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# The Long or Short of it: Determinants of Foreign Currency Exposure in External Balance Sheets \*

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## Abstract

A major focus of the recent literature on the determination of optimal portfolios in open-economy macroeconomic models has been on the role of currency movements in determining portfolio returns that may hedge various macroeconomic shocks. However, there is little empirical evidence on the foreign currency exposures that are embedded in international balance sheets. Using a new database, we provide stylized facts concerning the cross-country and time-series variation in aggregate foreign currency exposure and its various subcomponents. In panel estimation, we find that richer, more open economies take longer foreign-currency positions. In addition, we find that an increase in the propensity for a currency to depreciate during bad times is associated with a longer position in foreign currencies, providing a hedge against domestic output fluctuations. We view these new stylized facts as informative in their own right and also potentially useful to the burgeoning theoretical literature on the macroeconomics of international portfolios.

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## 1 Introduction

The rapid expansion of gross cross-border investment positions has stimulated a new wave of interest in the international balance sheet implications of currency movements. At the same time, recent advances in macroeconomic theory have provided a more nuanced consideration of the general equilibrium characteristics of the portfolio allocation problem than was attained in the earlier wave of “portfolio balance” models (see, amongst others, Devereux and Sutherland 2009a, Devereux and Sutherland 2009b, Tille and van Wincoop 2007 and Engel and Matsumoto 2009). A major concern of this new research programme has been to identify the appropriate currency exposure of optimal portfolios.

However, this literature has been constrained by a lack of empirical evidence concerning the currency exposures that are present in the international balance sheet. In recent work (Lane and Shambaugh 2009), we have compiled and described the currency composition of foreign asset and liability positions for a broad set of countries over 1990-2004. In that work, we established that the currency profiles of international portfolios show tremendous variation, both across countries and over time.

Accordingly, our goal in this paper is to synthesize two recent advances in the literature — the expansion of knowledge concerning the data on the currency composition of cross-border portfolios and the advances in theory regarding those positions — to study the cross-country and cross-time variation in aggregate foreign currency exposure. We pursue two broad lines of analysis. First, we provide a decomposition of aggregate foreign currency exposure into its constituent elements. This is important, since much of the theoretical literature has focused on particular dimensions of foreign-currency exposure, whereas the valuation impact of currency movements depends on the aggregate foreign currency position. Second, we conduct a panel analysis of variation in foreign currency exposure in order to identify which country characteristics help to explain the cross-sectional and time-series variation in the level of foreign currency exposure.

In the decomposition, we divide aggregate foreign-currency exposure into two primary subcomponents: the net foreign asset position and the level of foreign currency exposure embedded in a zero net foreign asset position. While some models focus on the latter component, the data suggest that the net foreign asset position is the most important determinant of aggregate foreign currency exposure. In addition, the decomposition shows that the structure of foreign liabilities (across portfolio equity, direct investment, local-currency debt and foreign-currency debt) is a key determinant of foreign currency exposure, with the equity share in liabilities more important than the currency composition of foreign

debt liabilities. These findings point to the importance of analyzing the full set of foreign-currency assets and liabilities, rather than focusing on a particular subcomponent of the data.

We next analyze the panel variation in foreign currency exposures. We find that factors such as trade openness and the level of development help to explain the cross-sectional variation in foreign currency exposure: richer, more open economies take longer positions in foreign currency. This means these countries experience gains when their currency depreciates and losses when it appreciates. Once the cross-sectional variation is eliminated by including a set of country fixed effects in the estimation, we find support for a key general prediction of the theoretical literature: an increase in the propensity for a currency to depreciate during bad times is associated with a longer position in foreign currencies, which acts as a hedge against domestic output fluctuations. Our final contribution is to show that there is substantial heterogeneity in the roles of each regressor in explaining the variation in individual subcomponents of foreign-currency exposure: accordingly, it is important to take a broad perspective rather than examining individual components in isolation.

The structure of the rest of the paper is as follows. Section 2 lays out the conceptual framework for the study, while Section 3 briefly describes our dataset. The analysis of the decomposition of foreign-currency exposure into its constituent elements is presented in Section 4, with the main econometric analysis reported in Section 5. Section 6 provides a summary of the main stylized facts established by our analysis and final conclusions are offered in Section 7.

## 2 Analytical Issues

### 2.1 Conceptual Framework

The role played by nominal exchange rate fluctuations in determining the payoffs to cross-border holdings and the pattern of international risk sharing has long been recognised. In what follows, we present a simple framework (adapted from Davis et al 2001) to guide our thinking in terms of the role of currency exposure in determining the composition of portfolios.

Consider a two-period small open economy model. The endowment of the home agent in period 1 is fixed at  $y_1$  but her period-2 endowment  $y_2$  is stochastic. In particular, the process for output is

$$y_2 = \bar{y} + \beta_y S + \varepsilon \quad (1)$$

where  $S$  is the period-2 rate of exchange rate depreciation,  $\beta_y$  is the beta from a regression of  $y_2$  on  $S$  and  $\varepsilon$  is the orthogonal stochastic component.

Consumption only takes place in the second period. There are two assets: a domestic-currency asset  $D$  which offers a fixed gross return  $R_D = \bar{R}$  and a foreign-currency asset  $F$ . The domestic-currency return on the foreign asset is

$$R_F = \alpha_F + \beta_F S + v \quad (2)$$

where  $\beta_F$  is the beta from a regression of  $R_F$  on  $S$  and  $v$  is the orthogonal stochastic component. With this setup, we can derive the equilibrium holdings of  $F$  as a function of  $\beta_y$ ,  $\beta_F$  and other factors.

The agent maximises utility over

$$U(c_2) = \left( \frac{1}{1 + \delta} \right) \left( \frac{-1}{A} \right) E \exp[-Ac_2] \quad (3)$$

where  $\delta$  is the discount rate,  $A$  is the coefficient of absolute risk aversion and the level of period-2 consumption is

$$c_2 = y_2 + (\omega_D R_D + \omega_F R_F) \quad (4)$$

where  $\omega_D, \omega_F$  are the domestic and foreign portfolio allocations respectively. The joint normality of  $y_2$  and  $R_F$  means that we can write the optimality condition as

$$ACov(c_2, R_F) = E(R_F) - R_D = RP \quad (5)$$

where  $RP$  is the risk premium. That is, the agent chooses portfolio allocations such that any remaining volatility in consumption that is correlated with the volatility in  $R_F$  is compensated through the risk premium.

With an optimal portfolio allocation, we can write consumption in the format equilibrium consumption can be written as

$$c_2 = \alpha + \beta_c R_F + \zeta \quad (6)$$

where  $\beta_c = RP/[AV(R_F)]$  is the agent's *desired exposure* to the foreign-currency asset and  $V(R_F)$  is the variance of the return on the foreign-currency asset. If the foreign-currency asset offers a risk premium, the agent will want some positive exposure to the foreign-currency asset; if the risk premium is zero, the agent will desire to have a consumption profile that has zero foreign-currency risk.

The agent's *endowed exposure* to the foreign-currency asset is  $\beta_y$ . Accordingly, the optimal portfolio allocation to the foreign-currency asset is

$$\omega_F = \beta_c - \beta_y \quad (7)$$

$$\omega_F = \frac{RP}{AV(R_F)} - \frac{Cov(y_2, S)}{V(S)} \quad (8)$$

Accordingly, the optimal portfolio foreign-currency position is increasing in the risk premium offered on the foreign-currency asset and declining in the volatility of the exchange rate and the degree of absolute risk aversion  $A$ . Importantly, it is decreasing in the covariance between the exchange rate and domestic output. If this covariance is negative (such that the currency depreciates when the domestic endowment is low), then the optimal portfolio share is positive even if the risk premium is zero. In contrast, even if the risk premium is positive, the optimal portfolio foreign-currency position can be negative if the covariance term is sufficiently positive (that is, the currency depreciates when the domestic endowment is high).

While we have analysed the determinants of foreign-currency exposure in a highly-stylized environment, similar themes have been explored in the new wave of macro-finance models in which cross-border portfolio positions are endogenously determined. In particular, several recent contributions have also emphasised the potential role played by nominal assets and liabilities in contributing to international risk sharing.

The mechanism varies across models. For instance, Devereux and Saito (2007) consider a single-good flexible-price world economy in which home and foreign countries are subject to shocks to endowments and inflation. If it is assumed that the covariance between productivity and inflation is negative (as is empirically the case), a striking result is that complete risk sharing can be achieved if asset trade is restricted to home and foreign nominal bonds. Since the return on nominal bonds is procyclical in this setting, risk sharing is accomplished by the home country taking a long position in the foreign currency bond and a short position in the domestic currency bond — the portfolio payoff will be high when the home endowment is low.

A similar result is obtained by Devereux and Sutherland (2009a) who consider independent shocks to output and money stocks. In their symmetric model, domestic residents hold a long position in foreign-currency bonds (financed by an opposite position in domestic-currency bonds). The long position in foreign currency is increasing in the relative importance of endowment shocks versus monetary shocks and also increasing in the persistence of the endowment shock. The intuition is that nominal bonds are better able to deliver risk sharing, the less important are monetary shocks (Kim 2002 also makes this

point). Moreover, the importance of risk sharing (and hence the gross scale of positions) is increasing in the volatility and persistence of output shocks.

An alternative account is provided by Engel and Matsumoto (2009) who provide an illustrative model featuring a one-period horizon, sticky prices and home bias in consumption. Sticky prices mean that hedging nominal exchange rate movements offers protection against shifts in the real exchange rate and the terms of trade and a simple foreign-exchange forward position (achievable through holding a long-short portfolio in foreign-currency and domestic-currency bonds) can deliver full risk sharing, making trade in equities redundant.<sup>1</sup> In their baseline model, a portfolio position that delivers a payoff that is proportional to the nominal exchange rate achieves full risk sharing. It is noteworthy that the optimal strategy in this model is to go short in foreign currency. Consistent with our stylized model, the short position is driven by the covariance between the exchange rate and output which is positive here: the exchange rate depreciates during productivity-driven output expansions (there are no nontradables in this model).

The overall message from this line of research is that a portfolio exhibiting exposure to exchange rate movements can play a role in contributing to international risk sharing. A country will wish to go long on foreign currency if the value of the domestic currency tends to positively co-move with domestic output but may wish to go short if the covariance has the opposite sign.<sup>2</sup> Moreover, nominal currency positions are more useful, the less volatile are monetary shocks. Finally, the gross scale of positions is increasing in the importance of sharing risk - that is, the more volatile and persistent are wealth shocks.

## 2.2 Moving from Theory to Empirics

In terms of empirical approach, we follow Lane and Shambaugh (2009) in defining aggregate foreign currency exposure by

$$FX_{it}^{AGG} = \omega_{it}^A * \left( \frac{A_{it}}{A_{it} + L_{it}} \right) - \omega_{it}^L * \left( \frac{L_{it}}{A_{it} + L_{it}} \right) \quad (9)$$

where  $\omega_{it}^A$  is the share of foreign assets denominated in foreign currencies, and  $\omega_{it}^L$  is defined analogously.  $FX_{it}^{AGG}$  lies in the range  $(-1, 1)$  where the lower bound corresponds to a

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<sup>1</sup>In an infinite horizon model with price adjustment, these authors show that trade in equities is also required to deliver full risk sharing. However, even in that case, only limited equity trade may be required in view of the stabilizing properties of foreign-currency hedges.

