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THE TRANSFER PROBLEM REVISITED: NET FOREIGN ASSETS AND REAL EXCHANGE RATES

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Abstract——The relationship between international payments and the real exchange rate-the transfer problem—is a classic question in international economics. We use cross-country data on real exchange rates and a newly constructed data set on countries' net external positions to shed new light on this question. We present a simple theoretical framework that leads to testable implications for the long-run comovements of real exchange rates, net foreign assets, relative GDP and terms of trade, and cross-country and time series evidence on the subject. We show that on average countries with net external liabilities have more depreciated real exchange rates, and that the main channel of transmission seems to be the relative price of nontraded goods, rather than the relative price of traded goods, across countries.

I. Introduction

THE relationship between international payments and the real exchange rate—the *transfer problem*—is one of the classic questions in international economics, brought to the fore by the debate in the 1920s between Keynes (1929) and Ohlin (1929) on the impact of German war reparations. A number of events during the past two decades—the 1980s debt crisis, the 1997 Asian crisis, and the ever-growing external liabilities of the United States—have led to a resurgence of interest in this topic, in view of the central prediction that the wealth effects and international investment income flows associated with nonzero net foreign asset positions require some degree of real-exchange-rate adjustment in the long run.[1] By extension, in terms of the current policy debate concerning the exchange rate regime choices of emerging market economies, the operation of a powerful transfer effect may suggest a preference for nominal-exchange-rate flexibility in order to allow the real adjustment to take place as smoothly as possible.[2] Finally, the transfer effect plays a central role in many "new open-economy macroeconomic" models that highlight the role of the net foreign asset position as a state variable that can generate persistent effects even from temporary shocks (Obstfeld & Rogoff, 1995; Lane, 2001). In this paper we use cross-country data on real exchange rates and a newly constructed data set on countries' net external asset positions—the key determinants of international payments—to shed new light on this old question.

There is a vast literature on the determinants of real exchange rates [see, for example, the surveys by Froot and Rogoff (1995), Rogoff (1996), and, for developing countries, Edwards (1989), Edwards and Savastano (2000), and Hinkle and Montiel (1999)]. However, relatively little empirical work has been done to assess the quantitative significance of the transfer effect— namely, to assess whether debtor (creditor) countries tend to have more depreciated (appreciated) real exchange rates. The paucity of data on net foreign asset positions, which determine the direction and size of investment income flows, may be responsible for the lack of research contributions in this area. In recent work (Lane & Milesi-Ferretti, 2001), we have sought to remedy this situation by constructing new estimates of foreign asset and liability positions for a large set of industrial and developing nations, covering the last three decades. In this paper we exploit this new data set to investigate the empirical importance of the transfer effect in the long run.

A second motivation for the study is that the limited existing literature on this topic has focused almost exclusively on the terms of trade as the mechanism by which international transfers affect relative prices, in line with the original argument by Keynes (see, for example, Broner, Loayza, and Lopez, 1997). We are uncomfortable with this

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[1] See Krugman (1999) amongst others.

[2] Goldfajn and Valdés (1999) show that real-exchange-rate adjustment typically takes place via nominal-exchange-rate adjustment.

approach, for several reasons. First, the terms of trade are endogenous to an individual country only if it exerts significant market power in its export/import markets. Though this may be important for the largest industrial countries, it is less likely to be so for small or developing economies.[3] Rather, for many countries, the terms of trade are instead an important source of exogenous fluctuations in the real exchange rate. Second, an exclusive focus on the terms of trade neglects the potentially large impact of international transfers on the relative price of nontradables, an effect already emphasized by Ohlin (1929). We seek to redress this imbalance by emphasizing the role played by the relative price of nontradables in determining long-run exchange rate behavior. Because we include the terms of trade as one of our regressors, any significant role for net foreign assets in determining real exchange rates in our empirics must be operating through some other channel.

