} has changed (Panel A of Table 7). While the lowest quartile sees a small decline in FX_{it}^{AGG}, the top quartile has increased on average 47 percentage points in the measure.

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, 15 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. Most countries see no change in (ω_{ijt}^{A}) as nearly all foreign assets are in foreign currency for most countries.

The drop in the foreign currency component of assets simultaneously with liabilities is largely an EMU phenomenon. We can see this better by examining the decomposition across country types in the bottom part of Table 7. 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 41 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.[26]

Columns (5)-(8) show 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

[25] See Lane and Shambaugh (2008) on the determinants of aggregate foreign-currency exposures.

[26] 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, 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 reduced the foreign currency share of assets and liabilities simultaneously, the impact of the liabilities is bigger.

in local currency, so increasing their share of liabilities will lower the foreign currency component of liabilities. Panel A 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.

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 for all quartiles increases in reserves contributed to the increase in 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 behavior 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.

6 Conclusions

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 data set 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 domestic-currency categories (such as portfolio equity and FDI). In addition, many countries (especially the advanced economies) have increased gross international positions so much that, even with relatively balanced net positions, they still may experience 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 sizable 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. Our findings highlight the importance of modelling the dual role of exchange rates in the international adjustment process: the financially-weighted exchange rate index operates through the valuation channel, while the trade-weighted index influences net exports. Accordingly, the inclusion of

the valuation channel in our models may enhance our understanding of domestic macroeconomic performance and the optimal design of macroeconomic policies for open economies.

Data Appendix

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.

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.

Portfolio Equity

The CPIS data set 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 data set, we employ a gravity-based model of bilateral equity holdings to construct estimated positions in these cases.[27]

Our approach relies on two key assumptions. First, we assume that equity issued by a country is denominated in the currency of that 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.[28] (See also the discussion in section 2 regarding the lack of correlation between returns and exchange rate changes).

[27] See Lane and Milesi-Ferretti (2008), 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.

[28] 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.

Second, following Lane and Milesi-Ferretti (2008), we eliminate holdings listed in offshore financial centers. Countries report very large holdings in these offshore centers (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 centers eventually wind up in the same pattern as those that go directly to other countries. After eliminating offshore centers, we are left with 50 reporting countries and 180 hosts.[29]

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 (2008) by running a bilateral equity holding regression of the form

$$\log(1 + EQ_{ijt}) = \phi_j + \theta_t + \beta Z_{ijt} + \gamma X_{it} + \varepsilon_{ijt} \tag{10}$$

where ϕ_j represent 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.[30] 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.[31] This regression has 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.[32]

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 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.

[29] We follow Lane and Milesi-Ferretti (2008) and primarily use the IMF Background Paper, "Offshore Financial Centers" (2000), as our guide to labelling countries as offshore centers.

[30] Geography and other gravity model controls come from the CEPII geography database. GDP data is from the World Bank WDI database.

[31] While Lane and Milesi-Ferretti (2008) 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 including trade. Since there are many missing observations for the trade data, we do not include it.

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

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-a-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.[33]

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.

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 has released the currency 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

[33] For a small number of countries we rely on flow data to create a general pattern because the stock data is 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 dollars) and the data appear incomplete, we drop FDI from total assets and rescale remaining assets.

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. [34] This dataset contains information on the currency denomination of international bonds for 113 issuing countries.[35] 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 na ïve 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 European Central Bank data suggests that investors from the euro area hold 66 percent of the euro-denominated debt issued by other countries (European Central Bank 2005).[36] Accordingly, we adjust the currency weights derived from the BIS data to take into account the portfolio choices by 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.[37]

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

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

[35] Where the BIS data set 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 BIS data make up a small fraction of internationally held debt assets. Our dataset focuses on international bond issues - while foreign investors have become active in the domestic bonds markets of developing countries in very recent years, the international bond issues are more important for the vast bulk of our sample period.

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

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

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.[38] 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.[39]

For individual members of the euro area, our procedure is as follows. First, we sum across the euro area members to get 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 is 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.