<sup>2</sup>As is emphasised by Pavlova and Rigobon (2007), the pattern of comovement between the exchange rate and domestic output will depend on the relative importance of ‘demand’ and ‘supply’ shocks. Accordingly, the covariance may shift over time. We return to this point in our empirical work.

country that has no foreign-currency assets and all its foreign liabilities are denominated in foreign currencies, while the upper bound is hit by a country that has only foreign-currency assets and no foreign-currency liabilities. Accordingly,  $FX^{AGG}$  captures the sensitivity of a country's portfolio to a uniform currency movement by which the home currency moves proportionally against all foreign currencies. This measure explicitly examines the financial or balance sheet currency exposure; the real side impact of currency movements on trade flows is not considered here.

In developing an empirical specification, we rely on an adapted version of the basic specification in equation (??). According to equation (??), the foreign-currency portfolio position should depend on the covariance between output and the exchange rate and the volatility of the exchange rate.<sup>3</sup> Both of these variables enter the baseline empirical specification. In addition, we control for the volatility of domestic and foreign inflation rates, in order to differentiate between volatility in the real exchange rate and volatility in nominal price levels. Moreover, nominal volatility at home plausibly limits the ability of domestic residents to issue domestic-currency assets to foreign investors, while nominal volatility overseas reduces the willingness of domestic investors to hold foreign-currency bonds. (The foreign (global) inflation rate is absorbed in the time dummy in the regressions.)

Next, we include two additional factors. First, we also include trade openness as an additional regressor, since the value of foreign assets in a portfolio is increasing in a country's propensity to consume imports (Obstfeld and Rogoff 2001). Second, we control for the volatility of output, since the importance of international risk sharing may be greater, the more volatile is the domestic economy (as in several of the models outlined in the preceding discussion).

Accordingly, we arrive at the baseline empirical specification by which the desired net foreign-currency exposure of country  $i$ 's balance sheet may be expressed as:

$$\begin{aligned}
 FX_{it}^{AGG*} = & \alpha + \phi_t + \gamma * COV(Y_{it}, E_{it}) - \varphi_H * VOL(\pi_{it}) - \varphi_F * VOL(E_{it}) \\
 & + \rho * OPEN_{it} + \beta * VOL(Y_{it}) + \varepsilon_{it}
 \end{aligned}
 \tag{10}$$

where  $Y_i$  is GDP growth,  $E_i$  is the nominal exchange rate,  $\pi_i$  is domestic inflation and  $OPEN_i$  is the level of trade openness.

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<sup>3</sup>The approach is partial equilibrium in nature, especially since we do not model the process for the exchange rate. While this is a limitation, it is also well understood that we do not have good models that successfully explain a high proportion of exchange rate variation.



However, a host of factors may inhibit a country's ability to attain its desired net foreign-currency position. The capacity to issue domestic-currency liabilities (whether domestic-currency debt or equity instruments) is limited by a poor-quality domestic institutional environment, especially in relation to the treatment of foreign investors. On the other side, the ability to acquire foreign-currency assets may be limited by capital controls, regulatory prohibitions on institutional investors, or simply the wealth of the country.

Accordingly, we also consider an extended specification which allows institutional frictions to shape the level of aggregate foreign currency exposure. Accordingly, the observed foreign-currency exposure may be characterized by

$$FX_{it}^{AGG} = FX_{it}^{AGG*} - C(F_{it}) \quad (11)$$

where  $F_i$  denotes the set of proxies for the limits on the capacity to issue domestic-currency liabilities and acquire foreign-currency assets.

This allows us to write the expanded empirical specification

$$\begin{aligned} FX_{it}^{AGG} = & \alpha + \phi_t + \gamma * COV(Y_{it}, E_{it}) - \varphi_H * VOL(\pi_{it}) - \varphi_F * VOL(E_{it}) \\ & + \rho * OPEN_{it} + \beta * VOL(Y_{it}) - \sigma F_{it} + \varepsilon_{it} \end{aligned} \quad (12)$$

We consider versions of equations (10) and (12) in our econometric analysis in Section 5 below.

Finally, we note that the theoretical models outlined in this section have focused on the determinants of steady-state portfolios. Some recent work has been successful in describing the dynamics of portfolios in response to various shocks (Tille and van Wincoop 2007, Devereux and Sutherland 2009b). Since our empirical work examines a low-frequency panel of observations on foreign-currency positions (there are four year gaps between observations), we base our interpretation on steady-state factors, rather than seeking to capture the cyclical dynamics of portfolios.

### 2.3 Components of the Net Foreign Currency Asset Position

Aggregate foreign currency exposure can be decomposed into two primary subcomponents

$$FX_{it}^{AGG} = \left( \frac{NFA_{it}}{A_{it} + L_{it}} \right) + \left[ \omega_{itDC}^L * \left( \frac{L_{it}}{A_{it} + L_{it}} \right) - \omega_{itDC}^A * \left( \frac{A_{it}}{A_{it} + L_{it}} \right) \right] \quad (13)$$

This expression shows that  $FX_{it}^{AGG}$  is the sum of the net foreign asset position plus the share of foreign liabilities which are in local currency minus the share of foreign assets which are in

local currency. Accordingly, if all assets and liabilities are in foreign currency, the aggregate foreign-currency exposure is simply the scaled net foreign asset position. Conversely, if the net foreign asset position is zero, aggregate foreign-currency exposure is the difference in the foreign-currency share between the asset and liability sides of the international balance sheet. Accordingly, we label this second part of the equation  $FX_{it}^{AGG,0}$  and rewrite our equation as

$$FX_{it}^{AGG} = \left( \frac{NFA_{it}}{A_{it} + L_{it}} \right) + FX_{it}^{AGG,0} \quad (14)$$

where  $NFA_{it}$  is the net foreign asset position (scaled by  $A + L$ ) and  $FX_{it}^{AGG,0}$  is the aggregate foreign currency exposure evaluated at a zero net foreign asset position. This decomposition is useful, since much of the theoretical literature has focused on scenarios in which the net foreign asset position is zero, even if non-zero net foreign asset positions are empirically important in determining aggregate foreign currency exposures.

In turn, it is helpful to make further decompositions of each of these terms

$$FX_{it}^{AGG} = \left[ \left( \frac{A_{NRit} - L_{it}}{A_{it} + L_{it}} \right) + \frac{FXR_{it}}{A_{it} + L_{it}} \right] + \left[ \left( \frac{PEQL_{it} + FDIL_{it}}{A_{it} + L_{it}} \right) + \left( \frac{DEBTL_{it}^{DC}}{A_{it} + L_{it}} \right) - \left( \frac{A_{NRit}^{DC}}{A_{it} + L_{it}} \right) \right] \quad (15)$$

That is,  $FX^{AGG}$  decomposes into two elements of the net foreign asset position (non-reserve net foreign assets  $A_{NR} - L$ , plus foreign-exchange reserves  $FXR$ ) and three elements of  $FX^{AGG,0}$  (portfolio equity and direct investment foreign liabilities, plus domestic-currency debt liabilities minus local-currency debt assets), where all terms are scaled by  $A + L$ . This decomposition has several appealing features. First, it clearly differentiates between the relative contributions of foreign-exchange reserves and non-reserve components in the overall net foreign asset position. Second, it highlights that  $FX_{it}^{AGG,0}$  is driven by three separate factors: all else equal, a greater share of equities in foreign liabilities reduces reliance on foreign-currency financing, while the foreign-currency position is more positive, the greater is the share of domestic currency in foreign debt liabilities and the smaller is the share of domestic-currency assets in non-reserve foreign assets.<sup>4</sup> In our empirical work, we examine each of these elements in some detail, since diverse strands of the existing the-

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<sup>4</sup>The domestic-currency share in non-reserve foreign assets will typically be driven by the domestic-currency share in non-reserve foreign debt assets. The exception are those countries that share a currency with other countries, such that a proportion of foreign equity assets will be denominated in domestic currency.

oretical and empirical literatures have typically focused on individual elements rather than the aggregate position.

Lane and Shambaugh (2009) show that the quantitative impact of a uniform currency movement is the product of  $FX^{AGG}$  and the gross scale of the international balance sheet

$$NETFX = FX^{AGG} * IFI \quad (16)$$

where  $IFI = (A + L)/GDP$  is the outstanding gross stock of foreign assets and foreign liabilities. We will examine  $NETFX$  in addition to  $FX^{AGG}$  and its subcomponents in our empirical analysis.

Finally, we also construct an alternative measure of foreign-currency exposure that only takes into account debt assets and liabilities. While we view the aggregate position as the most comprehensive and useful, some models have specific predictions for the debt-only position (see, amongst others, Coeurdacier, Kollman, and Martin 2007). We calculate

$$FXDEBT_{it}^{AGG} = \frac{FXR_{it} + PDEBTA_{it}^{FC} + ODEBTA_{it}^{FC} - PDEBTL_{it}^{FC} - ODEBTL_{it}^{FC}}{DebtA_{it} + DebtL_{it}} \quad (17)$$

where  $PDEBT$  and  $ODEBT$  denote portfolio and non-portfolio (“other”) debt respectively. The net foreign currency position in the debt portion of the balance sheet is scaled to the size of the debt-only balance sheet (debt assets plus debt liabilities).

### 3 Data

The construction of the underlying dataset is described in detail in Lane and Shambaugh (2009).<sup>5</sup> Since the focus in this paper is on aggregate foreign-currency exposure, we confine attention to our method for estimating the foreign-currency and domestic-currency components of foreign assets and foreign liabilities. Since, for this purpose, we do not depend on the composition of the foreign-currency component across different currencies, the calculations here are less taxing than the bilateral currency estimates reported by Lane and Shambaugh (2009).

In relation to foreign assets, foreign-exchange reserves are by definition denominated in foreign currencies. For the portfolio equity and direct investment categories, we make the assumption that an equity position in destination country  $j$  carries an exposure to the currency of country  $j$ . In effect, this assumption implies that the home-currency returns on

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<sup>5</sup>The dataset and documentation are available at <http://www.philiplane.org/LSAER/LSAERdata.html>.

foreign equity assets can be analyzed as consisting of two components: the foreign-currency return, plus the exchange rate shift between the foreign and home currencies. So long as the two components are not perfectly negatively correlated, the home-currency return will be influenced by currency movements such that the equity category indeed carries a currency exposure. Thus, for these two categories, we simply need the quantities on the balance sheet using the External Wealth of Nations dataset reported in Lane and Milesi-Ferretti (2007).

The portfolio debt asset category poses the most severe challenge since many countries issue debt in multiple currencies, while the propensity to purchase bonds issued in particular currencies varies across investors of different nationalities. We make extensive use of the international securities dataset maintained by the BIS, which reports the currency denomination of international bonds for 113 issuing countries.<sup>6</sup> In order to allow for the propensity of investors to buy international bonds that are denominated in their own currency, we exploit 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; the Bank of Japan data show that Japanese investors purchase (virtually) all of the yen-denominated debt issued by other countries; and the European Central Bank data suggests that investors from the euro area hold 66 percent of the euro-denominated debt issued by other countries. 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. This procedure delivers estimates of the foreign- and domestic-currency components of the foreign portfolio debt assets held by each country (in addition to details on the composition of the foreign-currency component). Finally, in relation to non-portfolio debt assets, we are able to exploit the BIS locational banking statistics to obtain a breakdown between home-currency and foreign-currency bank assets.