Although the short-run comovement between net foreign assets and the real exchange rate clearly depends on the type of the underlying shock, several theoretical approaches predict that real appreciations should be associated with accumulation of net foreign assets in the long run. In a simple Keynesian setting, countries with large external liabilities need to run large trade surpluses in order to service them, and achieving these trade surpluses requires (by assumption) a more depreciated level of the real exchange rate. Mussa (1984) presented a simple model of a small open economy consuming an exportable and an importable good where the trade balance depends on the country's terms of trade. The model implies a positive long-run comovement between terms of trade and net foreign assets. Broner et al. (1997) extended Mussa's model to allow for nontraded goods. In the long run, net foreign assets equal their desired level, and uniquely determine the terms of trade (which are the sole determinants of the trade balance).[4]

In intertemporal optimizing models, the transfer effect can operate in the presence of a home preference for domestic tradables, or through the impact of wealth effects on labor supply. In the former case (see, for example, Buiter, 1989), a transfer from the home to the foreign country implies a decline in global demand for home goods, and hence necessitates a fall in their relative price.[5] In the latter case (see, for example, Obstfeld & Rogoff, 1995), a transfer from the home to the foreign country reduces domestic wealth and hence raises the labor supply and the supply of exportables, affecting their relative price. Another alternative, presented in Obstfeld and Rogoff (1996), is a Ricardian model where a range of goods is not traded, due to transport costs. In this setting, a transfer from the home to the foreign country raises spending on foreign nontradables: foreign wages rise, the foreign export sector declines, and the home export sector expands. The foreign terms of trade improve, and the foreign real exchange rate appreciates. The latter is due to (a) an increase in the price of nontradables, due to higher wages; (b) a larger fraction of tradables that are imported from home and hence incur transport costs, raising prices.

As a theoretical framework to guide the empirical work, we develop in the next section a simple intertemporal optimizing model of the transfer effect, in which an endogenous relative price of nontradables is the mechanism linking international payments and the real exchange rate. We show that the real exchange rate is also influenced by relative output levels and exogenous shifts in the terms of trade. Based on this theoretical work, we derive a specification that guides the empirical work in the rest of the paper. This empirical specification is also consistent with a range of alternative theoretical models.

Our empirical results show a strong cross-sectional correlation between changes in real exchange rates and changes in net foreign assets, in both industrial and developing countries. A significant long-run transfer effect of remarkably similar magnitude is also found in the fixed-effects panel estimation: in the long run, improving net external positions are associated with appreciating real exchange rates. Moreover, we show that the magnitude of the transfer effect varies systematically with the way the real exchange rate is measured, and that it is larger for the CPI-based than for the WPI-based real effective exchange rate. Given the larger weight of nontraded goods in the CPI-based measure, this finding suggest that the transfer effect operates to a significant extent through the relative price of nontraded goods in the home country vis-à-vis its trading partners. The panel regressions also show that the size of the transfer effect is related to country characteristics such as trade openness, output per capita, country size, the composition of external liabilities, and restrictions on the external payments system.

The rest of the paper is organized as follows. Section II presents the theoretical framework, section III the data, and section IV the empirical results for cross-section and panel

[3] We acknowledge that a small country may have market power if it specializes in niche sectors, but maintain the standard assumption that, in broad terms, market power is a decreasing function of country size. For instance, suppose there are N equal-size firms in an industry. If $N - 1$ firms are located in a large country and 1 firm in a small country, the level of output in the small country should have small effects on the industry's output price under a range of assumptions concerning market structure.

[4] These are reduced-form models. In Broner et al.'s model, the relative price of nontraded goods also potentially depends on desired net foreign assets, but the sign is ambiguous. Moreover, its role is purely the achievement of "internal balance': the trade balance only depends on the terms of trade. Mussa (1984) recognizes that his model is isomorphic to one in which the terms of trade are exogenous and adjustment takes place via endogenous shifts in the relative price of nontradables. Alberola et al. (1999) employ a similar model.