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 banks residents in twenty reporter countries vis-à -vis a large number of counterpart countries over 1977-2005 (on a locational basis).[40][41][42][43]The reporters are the dominant banking centers and, despite the small number, capture the bulk of world bank holdings. When looking at the reporters' assets, 72 to 90 percent of them are in other reporter countries. Furthermore, Turkey, the

[38] 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.

[39] 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.

[40] 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).

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

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

[43] 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.

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 this tells 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 its banking system. If we assume that this proportion is representative for the claims of foreign banks in that 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 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 the 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 twenty reporters, these include all the major banking centers so that this approach should yield plausible estimates of the currency composition of the foreign non-portfolio debt assets of the non-reporting countries.

Reserves

The IMF tracks the currency composition of reserves for its member countries, in its COFER (Currency Composition of Official Foreign Exchange Reserves) database.[44] However, for confidentiality reasons, the only reported COFER data are for major aggregates (world, industrial country group, developing country group). However, the country-level data have been used on a few occasions in research by IMF-affiliated economists to analyze 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 this paper, the authors run separate regressions by currency to predict the share of reserves held in that currency. The independent variables are trade shares with major currency countries, share

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

of debt denominated in these currencies, and exchange rate regime relations with these countries. [45] 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 US. 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 DM (euro after 1999), the Swiss Franc, the Yen, and the Pound). Once we have predicted values for each currency, we impose an adding up constraint and re-normalize 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 countries' total reserves 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 reserves holdings over time. [46]

We merge this generated data with actual data on reserves for 2000-2004 for twenty 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 (US, Canada, UK) and blend our model generated data with 2000 actual data where in 1999 we weigh the actual data .9 and the model data .1, for 1998 it is .8, .2, etc. In practice our estimates were close tot he 2000-4 actual data, so a variety of blending techniques yielded nearly identical results and our model generated estimates for 2000-4 were quite similar to the actual numbers for most of the twenty 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 reserves 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) reserves

[45] 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 Mthieson.

[46] To make the adjustment, we increase (decrease) the constants used to make the predicted values for each currency by the amount that currency is under (over) predicted 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.

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 reserves in our calculations. China, who 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 euro in our work; Latin American countries tend to hold mostly dollars, Asian countries hold largely dollars with some yen and euro as well, and all these figures seem to mesh reasonably well with the scattered media reports on the subject.

Second, Ewe-Hhee Lim (2006) studies the changing international role of the euro and dollar and gives 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 neighboring 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.

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.

Portfolio Equity

Consistent with our treatment on the assets 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 is 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.

Direct Investment

Direct investment liabilities are assumed to be denominated in the currency of the host country.[47]

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 percent 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).[48]

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 twenty reporting countries, we know 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 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.

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[47] 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.

[48] 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.

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Table 1: Correlations of Exchange Rate Indices

Quartile		(A, L)	(A, T)	(L, T)	(A, A^D)	(L, L^{FC})
1	Mean	0.85	0.60	0.52	0.98	0.95
2	Mean	0.97	0.88	0.83	1.00	0.99
3	Mean	0.99	0.96	0.94	1.00	1.00
4	Mean	1.00	0.99	0.99	1.00	1.00
All	Mean	0.95	0.86	0.82	0.99	0.99
	Median	0.98	0.92	0.90	1.00	1.00
Advanced	Mean	0.97	0.90	0.85	0.99	0.95
	Median	0.98	0.91	0.84	0.99	0.95
Emerging	Mean	0.93	0.89	0.86	0.99	0.99
	Median	0.98	0.97	0.94	1.00	1.00
Developing	Mean	0.96	0.83	0.79	1.00	0.99
	Median	0.99	0.92	0.91	1.00	1.00

Means and medians of within country correlations between the percentage change in exchange rate indices, annual data over 1991-2005. Full sample of countries. A, L, T denote asset-, liability- and trade-weighted indices; A^D is the debt-only asset-weighted index, while L^{FC} is the liability index based only on the foreign-currency component.