The treatment of foreign liabilities is largely symmetric. Portfolio equity and direct investment liabilities are assumed to be in the home currency, while the BIS databanks on bank debt liabilities and securities issuance allows us to obtain a breakdown of debt liabilities between the domestic currency and foreign currency components. (For developing countries, we use the World Bank's Global Development Finance database to obtain the

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<sup>6</sup>Where the BIS data set lacks data on the currency of issue for a country, we rely on the World Bank's *Global Financial Development* database of the currency composition of external debt.

currency breakdown of external debt.)

As discussed in Lane and Shambaugh (2009), it is possible that some exposure is hedged using derivatives. It is important to note that any within-country derivative sales are moot as they simply shift exposure across parties within the country's overall balance sheet. Also, anecdotal evidence and some country studies suggest cross-border hedging is not on the same scale as the asset and liability positions we examine. Finally, Lane and Shambaugh (2009) show that that valuation effects that we derive from the financially-weighted exchange rate indices are strong predictors of actual valuation effects, suggesting our measures are good approximations of actual currency exposure positions.

Our full sample of countries includes 117 countries where we have full data. We eliminate hyperinflation episodes due to their status as outliers, and start a country's data after the conclusion of a hyperinflation (countries with hyperinflations late in the sample are dropped). Many results examine the variation between 1994 to 2004 (1996 to 2004 in the regression analysis). These results use a smaller 102 country sample that has full data from 1994 through 2004.<sup>7</sup>

#### 4 Foreign-Currency Exposure: Decomposition

Table 1 shows some summary statistics for  $FX^{AGG}$ ,  $NETFX$  and  $FXDEBT^{AGG}$  for different country groups for 1994 and 2004. The data show a general move towards a more positive  $FX^{AGG}$  position between 1994 and 2004. Table 1 also shows considerable cross-group variation. For each period,  $FX^{AGG}$  is more positive for the typical advanced economy relative to the typical emerging market economy, while the typical developing country has a negative  $FX^{AGG}$  position. These patterns also broadly apply in relation to  $NETFX$  but the long position of the typical advanced economy is amplified by the much higher level of international financial integration for this group than for the lower-income groups.

To put these figures in context, a negative  $NETFX$  value of minus 16 percent (the typical developing country) means that a uniform 20 percent depreciation against other

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<sup>7</sup>The remaining data come from standard sources. Exchange rate and inflation data are from the International Monetary Fund's *International Financial Statistics* database, while GDP and trade data are from the World Bank's *World Development Indicators* database, and the institutional data comes from the World Bank's *Worldwide Governance Indicators* database ([www.govindicators.org](http://www.govindicators.org)). The peg variable is from Shambaugh (2004), capital controls data come from di Giovanni and Shambaugh (2008) and is a binary variable summarizing information from the IMF yearbooks (using the alternative indicators developed by Chinn and Ito (2008) or Edwards (2007) makes nearly no difference and the choice is based on maximising data availability).

currencies generates a valuation loss of 3.2 percent of GDP, while the same currency movement generates an 8.4 percent of GDP valuation gain for a country with a positive  $NETFX$  value of 42 percent (the typical advanced economy). These wealth effects are considerable and demonstrate why the aggregate foreign-currency exposure against the rest of the world is an important indicator.

Table 1 also shows positions for  $FXDEBT^{AGG}$ . First, we note the mechanical pattern that debt-only positions are automatically more negative than overall positions. Since FDI and portfolio equity liabilities are in local currency and foreign equity assets are in foreign currency, equity positions on either side of the balance sheet makes  $FX^{AGG}$  more positive. Hence,  $FXDEBT^{AGG}$  is more negative than the overall  $FX^{AGG}$  in all years. A somewhat surprising result is that even advanced countries in 2004 have negative  $FXDEBT^{AGG}$  positions. This occurs because so many of their assets are either in local-currency debt assets or equity assets, even though they have few foreign currency debt liabilities, the net currency position in foreign bonds is negative.

Table 2 shows summary statistics for the cross-country distribution of  $FX^{AGG}$  and its various subcomponents (plus  $NETFX$ ) for 2004 (the final year in the dataset). Across the full sample, the average country has a roughly-balanced foreign-currency position (which implies no foreign currency exposure; balanced changes in the exchange rate would not affect the aggregate balance sheet) but the range extends from minus 72 percent to plus 66 percent. It is important to note that a positive value of  $FX^{AGG}$  is not in itself good or bad. Instead, the optimal allocation could depend on the factors noted above. While having a negative  $FX^{AGG}$  means losses on the balance sheet if there is a depreciation, it conversely means gains in the case of an appreciation.<sup>8</sup> The typical net foreign asset position is negative, on the order of 30 percent of assets and liabilities, while the  $FX_{it}^{AGG,0}$  terms tends to partly balance this out, since it is typically positive.<sup>9</sup>

As for the subcomponents, the non-reserve component of the net foreign asset position of most countries is negative but, by definition, foreign-exchange reserves are always at least slightly positive. Portfolio equity and direct investment are on average about 20

<sup>8</sup>Lane and Shambaugh (2009) provide an extensive discussion of the distribution and trends in this particular statistic. For context, a negative position of -0.5 suggests that for every 10 percent depreciation of the currency, the country will face valuation losses of 5 percent times the assets plus liabilities divided by GDP. For the typical country, this would mean a loss of 10 percent of GDP.

<sup>9</sup>To exhibit a negative value of  $FX_{it}^{AGG,zero}$  would require more foreign assets in local currency than foreign liabilities in local currency. Since most countries have some local currency foreign liabilities (due to direct investment and portfolio equity) and few countries have local currency foreign assets, only two countries actually have a negative value of  $FX_{it}^{AGG,zero}$ .

percent of liabilities, giving most countries a built-in set of domestic-currency liabilities. Many countries have no domestic-currency foreign debt liabilities, and even more have no domestic-currency foreign assets.<sup>10</sup> Finally,  $NETFX$  is a more skewed variable with a much larger standard deviation as some countries have very large ratios of foreign assets and liabilities to GDP.

We can re-organize the decomposition of  $FX^{AGG}$  into a series of bivariate decompositions. At the upper level, we decompose  $FX^{AGG}$  between  $NFA$  (scaled by  $A + L$ ) and  $FX^{AGG,0}$ . In turn, we decompose the overall net foreign asset position between non-reserve net foreign assets and foreign-exchange reserves and decompose  $FX_{it}^{AGG,0}$  between the equity share in foreign liabilities and the domestic currency share term ( $DCSHARE = DEBTL^{DC} - A_{NR}^{DC}$ ). Finally, the  $DCSHARE$  term can be disaggregated into its two constituent parts.

In order to assess the relative contributions of each term in a bivariate decomposition, we report three statistics. Taking the generic pair  $Q = N_1 + N_2$ , we generate: (i) the  $R^2$  from a regression of  $Q$  on  $N_1$ ; (ii) the  $R^2$  from a regression of  $Q$  on  $N_2$ ; and (iii)  $\rho(N_1, N_2) = Correl(N_1, N_2)$ . No technique can purely separate what is driving  $Q$  in such a decomposition, but these statistics are helpful in establishing some bounds. We show both the distribution of results for within-country analysis in Figures 1-5 and the pooled estimates in Table 3.

Figure 1 shows the country-by-country decomposition of  $FX^{AGG}$  between  $NFA$  and  $FX_{it}^{AGG,0}$ . It shows that both factors independently have high explanatory power for most countries but with the net foreign asset position typically having the higher bivariate  $R^2$ . In terms of comovement, the sample is evenly split between cases where the net foreign asset position and  $FX^{AGG,0}$  are positively correlated and those where the correlation is negative. In the pooled regressions in Table 3, net foreign assets are much more important, with the  $R^2$  from a regression of  $FX^{AGG}$  on  $FX^{AGG,0}$  typically close to zero, with the exception of the emerging market group. This is perhaps the most important result in the decomposition. To a great extent, the foreign currency exposure of a country is determined by its status as a debtor or creditor. Examining models where countries hold balanced net foreign asset positions will miss a large part of what determines currency exposure.

Figure 2 decomposes the net foreign asset position between the non-reserve net foreign asset position and foreign-exchange reserves. The former is clearly the dominant factor. Within countries, a regression of the aggregate net foreign asset position on the non-reserve

<sup>10</sup>The latter is expressed as a negative number, since it enters the decomposition negatively.

net foreign asset position has an  $R^2$  close to unity for nearly all countries, while at least half the sample has an  $R^2$  less than 0.5 when the regressor is the level of foreign-exchange reserves. Again, the split between positive and negative correlations between the two elements is relatively balanced, but is 60-40 in favor of positive cases. Thus, despite an extensive literature on reserves holdings, the portfolio balance literature's emphasis on the private sector appears appropriate. Central banks are not systematically offsetting the positions of private actors. The non-reserve NFA drives the overall position.

The pooled regressions in Table 3 emphatically reinforce this point. In the full sample and all subsamples, the  $R^2$  when the non-reserve net foreign asset position is the regressor is at least 0.9 and the only subsample where reserves appear important is the developing world. Table 3 shows a negative correlation of reserves and non-reserve NFA in advanced countries suggesting that reserves could be held as a hedge against losses in the non-reserve balance sheet, but there is no correlation in the emerging countries and developing countries actually show a positive correlation. This implies that countries with a positive NFA hold more reserves, suggesting that reserves are not a hedge for private positions in poor countries.

Figure 3 powerfully shows that the equity share in liabilities is far more important than the currency composition of debt assets and liabilities in driving the behaviour of  $FX_{it}^{AGG,0}$ . Especially in non-advanced countries, there is simply far more variation in the importance of FDI and portfolio equity liabilities than in domestic-currency foreign debt liabilities (which is relatively low) or domestic-currency foreign assets (which are almost always zero), meaning that  $FX_{it}^{AGG,0}$  will be almost entirely determined by the extent of portfolio equity and direct investment liabilities. In terms of comovements, it is interesting that there is a 60-40 balance in favor of negative cases. In turn, Figure 4 shows the relative contributions of the liability and asset sides to the currency composition factor and shows that the liability side has slightly more explanatory power. The correlation is 80-20 in favor of negative cases as countries with large domestic-currency debt liabilities also have large domestic-currency non-reserve foreign assets.

Finally, Figure 5 shows the decomposition of  $NETFX$  between  $FX^{AGG}$  and  $IFI$ .<sup>11</sup> It is interesting that  $FX^{AGG}$  has relatively more explanatory power than  $IFI$ : the overall net currency exposure of the economy is driven more by the currency exposure of the international balance sheet than by the gross scale of asset and liability positions relative to the economy. There is a reasonably even split between positive and negative correlations

<sup>11</sup>This decomposition is of a slightly different nature in that  $NETFX$  is the product of  $FX^{AGG}$  and  $IFI$ , whereas each of the other decompositions is of a sum.



(60–40 in favor of positive). In Table 3, we see that  $FX^{AGG}$  is more important than  $IFI$  in the full pooled sample, but their relative importance varies across the various subsamples.