[5] Keynes (1929) argued that in order for a transfer effect to exist, the composition of spending between the country effecting the transfer and the recipient must be different: "If £1 is taken from you and given to me and I choose to increase my consumption of precisely the same goods as those of which you are compelled to diminish yours, there is no Transfer Problem" (p. 2).

data. Section V provides a comparison with other empirical studies. Section VI concludes.

II. Theory

To illustrate how the net foreign asset position may influence the relative price of nontradables, we consider a small open economy model.[6] For simplicity, we assume the output of the tradable sector is an endowment Y_T that sells on world markets at the export price P_T^x in units of the imported tradable consumption good, which is the numeraire. Domestic consumption of the export good is zero. By this definition, P_T^x is the terms of trade (the ratio of export prices to import prices). Labor is supplied to a competitive nontraded sector.

Agent j has the objective function

$$V_j = \sum_{t=0}^{\infty} \beta^t \left(\frac{\sigma}{\sigma - 1} C_t^{\sigma-1/\sigma} - \frac{\kappa}{2} l_{Nt}^2 \right), \tag{1}$$

where $\beta \in (0,1)$ and $\sigma, \kappa > 0$. The consumption index C_t aggregates consumption of traded and nontraded goods:

$$C_t = [\gamma^{1/\theta} C_{Tt}^{(\theta-1)/\theta} + (1-\gamma)^{1/\theta} C_{Nt}^{(\theta-1)/\theta}]^{\theta/(\theta-1)}, \tag{2}$$

where θ is the constant elasticity of substitution between traded and nontraded goods. The second term in parentheses in the objective function V_j captures the disutility of work effort, where l_{Nt} is the amount of labor supplied to the nontraded sector.

The agent can invest in an international real bond, denominated in units of the import good. The flow budget constraint faced by agent j is given by

$$B_{t+1} = (1 + r) B_t + w_t l_{Nt} + P_{Tt}^x y_T - P_t C_t, \tag{3}$$

where B_t denotes real bonds (in units of the tradable good) that pay off a real return r, which is given exogenously. The nominal wage is w_t, and the consumption price index is given by

$$P_t = [\gamma + (1 - \gamma) P_{Nt}^{1-\theta}]^{1/(1-\theta)}, \tag{4}$$

where P_{Nt} is the price of the nontradable good.

The real exchange rate is defined as the ratio of the domestic to the foreign CPI,

$$RER_t \equiv \frac{P_t}{P_t^*} = P_t, \tag{5}$$

where we hold the foreign price level fixed at unity throughout the analysis. Notice that the CPI-based real exchange rate is mechanically independent of the terms of trade. In this model, the terms of trade may influence the real exchange rate indirectly only, through a wealth effect on the relative price of nontradables.[7]

The production function in the nontraded sector is linear in labor,

$$y_{Nt} = l_{Nt}, \tag{6}$$

the nominal price of the nontradable good is just equal to the wage:

$$P_{Nt} = w_t. \tag{7}$$

A. First-Order Conditions

For simplicity, we assume $\beta(1+r) = 1$, which rules out the desire to borrow and lend in the steady state. Optimal consumption and work effort decisions generate the relationships

$$\frac{C_{Tt+1}}{C_{Tt}} = \left(\frac{P_t}{P_{t+1}} \right)^{\sigma-\theta}, \tag{8}$$

$$\frac{C_{Nt}}{C_{Tt}} = \frac{1-\gamma}{\gamma} (P_{Nt})^{-\theta}, \tag{9}$$

$$y_{Nt} = \frac{1}{\kappa} C_t^{-1/\sigma} \frac{P_{Nt}}{P_t}. \tag{10}$$

Equation (8) is the Euler equation governing consumption dynamics. The dependence of consumption growth on the sequence of relative prices is the "consumption-based real interest rate" effect, first emphasized by Dornbusch (1983). If the aggregate price level relative to the price of traded goods is low relative to its future value, this encourages present over future consumption, as the consumption-based real interest rate is lower. However, it also encourages substitution from traded to nontraded goods. The former effect dominates if the intertemporal elasticity of substitution, σ, is greater that the intratemporal elasticity of substitution, θ, and conversely.