Table 2: Volatility of Exchange Rate Indices

		A	L	T	A^D	L^{FC}
All	Mean (s.d.)	0.173	0.132	0.152	0.175	0.181
	Median (s.d.)	0.102	0.076	0.091	0.105	0.121
Advanced	Mean (s.d.)	0.065	0.044	0.055	0.066	0.089
	Median (s.d.)	0.064	0.039	0.056	0.069	0.087
Emerging	Mean (s.d.)	0.182	0.133	0.167	0.186	0.189
	Median (s.d.)	0.132	0.082	0.115	0.134	0.136
Developing	Mean (s.d.)	0.206	0.162	0.179	0.207	0.209
	Median (s.d.)	0.152	0.115	0.128	0.152	0.154

Means and medians of within country standard deviation of annual changes in exchange rate indices over 1991-2005, full sample of countries. A, L, T denote asset-, liability- and trade-weighted indices; A^D is the debt-only asset-weighted index, while L^{FC} is the liability index based only on the foreign-currency component.

Table 3: Properties of Net Financial Indices

		Correlations		Volatility	
		(N, T)	(N, N^{FC})	$s.d.(N)$	$s.d.(N^{FC})$
All	Mean	-0.26	0.99	0.067	0.080
	Median	-0.61	1.00	0.027	0.044
Advanced	Mean	0.40	0.97	0.014	0.024
	Median	0.73	1.00	0.012	0.023
Emerging	Mean	-0.14	1.00	0.046	0.055
	Median	-0.27	1.00	0.030	0.035
Developing	Mean	-0.54	1.00	0.095	0.110
	Median	-0.83	1.00	0.067	0.080

N denotes net financial index, T the trade-weighted index and N^{FC} the net index based on only the foreign-currency components of foreign asset and liability positions. Means and medians of within country correlations between annual %changes in exchange rate indices and standard deviations of the annual %changes. Period 1991-2005.

Table 4: Relation between VAL^{XR} and VAL

		$VR_{VAL}^{VAL^{XR}}$	(β, R^2)	$\rho_{VAL}^{VAL^{XR}}$	$\rho_{VAL^{MV}}^{VAL^{XR}}$	δ_{VAL}	$\delta_{VAL^{XR}}$
All	Mean	0.47	(0.78,0.38)	0.46	-0.05	0.03	0.10
	Median	0.29	(0.83,0.29)	0.51	-0.09	0.00	0.10
Advanced	Mean	0.39	(0.54,0.14)	0.28	-0.24	0.00	0.11
	Median	0.24	(0.43,0.08)	0.29	-0.26	-0.08	0.09
Emerging	Mean	0.47	(0.64,0.34)	0.42	-0.12	-0.02	0.08
	Median	0.32	(0.80,0.18)	0.43	-0.15	0.01	0.05
Developing	Mean	0.50	(0.93,0.48)	0.55	0.04	0.06	0.10
	Median	0.34	(1.07,0.53)	0.73	0.15	0.00	0.12

Note: VR denotes variance ratio, β and R^2 are statistics from a simple regression of VAL on a constant andd VAL^{XR}, $\rho(,)$ denotes correlation, δ denotes autocorrelation coefficient. Statistics are means and medians of within country calculations.

Table 5: Relation between VAL^{XR} and FC

Panel A

		$VR_{FC}^{VAL^{XR}}$	VR_{FC}^{INC}	(β, R^2)	$\rho_{FC}^{VAL^{XR}}$	$\rho_{INC}^{VAL^{XR}}$	δ_{FC}	δ_{INC}
All	Mean	0.46	0.03	(0.88,0.40)	0.47	0.12	-0.08	0.56
	Median	0.26	0.02	(0.9,0.29)	0.53	0.15	0.00	0.67
Advanced	Mean	0.40	0.03	(0.7,0.18)	0.30	0.12	-0.03	0.67
	Median	0.23	0.02	(0.51,0.11)	0.29	0.20	-0.07	0.79
Emerging	Mean	0.45	0.04	(0.68,0.34)	0.40	0.12	-0.03	0.61
	Median	0.30	0.02	(0.79,0.15)	0.37	0.14	0.00	0.73
Developing	Mean	0.49	0.03	(1.04,0.5)	0.57	0.13	-0.11	0.49
	Median	0.29	0.01	(1.10,0.55)	0.74	0.12	0.01	0.50

Note: VR denotes variance ratio, β and R^2 are statistics from a simple regression of FC on a constant andd VAL^{XR}, $\rho(,)$ denotes correlation, δ denotes autocorrelation coefficient. FC denotes financial component of change in net foreign asset position and INC denotes net investment income. Statistics are means and medians of within country calculations.