Our analysis is static in nature, looking at exposure to a change in the exchange rate based on holdings at a given point in time. One may worry that a collapsing currency (or fears of one) could lead to a collapsing position if a country is suddenly forced to borrow extensively in foreign currency. This might mean that apparently safe positions are illusory. In fact, a change in the exchange rate typically has little impact on  $FX^{AGG}$ . Consider a country with no foreign assets and all foreign currency liabilities. If the exchange rate depreciates, they face valuation losses but  $FX^{AGG}$  is  $-1$  throughout. If assets equaled half of liabilities and  $FX^{AGG}$  is  $-0.5$ , the same applies. Only if there is an extensive amount of domestic currency liabilities on the balance sheet can a depreciation shift  $FX^{AGG}$  to a more negative position (by increasing the relative size of the foreign currency liabilities). In fact there is only a slight decrease in  $FX^{AGG}$  in the year prior to a sudden stop and  $FX^{AGG}$  on average does not change at all in the year of a sudden stop.<sup>12</sup> Thus we do not view this concern as particularly problematic, and instead see our measure as a good indicator of the external balance sheet exposure of countries.

## 5 Econometric Analysis

### 5.1 Regression Specification

We begin our analysis with the determinants of aggregate foreign currency exposure, before moving on to the subcomponents. Table 4 explores a variety of specifications to explain variation in  $FX^{agg}$ .

We adopt a panel framework

$$Y_{it} = \alpha + \phi_t + \beta' X_{it} + \varepsilon_{it} \quad (18)$$

We consider four specifications for  $X$ . The baseline specification follows the setup described in equation (??) above, which focuses on the types of variables that are identified as potentially important in a ‘friction free’ environment. We include the following variable: trade openness (trade to GDP ratio); volatility of real GDP per capita; covariance of real per capita GDP and the nominal effective exchange rate; volatility of the nominal effective exchange rate; and volatility of domestic inflation.

<sup>12</sup>Thailand and Korea in 1997 do show declining  $FX^{AGG}$ , but the decline is small and is balanced by countries that show an increasing  $FX^{AGG}$  (perhaps due to being forced to pay back foreign loans when funding dries up).

The volatility and covariance measures are calculated for the log changes of each variable over a rolling 15 year window (since the real variables are only available on an annual basis for many countries). As was discussed in Section 2.3, the importance of using the balance sheet to hedge domestic risk is increasing in the volatility of domestic wealth (proxied here by GDP per capita). A critical factor in determining whether  $FX^{AGG}$  should be long or short is the sign of the covariance term between domestic wealth and the nominal exchange rate, proxied here by the the covariance between GDP and the nominal effective exchange rate. The higher is the exogenous component in nominal exchange rate volatility, the more risky are foreign-currency assets while domestic inflation volatility increases uncertainty about the real returns on nominal positions.<sup>13</sup> Finally, a time fixed effect is included in equation (18) to control for global factors, such as time-variation in the volatility of global inflation.

We also consider an expanded specification that seeks to take into account institutional and policy factors that may alter the desired optimal net foreign currency position and/or restrict a country's ability to attain its desired level. These variables include: institutional quality; capital controls; the *de facto* exchange rate regime; and a marker for being in EMU. A third set of variables is also considered that are viewed as general control variables: GDP per capita; and population size.

The level of GDP per capita is included, since many of the characteristics listed above are plausibly correlated with the level of development and we want to be able to ascertain whether these variables have explanatory power even holding fixed GDP per capita. Country size is a second general control variable, since previous empirical evidence suggests that larger countries are better able to issue domestic-currency liabilities (Lane and Milesi-Ferretti 2000, Eichengreen et al 2003).

The regressions use data from three years: 1996, 2000, and 2004. We opt to leave 4 year breaks rather than use every year because of the serial correlation of some variables and because of the overlapping nature of the 15 year windows.<sup>14</sup> We have 306 observations from a total of 104 countries.<sup>15</sup> It is worth noting that while we present evidence for the full sample of countries, the results are strikingly similar even if exclude the set of advanced economies. We explicitly control for EMU, GDP per capita and use country fixed effects

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<sup>13</sup>While it is true that if the balance sheet is very large, risky assets could drive exchange rate volatility, the point is if the exchange rate is volatile, this may dampen a country's willingness to hold a large foreign currency portfolio.

<sup>14</sup>Moreover, the World Bank governance data are only available in even years and our data is complete for many countries only starting in 1996.

<sup>15</sup>Not all the countries in the full data set used in the decompositions have all the required covariates.

in some specifications. These techniques appear sufficient to take into account differences across the advanced, emerging, and developing samples.

We begin by reporting the results from pooled estimation of the baseline specification in column (1) of Table 4; we add the institutional and policy variables in column (2); while we alternatively add the general control variables in column (3); the full set of regressors are included in column (4). In order to isolate the time-series variation in the data, we add country fixed effects in columns (5) and (6); as an alternative (albeit with a drop in the degrees of freedom), we estimate a ‘long’ first-differences equation columns (7) and (8) which examines the changes in the variables between 1996 and 2004. Due to the need to have all covariates in both 1996 and 2004, we have 98 countries in the differences specifications.

## 5.2 Results for $FX^{AGG}$

### 5.2.1 Pooled Estimation

Table 4 provides the results. In the pooled estimation with year effects (the first four columns), we see that greater trade openness is clearly associated with a more positive value of  $FX^{AGG}$ : this is true whether more extensive controls are present or not, although the estimated coefficient drops in value once additional controls are included in columns (2)-(4). A positive association between trade openness and foreign currency exposure is consistent with the notion that the role of foreign assets in portfolios is more important, the greater is the share of imports in domestic consumption (Obstfeld and Rogoff 2001).

In relation to the other variables in the baseline specification, the estimated coefficients vary in significance and sign across columns (1)-(4). In terms of significant results, the volatility of the nominal exchange rate has the expected negative sign in column (1) only. The volatility of GDP is significant only in column (4) but with a positive sign. Finally, the covariance of output and the nominal exchange rate enters with a significant positive sign in column (1), but loses significance and the sign flips when more controls are added. Accordingly, the results from the pooled estimation do not provide very stable evidence in terms of the relation between the various volatility indicators and the level of foreign-currency exposure.

Turning to the institutional and policy variables, the results in column (2) indicate that a better institutional environment is associated with a more positive value for  $FX^{AGG}$ , while the estimated coefficient on the exchange rate peg is significantly negative - however, neither capital controls nor the *EMU* dummy is significant in column (2).<sup>16</sup> However, the inclusion

<sup>16</sup>In this specification, the EMU dummy reflects any extra impact of EMU beyond its stabilising impact

of GDP per capita as a control in column (4) alters these results: the only policy variable that is significant is the *EMU* dummy which enters with a significantly negative coefficient. Rather, the evidence from columns (3) and (4) is that  $FX^{AGG}$  is highly correlated with the level of development: richer countries have a more positive level of foreign-currency exposure. We surmise that the ability to issue domestic-currency liabilities and obtain foreign-currency assets is increasing in institutional dimensions that are highly correlated with the level of development. Finally, the estimated coefficient on country size in columns (3) and (4) is positive but not quite significant.

To obtain a perspective on the quantitative importance of the coefficients, we can consider the magnitudes of the coefficients on trade openness, GDP per capita and the EMU dummy in column (4). In relation to trade openness, the standard deviation in the sample is 0.48, such that that a one standard deviation in trade openness would generate a move of 0.05 in  $FX^{AGG}$ . The standard deviation of the natural log of GDP per capita in the sample is 1.64, thus the coefficient on this variable implies a one standard deviation move implies a move of 0.21 in  $FX^{AGG}$ , a very substantial shift. The EMU indicator is a dummy, thus being in EMU suggests an  $FX^{AGG}$  which is 0.14 lower than for other countries, which again is a non-trivial magnitude. The results show that in simple conditional correlations, many of the country characteristics highlighted by the literature do not seem to vary with  $FX^{agg}$  in a systematic manner. On the other hand, models should help to explain why richer and more open countries hold longer foreign currency positions.

### 5.2.2 Time Series Variation

The time series variation in the data is captured in the regressions reported in columns (5)-(8) of Table 4. The goal is not to study the business cycle fluctuations in  $FX^{AGG}$ , since our econometric model mainly only considers observations at four year intervals have observations every four years, while the differences specifications look across an eight year gap. Rather, the goal is to better understand the longer-run determinants by studying lower-frequency shifts in  $FX^{AGG}$ . By controlling for country fixed effects, we remove unobservable country characteristics to see which of our model based determinants affects within-country shifts in  $FX^{AGG}$ . The advantage to holding fixed the cross-sectional variation in the data is that there may be non-observed country characteristics that influence the cross-country distribution of  $FX^{AGG}$  values and reduce our ability to accurately cap-

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on the nominal effective exchange rate, which is captured by the *PEG* variable. It turns out that the pattern that EMU has led to a less positive foreign-currency position for euro area countries has been well timed, in that the euro has appreciated against other currencies.

ture the impact of some of our variables of interest; the drawback is that other variables in our specification mostly show cross-sectional variation with little time-series variations and these regressors will play less role in explaining intra-country variation. Thus, a variable losing significance in these specifications does not necessarily signal omitted variable problems, but may simply represent a lack of time series variation to provide identification.

In the time series dimension, we see several new results. The most striking finding is that, once either country fixed effects are included or the data are differenced across time, the covariance term now exhibits the expected positive coefficient. Holding fixed other factors, the value of  $FX^{AGG}$  becomes more positive for those countries that have experienced an increase in the covariance between domestic output growth and the nominal exchange rate. The result is borderline insignificant in the fixed effects specifications (p-value 0.11) and significant at the 99 and 95 percent confidence levels in the differences specifications.

This result is not simply driven by a few countries. Figure 6 shows the partial scatter of changes in  $FX^{AGG}$  against changes in the covariance of the exchange rate and GDP using the regression in column (8). We see a clear pattern where those countries with increasingly positive covariance take a more positive  $FX^{AGG}$  position. Returning to the size of the effect, a one standard deviation move in the size of the change in the covariance term is 0.005. This implies a one standard deviation shift in the change in the covariance term would come with an increase of 0.045 in  $FX^{AGG}$ . The models which predict this relationship do so for the level, not the change, but the result appears only in the time series. There is a considerable amount of cross-sectional variation that remains unexplained. Once it is controlled for with country fixed effects, we see the expected relationship.

Conversely, the trade openness result is not significant and GDP per capita weakens along the time series dimension: it is clear that these variables help to explain the cross-country variation in the data but are less useful in understanding shifts over time in the value of  $FX^{AGG}$ . In part, though, this simply reflects the slow moving nature of trade openness. Rich more open countries certainly have more positive  $FX^{AGG}$ , but GDP per capita and trade openness are fairly stable over time, and hence changes in these variables are not very helpful in explaining the changing nature of  $FX^{AGG}$ . In contrast, population growth now shows up as an important variable. The logic is twofold. Controlling for GDP per capita, a growing population suggests an economy that is growing larger. Thus, when an economy grows larger, there is a more positive  $FX^{AGG}$ . If we instead include population and GDP directly, however, population is still positive and significant, suggesting the demographics themselves may matter directly, and that models should include a role for population growth

in the optimal portfolio determinants of countries.