Equation (9) links consumption of nontraded and traded goods. The elasticity of substitution is parameterized by θ; if the relative price is unity, then the relative consumption of nontraded goods is decreasing in the parameter γ. Finally, the equilibrium supply of nontraded goods is given by

[6] See also Obstfeld and Rogoff (1996, chapter 10). Our goal here is to develop a simple model that links the real exchange rate to the net foreign asset position, plus some control variables. It is well understood that there exist a range of two-sector models in which the relative price of nontradables depends only on relative productivity levels—see, for example, Turnovsky (1997). In the regressions, we hold fixed the terms of trade, so a small open economy assumption is appropriate in formulating the background model. Whether the net foreign asset position matters for the real exchange rate is ultimately an empirical question.

[7] More generally, the terms of trade could directly affect the CPI-based real exchange rate if there were home bias in consumption of tradables. The terms of trade of course directly affects real-exchange-rate measures that are based on production rather than consumption indices. See also Appendix A.

equation (10): the higher is the consumption index C, the lower is the level of production, as agents increase leisure in line with consumption of other goods.

B. Steady-State Analysis

We first consider a benchmark steady state in which all variables are constant. In this state, we assume the stock of net foreign assets is zero. We normalize the endowment of the traded good so that the relative price of nontraded goods in terms of traded goods P_N is unity. We also assume the terms of trade is unity ($P_T^x = 1$). In this symmetric equilibrium, the steady-state production and consumption of nontraded and traded goods are given by

$$Y_N = C_N = \left(\frac{1}{\kappa}\right)^{\sigma/\sigma+1} (1-\gamma)^{1/(1+\sigma)}, \tag{11}$$

$$C_T = Y_T = \frac{\gamma}{1-\gamma} Y_N. \tag{12}$$

From equation (11), production of the nontraded good will be higher, the less taxing is work effort (the smaller is κ) and the larger is the weight $1 - \gamma$ placed on consumption of nontraded goods in the utility function.

We next take a linear approximation around this benchmark, to derive the impact of steady-state variation in net foreign assets (B), tradable output (Y_T), and the terms of trade (P_T^x).[8] Let tildes denote percentage changes relative to the benchmark steady state, so that

$$\tilde{C}_T = r\tilde{B} + \tilde{Y}_T + \tilde{P}_T^x, \tag{13}$$

where $\tilde{B} \equiv dB/C_{T0}$. Three factors drive steady-state consumption of tradables: net foreign assets, the level of the tradable output endowment, and the terms of trade. Steady-state variations in production and consumption of nontradables are derived by taking linear approximations to equations (8)–(10) in the neighborhood of the steady state defined by (11) and (12):

$$\tilde{Y}_N = \tilde{C}_N = \tilde{C}_T - \theta\tilde{P}_N, \tag{14}$$

$$\tilde{Y}_N = \tilde{C}_N = \frac{(\sigma-\theta)\gamma}{1+\sigma}\tilde{P}_N. \tag{15}$$

Combining equations (13)–(15), we obtain an expression for the relative price of nontradables:

$$\tilde{P}_N = \frac{1+\sigma}{(1-\gamma)\theta + (\gamma+\theta)\sigma}(r\tilde{B} + \tilde{Y}_T + \tilde{P}_T^x), \tag{16}$$

[8] The experiment here is a comparison of alternative steady states with different values for the net foreign asset position, output, and the terms of trade. We do not model the origin of these differences in fundamentals: our goal is just to examine the link between these fundamentals and the steady-state real exchange rate.