Panel B

		VAL	VAL^{XR}	VAL^{MV}	INC	FCO	FC
All	Mean	8.24	4.71	6.23	3.12	7.19	9.53
	Median	3.87	1.53	3.52	2.16	4.38	5.03
Advanced	Mean	5.32	2.54	5.28	2.59	6.02	6.18
	Median	3.03	1.31	2.55	1.49	3.44	3.65
Emerging	Mean	5.69	3.17	4.53	2.45	5.70	7.13
	Median	2.80	1.10	2.68	2.12	3.97	4.66
Developing	Mean	10.57	6.26	7.40	3.66	8.41	12.08
	Median	5.26	2.03	4.47	2.55	5.09	6.43

Note: Size of various components as a share of GDP. $FCO = INC + VAL^{MV}$.

Table 6: Aggregate Foreign Currency Exposure

	1994		2004	
	Mean	Median	Mean	Median
		FX^{AGG}		
All	-0.23	-0.26	-0.03	-0.03
Advanced	0.04	0.08	0.12	0.09
Emerging	-0.09	-0.01	0.06	0.05
Developing	-0.41	-0.45	-0.14	-0.22
		IFI		
All	151.3	112.3	227.9	147.4
Advanced	186.3	145.8	471.0	377.9
Emerging	138.6	79.3	214.6	132.0
Developing	143.3	125.8	132.2	122.1
		$NETFX$		
All	-0.27	-0.25	0.11	-0.03
Advanced	0.17	0.08	0.53	0.37
Emerging	0.06	-0.01	0.41	0.04
Developing	-0.63	-0.45	-0.22	-0.22

Note: $FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L}$. $NETFX_{it} = FX_{it}^{AGG} * IFI_{it}$. Sample includes the 102 countries with data from 1994 to 2004. Statistics are means and medians of within country calculations.

Table 7: Decomposition of Shift in Aggregate Foreign Currency Exposure 1994-2004

Quartile	ΔFX^{AGG}	Δs_{it}^{A}	$\Delta \omega_{it}^{A}$	$\Delta \omega_{it}^{L}$	ΔRes $/\Delta A$	ΔNFA^{priv} $/GDP$	$\Delta(\lambda_{Lit}^{PEQ}$ $+\lambda_{Lit}^{FDI})$	$\Delta DebtL^{FC}$
1	-0.08	-0.05	-0.15	-0.15	0.37	-0.13	0.07	-0.14
2	0.12	0.04	-0.06	-0.12	0.27	0.11	0.06	-0.08
3	0.25	0.06	0.01	-0.21	0.45	0.07	0.22	-0.01
4	0.47	0.15	-0.02	-0.29	0.54	0.41	0.28	-0.03
All	0.193	0.05	-0.05	-0.20	0.41	0.12	0.16	-0.06
Advanced	0.075	0.04	-0.25	-0.24	0.02	0.05	0.06	-0.27
EMU	-0.006	0.01	-0.52	-0.41	-0.02	-0.01	0.05	-0.54
Non-EMU	0.156	0.07	0.02	-0.07	0.07	0.10	0.08	-0.01
Emerging	0.150	0.02	-0.0003	-0.19	0.40	-0.07	0.19	-0.01
Developing	0.267	0.07	0.0000	-0.18	0.58	0.25	0.18	0.00

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. $\Delta Res/\Delta A$ 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. Statistics are means of within country calculations.