The global shift to more positive  $FX^{AGG}$  positions documented in Lane and Shambaugh (2009) can be seen in the positive year dummies for 2000 and 2004 (1996 is the excluded dummy) in columns (1) through (5). Once we consider all controls and include country fixed effects in column (6), the year dummies are no longer significant: the regressors explain a substantial component of the shift to a more positive  $FX^{AGG}$  position. We also note that the EMU dummy is negative and significant along the time series dimension, such that the euro area countries clearly shifted towards a more negative position upon the formation of the currency union.

### 5.3 Results for $FXDEBT^{AGG}$

We have repeated similar regressions for the debt-only measure of exposure,  $FXDEBT^{AGG}$ . Table 5 reproduces the specifications in columns (1), (6) and (8) from Table 4 but with  $FXDEBT^{AGG}$  as the dependent variable. The results are nearly identical to those for the overall measure. Without country fixed effects, trade openness and GDP per capita are positive and significant (with nearly the same magnitude). The only substantial difference is that the EMU dummy is cut in half and no longer significant when comparing columns (1) and (2). With the inclusion of country fixed effects, the covariance term is still positive and significant, and is in fact slightly larger. The variance of the exchange rate is negative and population is positive and significant and again the EMU dummy has a slightly smaller size, though in this case it is still statistically significant. Looking at the changes specification, the regressions for the debt measure show coefficients with a similar direction but larger size and significance.

### 5.4 Results for Subcomponents and $NETFX$

We can learn more about the mechanisms behind both the cross-country and time-series variation in the data by examining the various subcomponents of  $FX^{AGG}$ ; in addition, it is useful to also examine whether the results for  $FX^{AGG}$  carry over to  $NETFX$ . The limitation to this exercise is that the strong patterns of co-variation across the different subcomponents that were identified in Section 3 mean that results for  $FX^{AGG}$  may not be easily attributed to the individual subcomponents. For simplicity, we adopt a symmetric approach, whereby we maintain the same set of regressors for each subcomponent of  $FX^{AGG}$  and  $NETFX$ .

To conserve space, we focus on the most general specification which includes the full set

of regressors. We report the pooled estimates in Table 6, while the fixed-effects results are contained in Table 7. To assist in comparing results, column (1) in Table 6 repeats column (4) from Table 4, while column (1) in Table 7 repeats column (6) from Table 4.

In relation to the pooled estimates in Table 6, a series of interesting observations arise. In relation to the two primary subcomponents of  $FX^{AGG}$ , the positive effect of GDP per capita is clearly operating via the net foreign asset position; in contrast, the *EMU* dummy affects the  $FX^{AGG,0}$  term. At a lower level of decomposition, GDP per capita affects the non-reserve net foreign asset position; in addition, it is associated with higher values for the domestic-currency share of debt liabilities and the domestic-currency share of foreign assets. The EMU dummy has a similar relation with the domestic-currency share of debt liabilities and the domestic-currency share of foreign assets; EMU membership is also associated with a reduction in the level of reserves and a decline in the equity share of liabilities, with both of these effects acting to reduce  $FX^{AGG}$ .

The other variables that are individually significant in column (1) – trade openness, the volatility of GDP and the covariance term – are not individually significant for either the net foreign asset position or  $FX^{AGG,0}$ . However, at a lower level of decomposition, we see that trade openness raises the equity share in foreign liabilities but reduces the domestic-currency share in foreign debt liabilities, which act in opposite directions.<sup>17</sup> The volatility of GDP is only significant in raising the domestic-currency share of non-reserve foreign assets (which mechanically reduces the foreign-currency position). An increase in the covariance between GDP and the nominal exchange rate is associated with a decline in the non-reserve net foreign asset position, a reduction in the domestic-currency share of foreign debt liabilities and the domestic-currency share of non-reserve foreign assets.

The main impact of the institutional/policy variables is seen in columns (7) and (8), which show that capital controls are associated with a reduction in the domestic-currency share of foreign debt liabilities and the domestic-currency share of non-reserve foreign assets, while an exchange rate peg raises the domestic-currency share in foreign debt liabilities. Larger countries have more positive non-reserve net foreign asset positions and a higher domestic-currency share in foreign debt liabilities and non-reserve foreign assets. The pattern that country size is positively associated with a higher domestic-currency share in foreign debt liabilities is consistent with the evidence of Eichengreen et al (2005), who find that original sin is more prevalent for smaller countries.

Turning to the fixed-effects estimates in Table 7, the positive association between the

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<sup>17</sup>In different specifications, Lane and Milesi-Ferretti (2001) and Faria et al (2007) also show that trade openness is positively associated with the equity share in foreign liabilities.

covariance term and  $FX^{AGG}$  in column (1) cannot be traced to individual components in columns (2)-(8): although it carries the expected sign for each component (with the exception of the domestic-currency share in non-reserve foreign assets), none of these effects are individually significant. In results not reported, we also ran the first-difference specification as in column (8) of Table 4 and found that the covariance term has a positive coefficient in regressions for both the net foreign asset position and  $FX^{AGG,0}$  but it is larger and statistically significant in the latter case.

The pattern for the EMU dummy is very similar to the pooled estimates, with the exception that it is not significant for the equity share in foreign liabilities once country fixed effects are introduced. The positive time-series association between population growth and  $FX^{AGG}$  in column (1) is shown to operate via both the reserve and non-reserve components of the net foreign asset position but does not affect  $FX^{AGG,0}$  or its subcomponents.

With regard to the variables that are not individually significant in the  $FX^{AGG}$  regression in column (1), several turn out to be significant in regressions for particular subcomponents. While the pattern of time-series results for trade openness are qualitatively similar to the pooled estimates, different patterns obtain for the capital controls and exchange rate peg variables. In particular, capital account liberalization is associated with an increase in the net foreign asset position but an offsetting decline in  $FX^{AGG,0}$ , while moving from a float to a peg is associated with an increase in  $FX^{AGG,0}$ .

Finally, column (9) in Tables 6 and 7 report the regression results in explaining  $NETFX$ . The  $NETFX$  estimates are broadly similar to those for  $FX^{AGG}$  but with some exceptions. In particular, the volatility and covariance terms do not show up as significant in the pooled estimates for  $NETFX$ , while country size is significant. Along the time series dimension, only the volatility of GDP is individually significant for  $NETFX$  but it was not for  $FX^{AGG}$ .

## 6 Summary of Stylized Facts

Our empirical analysis provides a number of stylized facts regarding the foreign currency exposure of the external balance sheet. From the decompositions, we learn a number of important facts. First, the net foreign asset position of a country is the critical driving component of its aggregate foreign currency exposure. Beyond that, the non-reserve portion of the balance sheet seems to determine the NFA position with the exception of some developing countries. Within the currency composition, the leading factor is the equity share of liabilities. Less than being able to issue debt in one's currency, it is the share of



liabilities that are in equity and FDI that determines the currency position.

The panel analysis of  $FX^{AGG}$  also provides interesting insights. Richer countries that trade more are more likely to be long in foreign currency, while euro area countries are (controlling for other factors) more likely to be short foreign currency. In the time series, some key findings include an observed increase in the propensity to depreciate during bad times associated with a longer foreign currency position, while an increase in exchange rate volatility is associated with a move to a shorter position.

## 7 Conclusions

Advances in the theoretical modelling of optimal portfolio allocations have enriched our understanding of the potential risk sharing across countries but also raised questions regarding how country portfolios are actually structured. This paper builds on the data set developed Lane and Shambaugh (2009) in order to generate a new set of stylized facts regarding the determinants of the aggregate foreign currency exposure embedded in external positions. In addition, our regression analysis reveals some covariation patterns in the data that may be helpful in evaluating this new set of models.

We believe the project generates a number of stylized facts that are both important in their own right and also of interest to the growing theoretical literature. We highlight that the net foreign asset position plays a key role in determining aggregate foreign-currency exposure: looking only at the currency composition of foreign assets and foreign liabilities misses the fact that the dominant factor for many countries is simply the net balance between foreign assets and foreign liabilities. Still, composition plays a role but the equity share in foreign liabilities is quantitatively more important than whether foreign debt liabilities are denominated in domestic currency or foreign currency. Moreover, the pattern is that many of those countries that issue domestic-currency foreign debt liabilities are also significant holders of domestic-currency foreign assets, such that the net impact on aggregate foreign currency exposure is limited.

In our pooled regression analysis with year fixed effects, we find that country characteristics such as trade openness and GDP per capita are helpful in explaining the cross-country variation in  $FX^{AGG}$ . However, there is considerable unexplained variation along the cross-sectional dimension, which may help explain why the volatility and covariance measures suggested in the theoretical literature are either weak or incorrectly signed. Once we eliminate the cross-sectional variation by including country fixed effects, we obtain more support for the theoretical priors. Most notably, we find that an increase in the propensity for a cur-

rency to depreciate during bad times is associated with a more positive value for  $FX^{AGG}$ , such that a long position in foreign currencies helps to hedge against domestic output fluctuations. Our final contribution is to show that there is substantial heterogeneity in the roles of each regressor in explaining the variation in individual subcomponents of  $FX^{AGG}$ . Accordingly, in assessing hypotheses about the determinants of foreign-currency exposures, it is important to take a broad perspective rather than examining individual components in isolation.

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Table 1: Aggregate Foreign Currency Exposure

	1994		2004	
	mean	median	mean	median
<i>FX<sup>AGG</sup></i>				
All	-0.23	-0.24	-0.03	-0.01
Advanced	0.04	0.08	0.12	0.09
Developing & Emerging	-0.30	-0.41	-0.07	-0.09
Developing	-0.41	-0.47	-0.14	-0.19
Emerging	-0.10	-0.06	0.06	0.06
<i>FXDEBT<sup>AGG</sup></i>				
All	-0.33	-0.39	-0.12	-0.12
Advanced	-0.12	-0.05	-0.07	-0.04
Developing & Emerging	-0.38	-0.51	-0.13	-0.16
Developing	-0.50	-0.57	-0.19	-0.25
Emerging	-0.17	-0.17	-0.01	-0.06
<i>NETFX</i>				
All	-0.31	-0.24	0.18	-0.002
Advanced	0.18	0.08	0.54	0.42
Developing & Emerging	-0.44	-0.33	0.07	-0.10
Developing	-0.71	-0.58	-0.16	-0.16
Emerging	0.05	-0.03	0.44	0.06

Note:  $FX^{AGG} = \omega^A s^A - \omega^L s^L$ ;  $NETFX = FX^{AGG} * IFI$ . Sample includes the 102 countries with data from 1994 to 2004. Source: Lane and Shambaugh (2007).

Table 2: Foreign Currency Exposure ( $FX^{AGG}$ ) and Subcomponents

Variable	Mean	Std. Dev.	Min	Max	Median
$FX^{AGG}$	-0.03	0.27	-0.72	0.66	-0.03
$(A - L)/(A + L)$	-0.28	0.28	-0.87	0.55	-0.30
$FX^{AGG,0}$	0.25	0.14	-0.03	0.87	0.23
$(A_{NR} - L)/(A + L)$	-0.40	0.26	-0.90	0.14	-0.46
$FXR/(A + L)$	0.12	0.10	0.00	0.55	0.11
$(PEQL + FDIL)/(A + L)$	0.25	0.13	0.03	0.87	0.22
$DEBTL^{DC}/(A + L)$	0.03	0.09	0.00	0.45	0.00
$A_{NR}^{DC}/(A + L)$	-0.03	0.09	-0.42	0.00	0.00
$NETFX$	0.15	0.87	-0.75	6.25	-0.02
$FXDEBT^{AGG}$	-0.12	0.32	-0.85	0.66	-0.12

Summary statistics for 2004.