in log levels,

$$\log(P_N) = \Omega + \frac{\lambda r}{\gamma}\frac{B}{Y_0} + \lambda \log(Y_T) + \lambda \log(P_T^x), \tag{17}$$

where Ω is a constant, $\lambda \equiv (1+\sigma)/[(1-\gamma)\theta + (\gamma+\theta)\sigma]$, and $Y_0 \equiv C_0$.[9] According to equation (17), the relative price of nontradables is increasing in the level of net foreign assets, in the level of (tradable) output, and in the terms of trade. The intuition is straightforward. Any factor that raises consumption of tradables also exerts a positive wealth effect that reduces the labor supply to the nontradable sector, leading to a increase in the relative price of nontradables and hence a real appreciation. We derive the variation in the real exchange rate by

$$\widetilde{RER} = \tilde{P} = (1-\gamma)\tilde{P}_N \tag{18}$$

or, in log levels,

$$\begin{aligned}\log(RER) &= (1-\gamma)\log(P_N) \\ &= (1-\gamma)\Omega + \frac{(1-\gamma)\lambda r}{\gamma}\frac{B}{Y_0} \\ &\quad + (1-\gamma)\lambda \log(Y_T) + (1-\gamma)\lambda \log(P_T^x) \\ &= \alpha + \beta_1\frac{B}{Y_0} + \beta_2 \log(Y_T) + \beta_3 \log(P_T^x),\end{aligned} \tag{19}$$

where $\beta_1, \beta_2, \beta_3 > 0$. In this setup, the real exchange rate is just a monotonic transformation of the relative price of nontradables.[10] Equation (19) forms the basis for our empirical analysis.

III. Data: Sources and Construction

Our sample includes 64 industrial and (mostly) middle-income developing countries, listed in Appendix C, and is based on the availability of data on net external positions. The source of data for that variable is Lane and Milesi-Ferretti (2001), to which the reader is referred for a detailed discussion of data construction. Net foreign assets NFA are defined as

$$\begin{aligned} NFA = {} & FDIA + EQA + DEBTA + FX \\ & - FDIL - \mathrm{EQL} - \mathrm{DEBTL}, \end{aligned} \tag{20}$$

[9] We derive the log-level equation as a Taylor approximation around the benchmark steady state.

[10] The level of output should be understood to be measured relative to output overseas. A global tradable output increase would increase the relative price of nontradables in all countries, leaving the real exchange rate unchanged. In the empirics, relative GDP per capita is employed as a proxy for relative levels of tradable output, because sectoral output data are not available for a broad range of countries.

where FX is foreign exchange reserves, and FDI, EQ, and $DEBT$ are the stocks of direct investment, portfolio equity investment, and debt instruments, respectively, with the letter A indicating assets and the letter L liabilities. The balance-of-payments identity states that the current account, net financial flows, and changes in foreign exchange reserves sum to 0, so that

$$CA = (\Delta FDIA - \Delta FDIL) + (\Delta EQA - \Delta EQL) + (\Delta DEBTA - \Delta DEBTL) + \Delta FX - \Delta KA - EO, \tag{21}$$

where a Δ indicates flows, ΔKA capital account transfers, and EO errors and omissions. Assuming that EO reflects changes in debt assets held by country residents abroad, in line with the capital flight literature, and disregarding asset valuation changes, we can approximate the change in NFA with the current account balance CA, net of capital account transfers KA:

$$\Delta NFA \cong CA + \Delta KA. \tag{22}$$

Hence, given an initial stock of net external assets, we can obtain a crude estimate of the current stock by cumulating the current account balance, net of capital transfers. The composition of NFA can correspondingly be obtained by cumulating the relevant flows on the RHS of equation (21). We improve on this crude NFA measure along several dimensions. First, we make use of direct stock measures, rather than cumulative flows, for foreign exchange reserves FX and (with respect to developing countries) gross external debt $DEBTL$, and adjust our NFA measure correspondingly. This allows us to take into account the impact on NFA of debt forgiveness and reduction agreements, cross-currency fluctuations, misreporting of capital flows, and capital gains and losses on foreign reserves. Second, we allow, albeit imperfectly, for the impact of changes in relative prices across countries on the value of FDI assets and liabilities, as well as for the impact of variations of stock market prices on portfolio equity stocks. The impact of these adjustments is quite substantial: for some industrial countries, the correlation between the changes in NFA and the current account is actually zero or negative. A comparison with direct measures of NFA shows the robustness of our methodology, with our estimates tracking official ones quite closely (see Lane & Milesi-Ferretti, 2001). Appendix D describes the data construction process in more detail, as well as the data sources for the other variables.