Figure 1a-d: Examples of indices

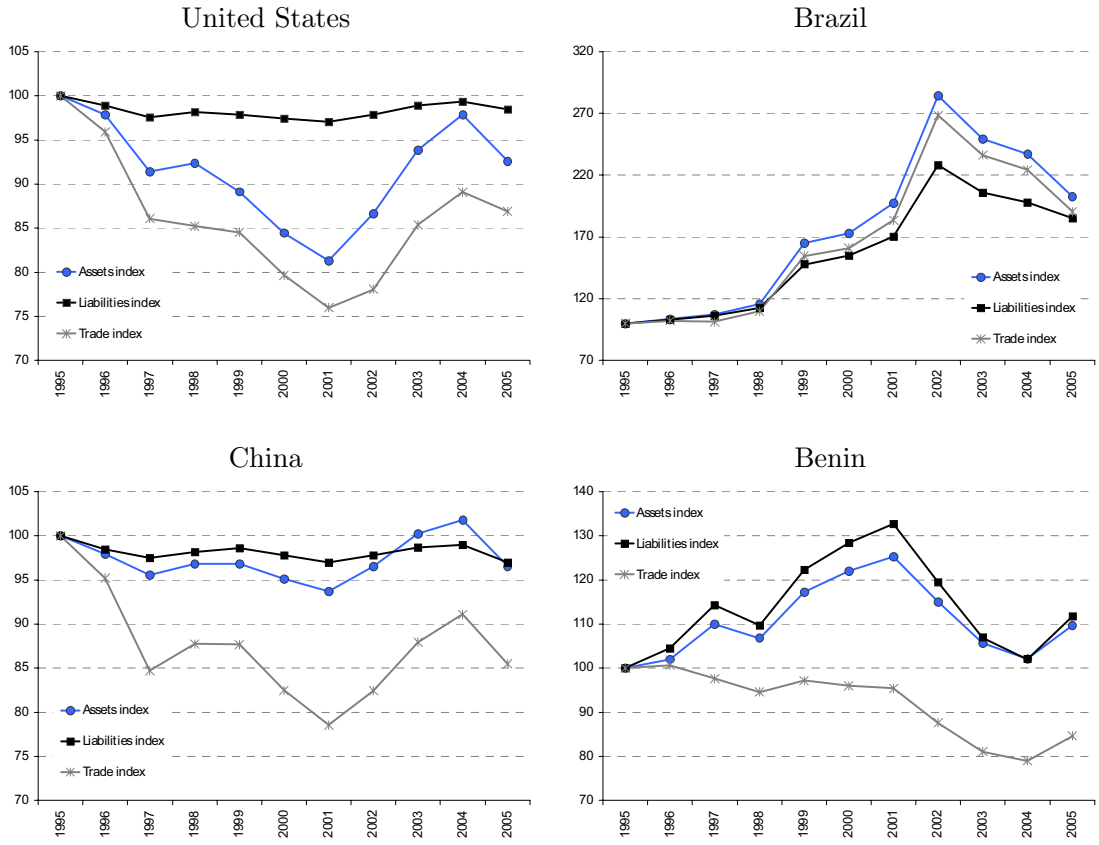


Figure 2: Distribution of Correlation between Net Financial and Trade-Weighted Exchange Rate Indices: All Countries.