Table 3: Variance Decomposition of Foreign Currency Exposure: Pooled Analysis

	$(FX^{AGG}, IFI)$	$(NFA, FX^{AGG,0})$	$(NFA_{NR}, FXR)$	$(EQSH_L, DCSHARE)$	$(DCDEBT_L, A_{NR}^{DC})$
ALL	(0.56,0.34,0.28)	(0.83,0.11,-0.10)	(0.91,0.14,0.08)	(0.94,0.08,0.04)	(0.01,0.16,-0.87)
ADV	(0.47,0.53,0.29)	(0.65,0.03,-0.43)	(0.97,0.02,-0.33)	(0.66,0.47,0.13)	(0.01,0.30,-0.79)
EMU	(0.45,0.62,0.25)	(0.37,0.12,-0.53)	(0.92,0.10,-0.58)	(0.40,0.48,-0.12)	(0.00,0.38,-0.76)
NON-EMU	(0.47,0.76,0.41)	(0.75,0.01,-0.40)	(0.99,0.00,-0.19)	(0.87,0.50,0.41)	(0.36,0.00,-0.78)
EM	(0.37,0.82,0.43)	(0.86,0.23,0.12)	(0.93,0.05,-0.04)	(1.00,0.02,0.12)	(0.48,0.04,-0.84)
DEV	(0.65,0.41,-0.21)	(0.76,0.15,-0.11)	(0.92,0.66,0.62)	(1.00,0.00,-0.03)	(1.00,0.00,)

Each cell reports  $(R_{N1}^2, R_{N2}^2, \rho[N1, N2])$  where  $Q = N1 + N2$  and  $R_{N1}^2$  denotes the  $R^2$  from a regression of  $Q$  on  $N1$ ,  $R_{N2}^2$  denotes the  $R^2$  from a regression of  $Q$  on  $N2$ , and  $\rho[N1, N2]$  is the correlation between  $N1$  and  $N2$ . ( $Q = N1 * N2$  for the pair  $FX^{AGG}, IFI$ . Pooled data over 1994 to 2004.

Table 4: Determinants of  $FX^{AGG}$ : Panel Estimation

	(1) YFE	(2) YFE	(3) YFE	(4) YFE	(5) CFE,YFE	(6) CFE,YFE	(7) $\Delta$	(8) $\Delta$
Trade	0.16 (0.04)**	0.10 (0.03)**	0.10 (0.03)**	0.10 (0.03)**	0.00 (0.07)	0.03 (0.06)	0.01 (0.10)	0.05 (0.09)
$Vol(GDP)$	-0.79 (0.85)	0.21 (0.37)	0.68 (0.37)+	0.65 (0.36)+	0.10 (0.61)	-0.21 (0.61)	0.00 (0.74)	-0.49 (0.82)
$Cov(GDP, E)$	3.68 (1.79)*	0.24 (1.44)	-1.42 (1.30)	-1.66 (1.26)	5.30 (3.39)	5.82 (3.55)	6.30 (2.06)**	9.07 (4.53)*
$Vol(\pi)$	0.22 (0.24)	-0.13 (0.21)	-0.20 (0.17)	-0.26 (0.17)	0.77 (0.37)*	0.61 (0.36)+	0.91 (0.40)*	0.76 (0.44)+
$Vol(E)$	-1.69 (0.59)**	0.19 (0.50)	0.48 (0.47)	0.49 (0.44)	-1.39 (0.72)+	-1.04 (0.75)	-1.77 (0.49)**	-1.64 (0.77)*
Institutions		0.17 (0.03)**		0.00 (0.05)		0.03 (0.06)		0.06 (0.09)
Capital controls		-0.05 (0.05)		-0.02 (0.04)		0.04 (0.04)		0.04 (0.05)
Peg		-0.08 (0.03)*		-0.03 (0.03)		0.03 (0.03)		0.06 (0.04)
EMU		-0.06 (0.05)		-0.14 (0.04)**		-0.13 (0.04)**		-0.17 (0.04)**
GDP per capita			0.13 (0.01)**	0.13 (0.02)**		0.15 (0.10)		0.02 (0.14)
POP			0.03 (0.02)	0.03 (0.02)		0.64 (0.27)*		0.62 (0.29)*
y2000	0.05 (0.02)**	0.06 (0.02)**	0.05 (0.01)**	0.07 (0.01)**	0.07 (0.01)**	0.03 (0.02)		
y2004	0.12 (0.02)**	0.16 (0.02)**	0.13 (0.02)**	0.14 (0.02)**	0.15 (0.02)**	0.08 (0.04)+		
Constant	-0.20 (0.06)**	-0.25 (0.05)**	-1.34 (0.11)**	-1.33 (0.21)**	-0.18 (0.06)**	-3.02 (1.20)*	0.15 (0.02)**	0.10 (0.05)*
Obs.	306	306	306	306	306	306	99	98
$R^2$	0.19	0.44	0.56	0.58	0.91	0.92	0.07	0.23

Standard errors clustered at the country level in parentheses. + significant at 10%; \* significant at 5%; \*\* significant at 1% .

Table 5: Determinants of  $FXDEBT^{AGG}$ .

	(1) $FX^{AGG}$ YFE	(2) $FX^{agg}$ Debt YFE	(3) $FX^{AGG}$ CFE, YFE	(4) $FX^{agg}$ Debt CFE, YFE	(5) $FX^{AGG}$ $\Delta$	(6) $FX^{agg}$ Debt $\Delta$
Trade	0.10 (0.03)**	0.15 (0.04)**	0.03 (0.06)	0.00 (0.09)	0.05 (0.09)	0.05 (0.13)
$Vol(GDP)$	0.65 (0.36)+	0.87 (0.50)+	-0.21 (0.61)	-0.08 (0.78)	-0.49 (0.82)	-0.28 (1.05)
$Cov(GDP, E)$	-1.66 (1.26)	-1.35 (1.87)	5.82 (3.55)	8.53 (4.81)+	9.07 (4.53)*	12.29 (6.09)*
$Vol(\pi)$	-0.26 (0.17)	-0.23 (0.23)	0.61 (0.36)+	1.07 (0.47)*	0.76 (0.44)+	1.42 (0.60)*
$Vol(E)$	0.49 (0.44)	0.22 (0.52)	-1.04 (0.75)	-1.64 (0.92)+	-1.64 (0.77)*	-2.53 (0.95)**
Institutions	0.00 (0.05)	-0.07 (0.06)	0.03 (0.06)	0.00 (0.07)	0.06 (0.09)	0.04 (0.11)
Capital controls	-0.02 (0.04)	-0.02 (0.06)	0.04 (0.04)	0.07 (0.05)	0.04 (0.05)	0.08 (0.07)
Peg	-0.03 (0.03)	-0.04 (0.04)	0.03 (0.03)	0.01 (0.04)	0.06 (0.04)	0.06 (0.06)
EMU	-0.14 (0.04)**	-0.07 (0.06)	-0.13 (0.04)**	-0.12 (0.04)**	-0.17 (0.04)**	-0.16 (0.05)**
GDP per capita	0.13 (0.02)**	0.14 (0.03)**	0.15 (0.10)	0.15 (0.15)	0.02 (0.14)	0.00 (0.21)
POP	0.03 (0.02)	0.02 (0.03)	0.64 (0.27)*	0.64 (0.31)*	0.62 (0.29)*	0.61 (0.35)+
y2000	0.07 (0.01)**	0.04 (0.02)+	0.03 (0.02)	0.02 (0.03)		
y2004	0.14 (0.02)**	0.12 (0.03)**	0.08 (0.04)+	0.09 (0.05)+		
Constant	-1.33 (0.21)**	-1.50 (0.27)**	-3.02 (1.20)*	-3.15 (1.60)+	0.10 (0.05)*	0.12 (0.07)+
Obs.	306	306	306	306	98	98
$R^2$	0.58	0.4	0.92	0.9	0.23	0.19

Robust standard errors in parentheses. + significant at 10%; \* significant at 5%; \*\* significant at 1% .



Table 6: Determinants of Subcomponents: Pooled Estimates

	(1) $FX^{AGG}$	(2) $NFA$	(3) $FX^{AGG,zero}$	(4) $A_{NR} - L$	(5) $FXR$	(6) $EQSH_L$	(7) $DC_{DL}$	(8) $DC_{NRA}$	(9) $NETFX$
Trade	0.10 (0.03)**	0.05 (0.03)	0.05 (0.02)+	0.03 (0.03)	0.02 (0.01)	0.06 (0.03)*	-0.02 (0.01)**	0.01 (0.01)	0.85 (0.29)**
$Vol(GDP)$	0.65 (0.36)+	0.53 (0.37)	0.13 (0.18)	0.41 (0.28)	0.12 (0.15)	0.12 (0.17)	0.07 (0.05)	-0.06 (0.03)+	1.09 (1.01)
$Cov(GDP, E)$	-1.66 (1.26)	-2.23 (1.62)	0.57 (1.09)	-2.77 (1.48)+	0.54 (0.62)	0.62 (1.08)	-0.48 (0.26)+	0.43 (0.20)*	-3.18 (3.75)
$Vol(\pi)$	-0.26 (0.17)	-0.30 (0.23)	0.04 (0.15)	-0.32 (0.20)	0.02 (0.07)	0.05 (0.15)	-0.04 (0.03)	0.03 (0.02)	-0.38 (0.45)
$Vol(E)$	0.49 (0.44)	0.37 (0.61)	0.12 (0.39)	0.48 (0.53)	-0.10 (0.17)	0.13 (0.38)	0.01 (0.04)	-0.02 (0.03)	0.93 (1.14)
Institutions	0.00 (0.05)	0.00 (0.05)	0.00 (0.02)	0.01 (0.04)	-0.02 (0.02)	0.00 (0.02)	0.01 (0.01)	0.00 (0.01)	0.09 (0.11)
Capital controls	-0.02 (0.04)	-0.01 (0.04)	-0.01 (0.02)	-0.03 (0.04)	0.02 (0.01)	-0.01 (0.02)	-0.02 (0.01)**	0.02 (0.01)**	-0.11 (0.10)
Peg	-0.03 (0.03)	-0.03 (0.03)	0.00 (0.02)	-0.01 (0.02)	-0.02 (0.01)	0.00 (0.02)	0.01 (0.004)+	0.00 (0.003)	0.05 (0.10)
EMU	-0.14 (0.04)**	-0.01 (0.04)	-0.13 (0.05)**	0.06 (0.04)	-0.07 (0.02)**	-0.06 (0.03)*	0.18 (0.03)**	-0.25 (0.03)**	-0.42 (0.20)*
GDP per capita	0.13 (0.03)**	0.12 (0.03)**	0.01 (0.01)	0.12 (0.02)**	0.00 (0.01)	0.01 (0.01)	0.01 (0.003)*	-0.01 (0.003)*	0.20 (0.05)**
POP	0.03 (0.02)	0.02 (0.02)	0.00 (0.01)	0.03 (0.01)+	0.00 (0.01)	0.00 (0.01)	0.01 (0.004)*	-0.01 (0.003)**	0.13 (0.05)**
y2000	0.07 (0.01)**	0.02 (0.01)	0.05 (0.01)**	0.02 (0.01)	0.01 (0.01)	0.05 (0.01)**	-0.01 (0.003)**	0.01 (0.003)**	0.07 (0.04)+
y2004	0.14 (0.02)**	0.06 (0.02)**	0.07 (0.01)**	0.04 (0.02)*	0.02 (0.01)**	0.07 (0.01)**	0.00 (0.003)	0.01 (0.003)*	0.18 (0.06)**
Constant	-1.33 (0.21)**	-1.38 (0.23)**	0.05 (0.09)	-1.45 (0.17)**	0.07 (0.09)	0.05 (0.09)	-0.04 (0.03)	0.04 (0.02)*	-2.70 (0.61)**
Obs.	306	306	306	306	306	306	306	306	300
$R^2$	0.58	0.5	0.17	0.64	0.15	0.17	0.77	0.86	0.57

Standard errors clustered at the country level in parentheses. + significant at 10%; \* significant at 5%; \*\* significant at 1% .