The CPI- and WPI-based multilateral real exchange rates were constructed as the ratio between the domestic price index, converted in dollar terms at the average nominal exchange rate for the year, and a trade-weighted average of trade partners' price indices in U.S. dollar terms. Cross-country differences in the construction and coverage of WPI indices, together with their more limited availability, implies that the CPI-based real-exchange-rate measure is more reliable. An additional issue, which is particularly relevant in the earlier part of our sample, is the existence in a few developing countries of sizable black-market premia, implying that the official exchange rate cannot really be considered an equilibrium price. In the empirical analysis we highlight when this factor is likely to play an important role.

The GDP per capita relative to trading partners was constructed using Summers and Heston's data on GDP per capita at constant 1985 international dollars, updated to 1997 using the growth rate of per capita GDP calculated by the World Bank.[11] For each country, we use the same partner countries' trade weights used for the real effective exchange rate. Most studies testing the Balassa-Samuelson hypothesis use total factor (or labor) productivity differentials between traded and nontraded goods to explain real-exchange-rate dynamics [see, for example, Asea and Mendoza (1994); De Gregorio, Giovannini, and Wolf (1994); and the recent treatment in Canzoneri, Camby, and Diba (1999)]. However, these data are unavailable for developing countries, furthermore, we want to allow for alternative channels of influence of relative output levels on real exchange rates, such as a higher income elasticity of demand for nontraded goods (see, for example, Bergstrand, 1991).

Finally, the terms of trade is defined as the ratio of a country's export prices (or export unit values) to its import prices (or import unit values), both expressed in U.S. dollars.

IV. Empirical Methodology

We focus on the long-run relation between NFA and the real exchange rate. Although interesting, the short-run relation between these variables is outside the scope of our analysis.[12] We examine two dimensions of the data. We first study the cross-sectional evidence where the specification is

$$\begin{aligned}\log(RER_{i,tT}) - \log(RER_{i,st}) &= \alpha + \beta_{xs}^{NFA}(NFA_{i,tT} - NFA_{i,st}) \\ &\quad + \beta_{xs}^{YD}[\log(YD_{i,tT}) - \log(YD_{i,st})] \\ &\quad + \beta_{xs}^{TT}[\log(TT_{i,tT}) - \log(TT_{i,st})] + \varepsilon_{i,xs},\end{aligned} \tag{23}$$

where st and tT denote average values over the intervals $[s,t]$ and $[t,T]$, respectively.[13] For the cross section, it is necessary to look at differences on differences, because the real exchange rate and the terms of trade are index-based, making levels not directly comparable across countries.

[11] Using a GDP volume index at 1990 prices (from the IMF's International Financial Statistics) divided by population yields similar results.

[12] We adopt a single-equation estimation approach. Clearly, a multi-equation structural model would be preferable in order to sort out the various causal links between the variables, but the identification and data problems in estimating a full system are forbidding. Modeling the short-run dynamics would also be challenging, in that nonlinearities appear to be important in real-exchange-rate adjustment (see Taylor, 2001).

[13] We use period averages rather than end years, because real exchange rates may deviate from fundamental values in the short run.

However, a cross-sectional approach is clearly constrained in terms of sample size, and may not fully capture the long-run patterns that are our focus. Accordingly, we also examine time series fixed-effects panel evidence. We will show that a cointegrated relation exists among the components of the vector [*RER, NFA, YD, TT*]. By estimating the cointegration equation, the long-run relation among these variables is uncovered. Moreover, the superconsistency property of cointegrated equations means that any possible endogeneity running from the real exchange rate to the regressors does not affect the estimated long-run coefficients.