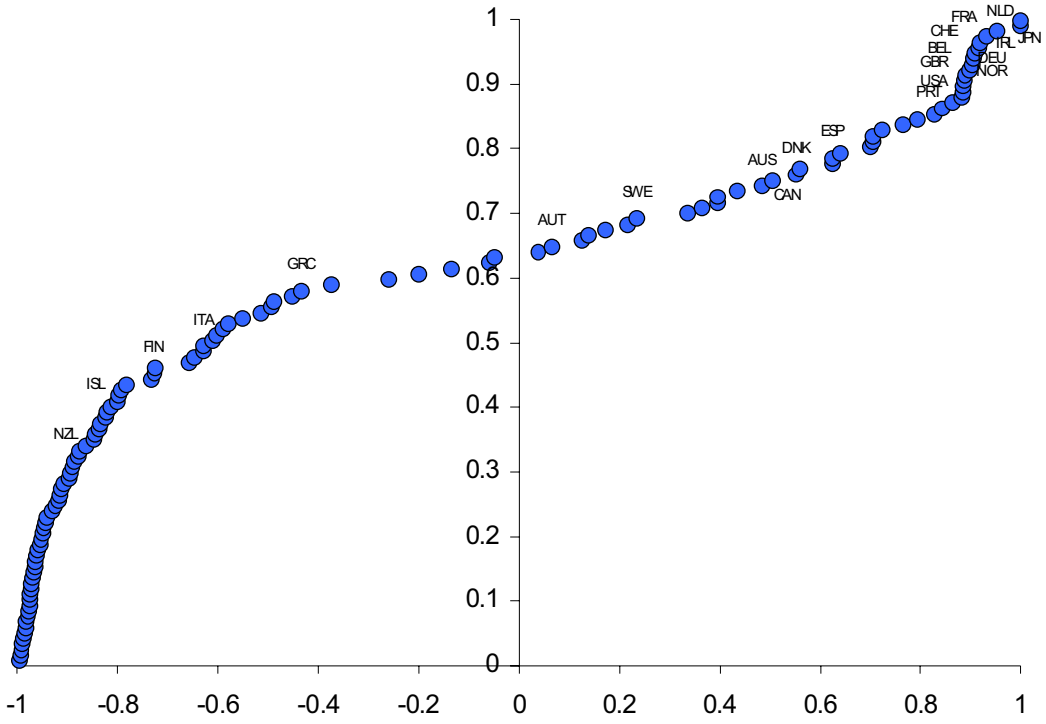
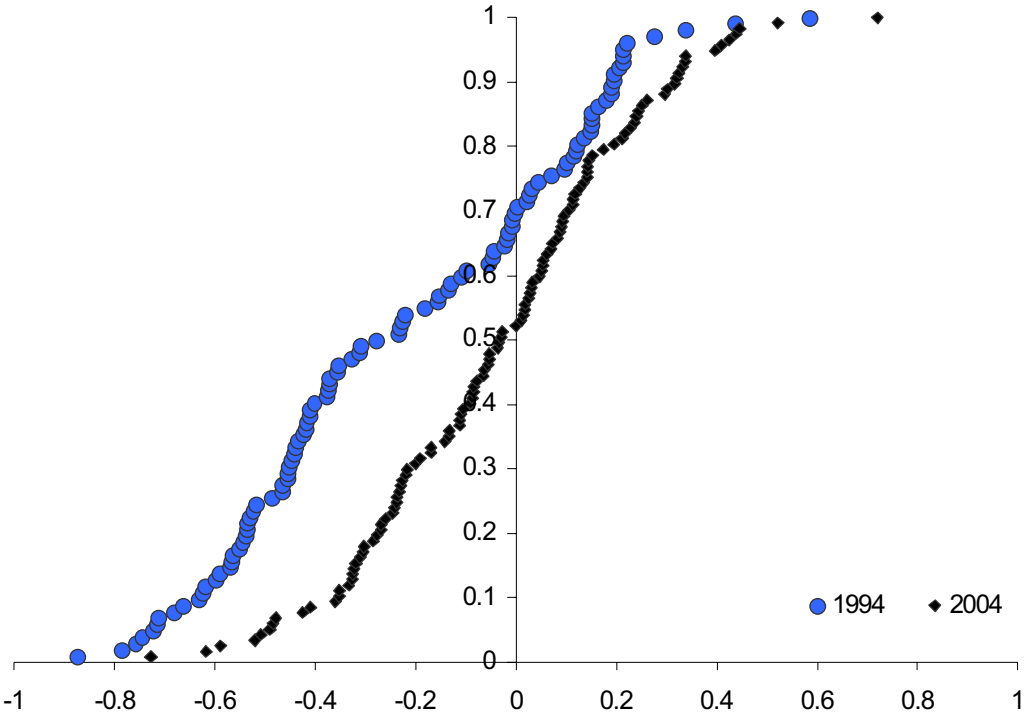


Figure 3: Distribution of Aggregate Foreign Currency Exposures, 1994 and 2004.



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