Table 7: Determinants of Subcomponents: Fixed-Effects Estimates

	(1) <i>FX<sup>AGG</sup></i>	(2) <i>NFA</i>	(3) <i>FX<sup>AGG,zero</sup></i>	(4) <i>ANR - L</i>	(5) <i>FXR</i>	(6) <i>EQSH<sub>L</sub></i>	(7) <i>DC<sub>DL</sub></i>	(8) <i>DC<sub>NRA</sub></i>	(9) <i>NETFX</i>
Trade	0.03 (0.06)	-0.02 (0.07)	0.05 (0.05)	-0.02 (0.06)	-0.01 (0.02)	0.07 (0.04)	-0.02 (0.01)*	0.00 (0.009)	0.54 (0.45)
<i>Vol(GDP)</i>	-0.21 (0.61)	-0.16 (0.62)	-0.05 (0.32)	0.18 (0.57)	-0.34 (0.36)	-0.08 (0.33)	0.03 (0.05)	0.00 (0.03)	2.77 (1.40)+
<i>Cov(GDP, E)</i>	5.82 (3.55)	3.50 (2.89)	2.31 (1.91)	2.38 (2.54)	1.12 (1.22)	1.82 (1.93)	0.36 (0.44)	0.14 (0.20)	2.28 (10.03)
<i>Vol(π)</i>	0.61 (0.36)+	0.74 (0.33)*	-0.13 (0.19)	0.41 (0.26)	0.33 (0.11)**	-0.20 (0.18)	0.06 (0.04)	0.01 (0.02)	1.19 (1.03)
<i>Vol(E)</i>	-1.04 (0.75)	-0.71 (0.56)	-0.33 (0.36)	-0.40 (0.45)	-0.32 (0.20)	-0.23 (0.34)	-0.06 (0.05)	-0.05 (0.03)	-0.13 (1.40)
Institutions	0.03 (0.06)	-0.01 (0.06)	0.04 (0.03)	-0.03 (0.05)	0.02 (0.02)	0.03 (0.03)	0.00 (0.005)	0.01 (0.005)	-0.08 (0.09)
Capital controls	0.04 (0.04)	0.08 (0.04)*	-0.04 (0.02)*	0.06 (0.03)+	0.02 (0.01)+	-0.03 (0.02)	-0.01 (0.01)	0.00 (0.002)	0.03 (0.07)
Peg	0.03 (0.03)	-0.02 (0.03)	0.05 (0.02)**	-0.02 (0.02)	0.01 (0.02)	0.03 (0.01)*	0.01 (0.01)	0.01 (0.01)	0.07 (0.09)
EMU	-0.13 (0.04)**	-0.04 (0.03)	-0.10 (0.03)**	0.00 (0.03)	-0.04 (0.01)**	-0.04 (0.02)+	0.16 (0.02)**	-0.21 (0.02)**	-0.17 (0.12)
GDP per capita	0.15 (0.11)	0.15 (0.13)	0.00 (0.10)	0.13 (0.11)	0.02 (0.05)	0.03 (0.09)	-0.02 (0.01)+	-0.01 (0.02)	0.08 (0.27)
POP	0.64 (0.27)*	0.59 (0.27)*	0.06 (0.17)	0.36 (0.24)	0.22 (0.08)**	0.09 (0.16)	-0.04 (0.03)	0.01 (0.03)	0.72 (0.56)
y2000	0.03 (0.02)	-0.01 (0.03)	0.04 (0.02)+	0.01 (0.02)	-0.01 (0.01)	0.03 (0.02)+	0.00 (0.003)	0.00 (0.003)	0.06 (0.06)
y2004	0.08 (0.04)+	0.02 (0.05)	0.06 (0.04)	0.02 (0.04)	0.00 (0.02)	0.05 (0.03)	0.02 (0.01)*	0.00 (0.01)	0.18 (0.10)+
Constant	-3.02 (1.20)*	-3.04 (1.48)*	0.01 (1.12)	-2.41 (1.26)+	-0.62 (0.49)	-0.31 (1.03)	0.31 (0.16)+	0.01 (0.21)	-3.30 (3.01)
Obs.	306	306	306	306	306	306	306	306	300
<i>R</i> <sup>2</sup>	0.92	0.92	0.87	0.94	0.85	0.87	0.95	0.97	0.93

Standard errors clustered at the country level in parentheses. + significant at 10%; \* significant at 5%; \*\* significant at 1% .

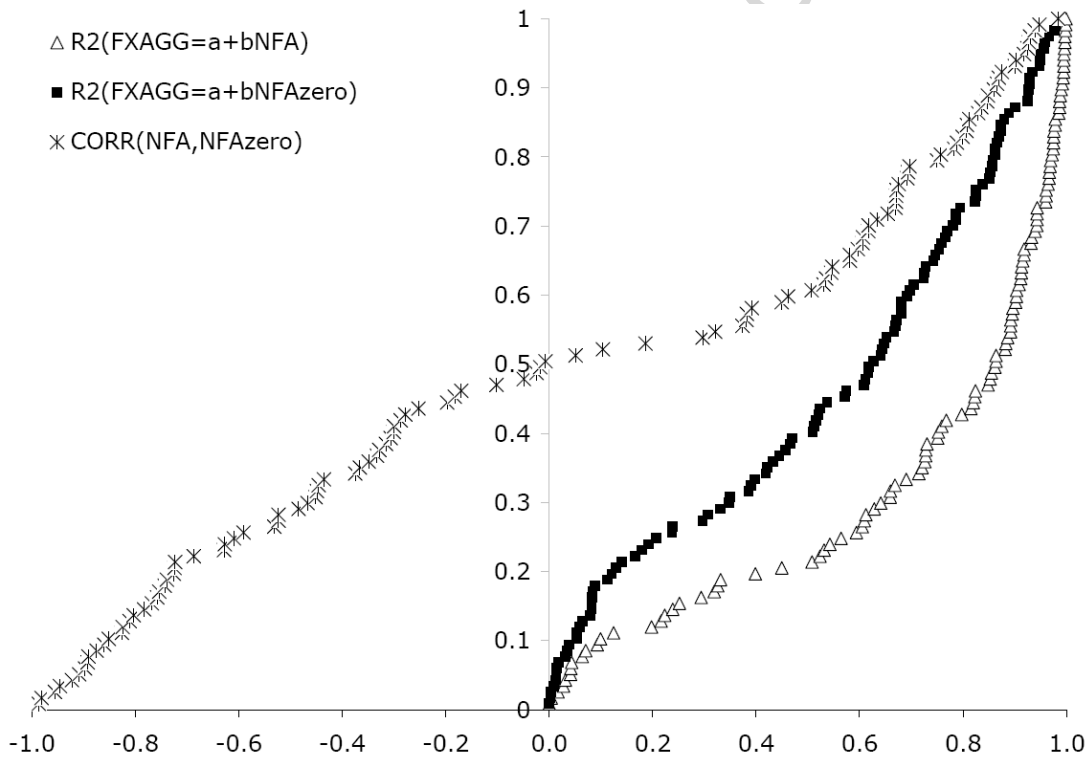


Figure 1: Decomposition  $FX^{AGG} = NFA + FX^{AGG,0}$ . Cross-country distribution of statistics.

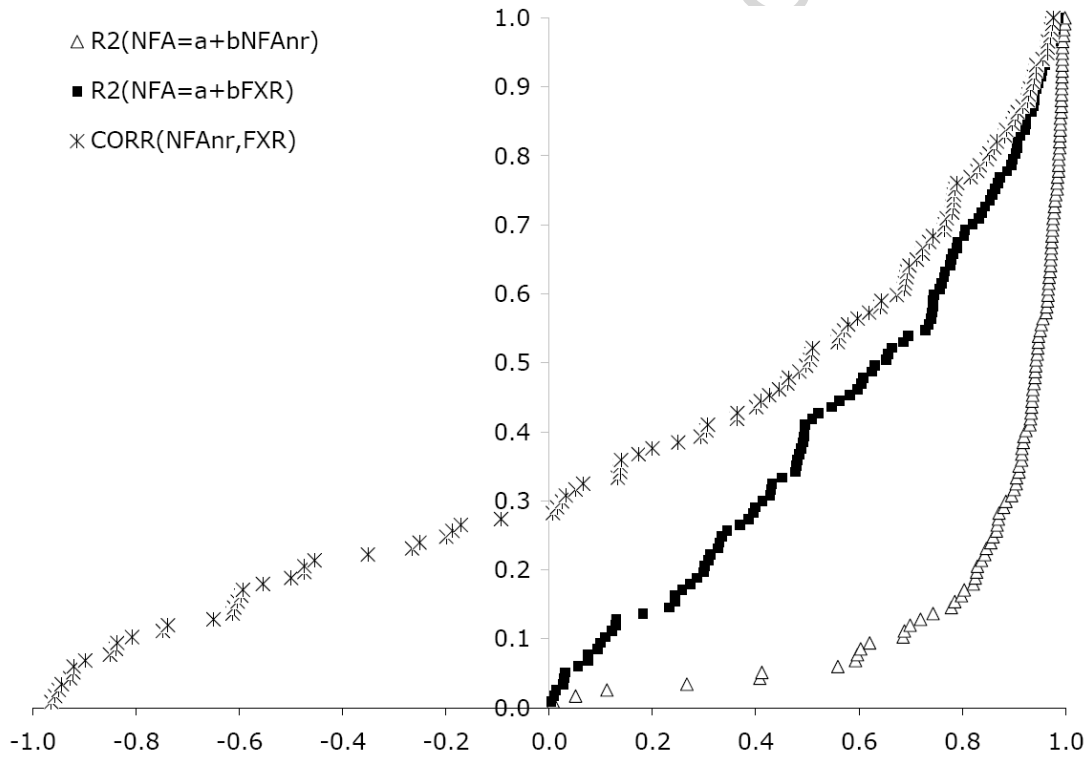


Figure 2: Decomposition of  $NFA = NFA_{NR} + FXR$ . Cross-country distribution of statistics.