We estimate the cointegration equation by a panel version of the dynamic ordinary least squares (DOLS) estimator developed by Stock and Watson (1993). Kao and Chiang (2000) and Mark and Sul (2002) provide evidence that DOLS outperforms other panel estimators in obtaining reliable long-run coefficients. The general specification is

$$\begin{aligned}\log(RER_{it}) = {} & \alpha_i + \beta^{NFA}\, NFA_{it} + \beta^{YD} \log(YD_{it}) \\ & + \beta^{TT} \log(TT_{it}) + \sum_{k=-1}^{k=1} v_k^{NFA} \Delta NFA_{it+k} \\ & + \sum_{k=-1}^{k=1} V_k^{YD} \Delta \log(YD_{it+k}) \\ & + \sum_{k=-1}^{k=1} V_k^{TT} \Delta \log(TT_{it+k}) + \varepsilon_{it}, \qquad (24)\end{aligned}$$

where RER_{it} is the multilateral (CPI or WPI) real exchange rate, α_i is a country dummy, NFA_{it} is the ratio of *NFA* to the GDP, YD_{it} is the GDP per capita relative to trading partners, TT_{it} is the terms of trade, Δ is the first-difference operator, and ε_{it} is a residual. Including leads and lags of first differences of the regressors improves the efficiency in estimating the long-run β coefficients.

A. *Cross-Section Results*

The question we address in this subsection is whether changes in the average real exchange rates across countries over prolonged periods of time are correlated with changes in their net external position, relative GDP per capita, and terms of trade. In order to undertake this exercise, we calculate the averages of these variables for the periods 1975–1985 and 1986–1996, and then take the difference between the two. Changes in *NFA* will in general be endogenous with respect to exchange rate changes, at least in the short run.[14] To address this issue, we also present empirical evidence relating real exchange rates and *NFA,* in which the latter variable is instrumented using a parsimonious set of long-run determinants (public debt, demographic variables, and GDP per capita) suggested in Lane and Milesi-Ferretti (2002a).

We present results using both the CPI-based and the WPI-based real exchange rates. As argued earlier, different channels of transmission of the impact of *NFA* on real exchange rates would imply different correlation patterns with these real-exchange-rate measures. We first focus on the bivariate correlation between real-exchange-rate changes and changes in *NFA* (actual and fitted), relative GDP per capita, and terms of trade, respectively, and then present multivariate regressions. We report results for the full sample, industrial countries, and developing countries. For the last, we also present results for a sample that excludes countries experiencing large changes in the black-market premium between the two periods.[15]

Bivariate Correlations: Table 1 lists bivariate correlations between changes in our two real-exchange-rate indices—$\Delta RERCPI$ and $\Delta RERWPI$—and changes in the ratio of *NFA* to GDP (ΔNFA), the fitted (instrumental variables) change in the *NFA* ratio [$\Delta NFA(IV)$], the relative GDP per capita (ΔYD), and the terms of trade (ΔTT). The instrumental variables used to construct the fitted change in *NFA* are the ratio of public debt to GDP, demographic variables, and GDP per capita. As shown in Lane and Milesi-Ferretti (2002a), these variables capture medium- and long-term movements in *NFA* quite well. Data availability for public debt and demographic variables reduces the ΔNFA (*IV*) sample size to 54 countries. Appendix D describes the construction of $\Delta NFA(IV)$ in more detail.