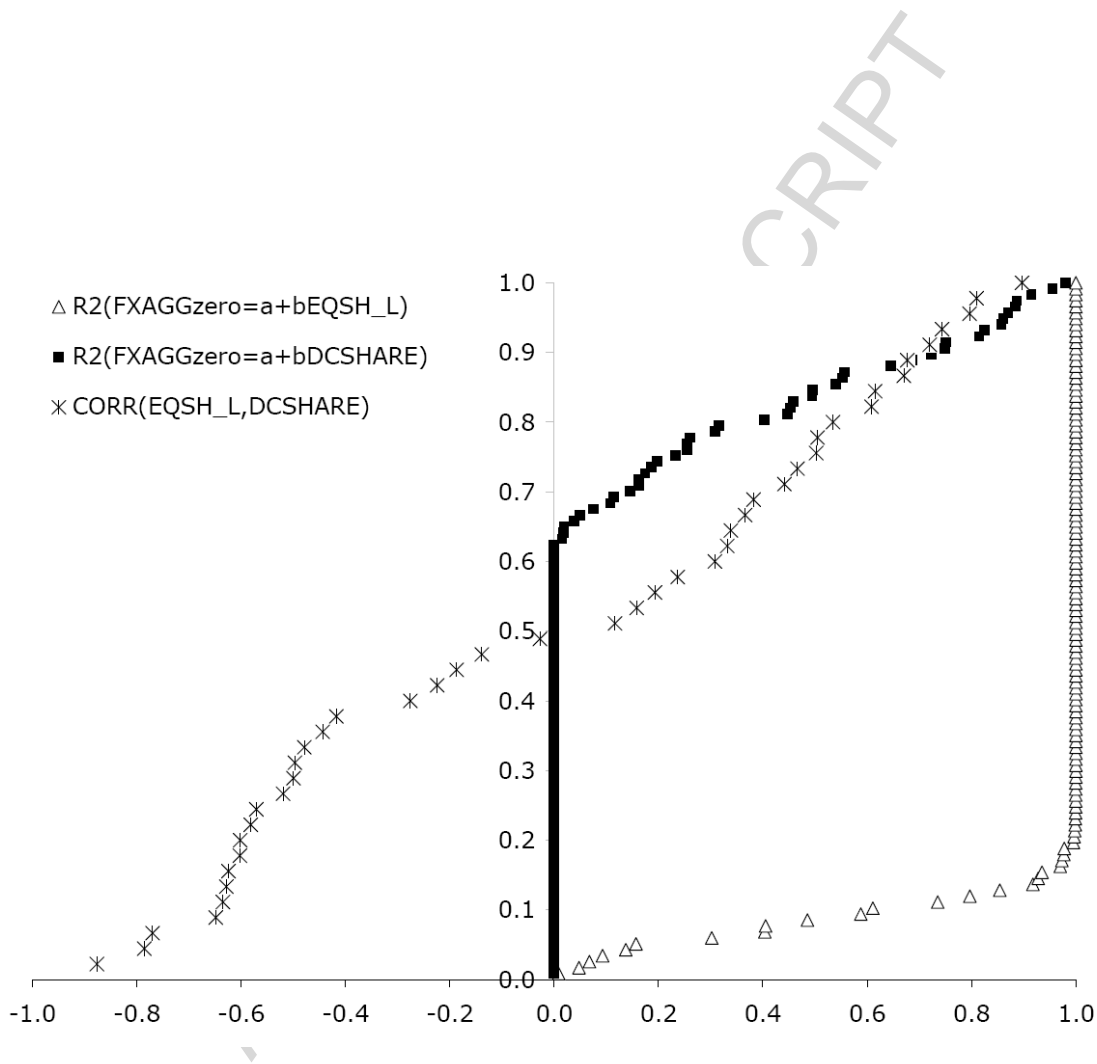


Figure 3: Decomposition  $FX^{AGG,0} = EQSH_L + DCSHARE$ . Cross-country distribution of statistics.

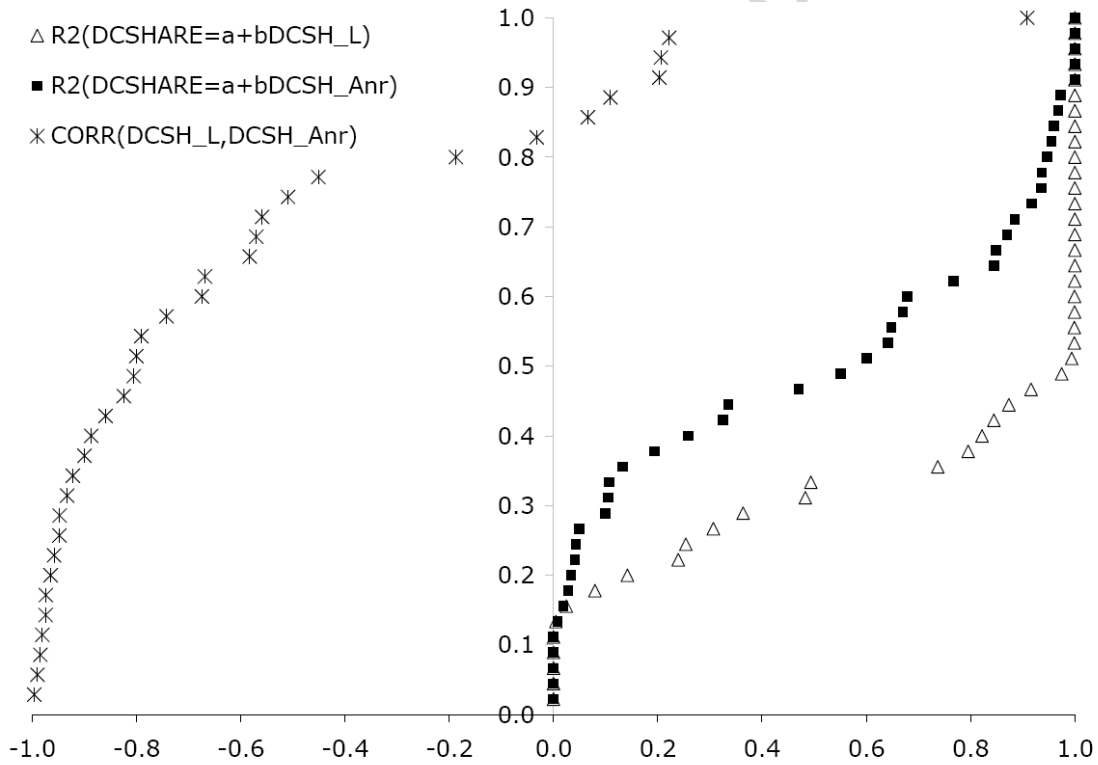


Figure 4: Decomposition of  $DCSHARE = DEBTL^{DC} - A_{NR}^{DC}$ . Cross-country distribution of statistics.

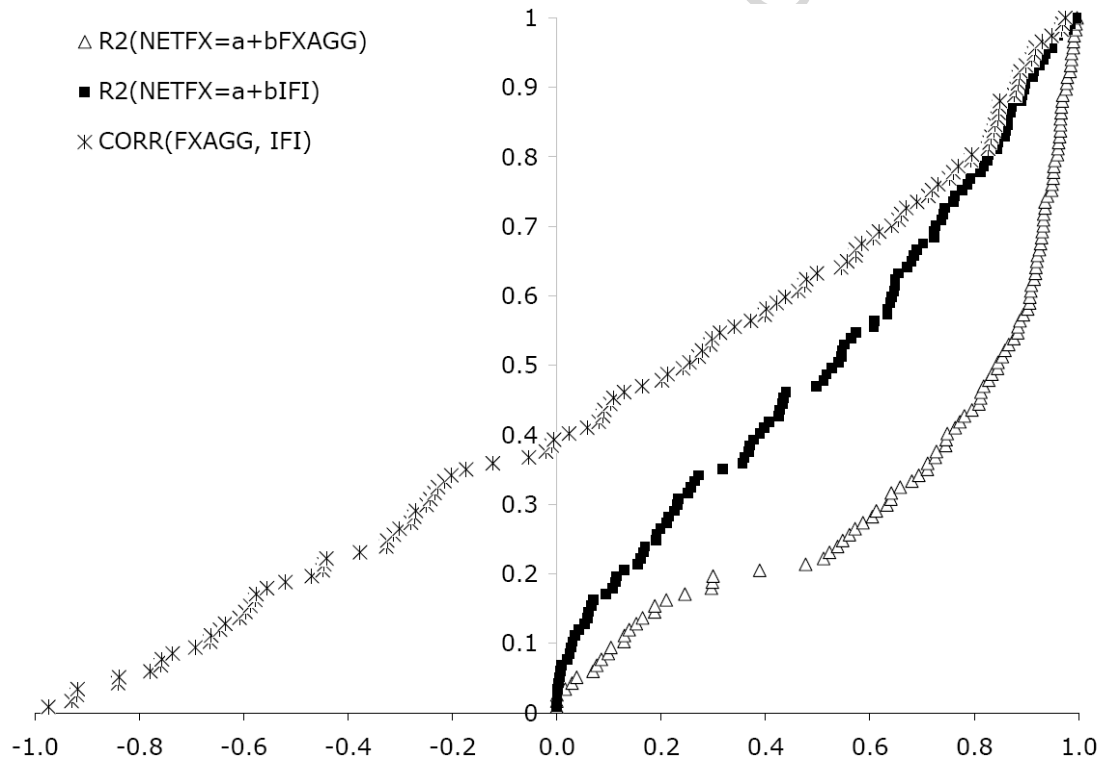


Figure 5: Decomposition of  $NETFX = FX^{AGG} * IFI$ . Cross-country distribution of statistics.

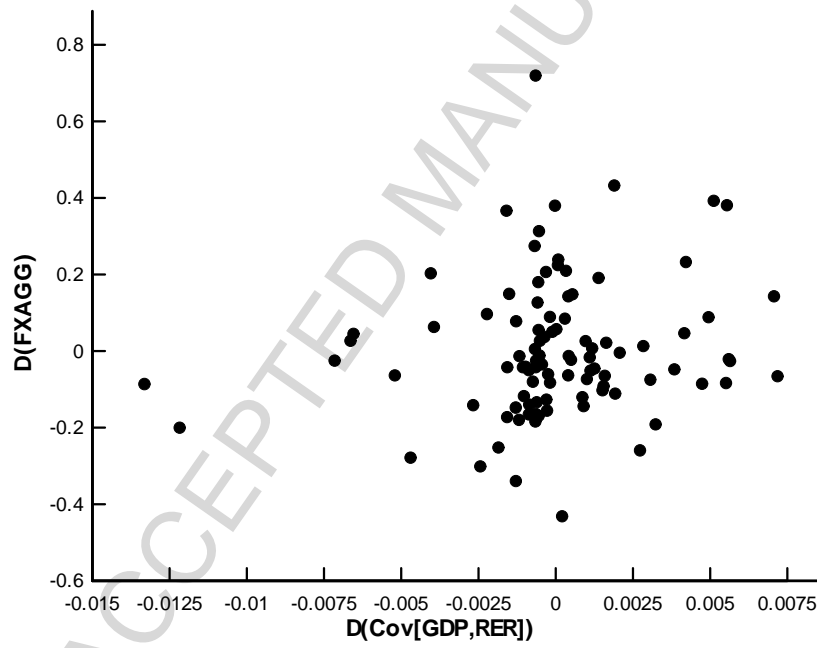


Figure 6: Scatter of Partial Relation between  $\Delta \text{COV}(\text{GDP}, \text{NEER})$  and  $\Delta \text{FX}^{\text{AGG}}$ .