As shown in table 1, the correlation of ΔNFA with $\Delta NFA(IV)$ is high (between 0.64 and 0.78, depending on the sample). Other findings can be summarized as follows:

1. $\Delta RERCPI$ and [ΔNFA (IV)] are strongly correlated for industrial countries, in line with the prediction of our theoretical model; the correlation is positive but weaker for developing countries (see figures 1 and 2, first panel). The correlation of $\Delta RERWPI$ with ΔNFA

[14] For example, a nominal depreciation causes both the real exchange rate to depreciate and the GDP in U.S. dollars to fall. If the country has net external liabilities that are primarily denominated in U.S. dollars, the *NFA*-to-GDP ratio will deteriorate. This effect will be partly offset by the fall in the dollar value of equity and direct investment liabilities, which are denominated in domestic currency. If the country is a foreign-currency creditor, the bias is in the opposite direction (real depreciation associated with an improvement in the *NFA*/GDP ratio). Because we are looking at long-run effects, the problem is likely to be less serious than at higher frequencies (for example, real and nominal exchange rates are less correlated at lower frequencies).

[15] In the presence of sizable black-market premia, the nominal exchange rate used in our calculations is clearly not an equilibrium price. In this case, a large measured real depreciation may just be the reflection of, say, a unification in foreign exchange markets with a consequent reduction in the black-market premium.

TABLE 1.—CROSS-SECTIONAL CORRELATIONS*

	$\Delta RERCPI$	$\Delta RERWPI$	ΔNFA	$\Delta NFA(IV)$	ΔYD	ΔTT
			A. Full Sample†			
$\Delta RERCPI$	1					
$\Delta RERWPI$	0.72	1				
ΔNFA	0.36	0.18	1			
$\Delta NFA(IV)$	0.40	0.34	0.69	1		
ΔYD	0.21	−0.07	0.52	0.41	1	
ΔTT	0.51	0.47	0.46	0.44	0.47	1
			B. Industrial Countries‡			
$\Delta RERCPI$	1					
$\Delta RERWPI$	0.73	1				
ΔNFA	0.48	0.20	1			
$\Delta NFA(IV)$	0.37	0.04	0.64	1		
ΔYD	0.45	0.15	0.76	0.82	1	
ΔTT	0.56	0.54	0.12	0.00	0.14	1
			C. Developing Countries§			
$\Delta RERCPI$	1					
$\Delta RERWPI$	0.60	1				
ΔNFA	0.40	0.21	1			
$\Delta NFA(IV)$	0.44	0.30	0.78	1		
ΔYD	0.17	−0.10	0.49	0.50	1	
ΔTT	0.30	0.14	0.55	0.49	0.57	1
			D. Developing Countries (Excluding Large Changes in Black-Market Premium)‖			
$\Delta RERCPI$	1					
$\Delta RERWPI$	0.56	1				
ΔNFA	0.38	0.18	1			
$\Delta NFA(IV)$	0.37	0.24	0.77	1		
ΔYD	0.01	−0.22	0.49	0.46	1	
ΔTT	0.23	0.16	0.55	0.46	0.49	1

*See Appendix D for a description of the variables.
†Number of observations: 54 (44 for correlations with RERWPI).
‡Number of observations: 22 (20 for correlations with RERWPI).
§Number of observations: 42 (29 for correlations with RERWPI).
‖Number of observations: 28 (21 for correlations with RERWPI).

[$\Delta NFAIV$)] is weaker than for the CPI-based measure.[16]

2. $\Delta RERCPI$ is strongly correlated with ΔYD in industrial countries, but not in developing countries (figures 1 and 2, second panel). That is, the bivariate correlations are in line with the predictions of the Balassa-Samuelson hypothesis or of the hypothesis of a higher income elasticity for the demand of nontraded goods only for industrial countries.
3. $\Delta RERCPI$ and ΔTT are strongly correlated in industrial countries, but not in developing countries (figures 1 and 2, third panel). In contrast, ΔTT is strongly correlated with ΔNFA [$\Delta NFA(IV)$] as well as with ΔYD in developing countries, but not in industrial countries.[17]
4. ΔNFA [$\Delta NFA(IV)$] and ΔYD are strongly correlated in both industrial and developing countries. In other words, countries that grow faster than their trading partners also tend to have significant improvements in their net external position (figures 1 and 2, fourth panel).

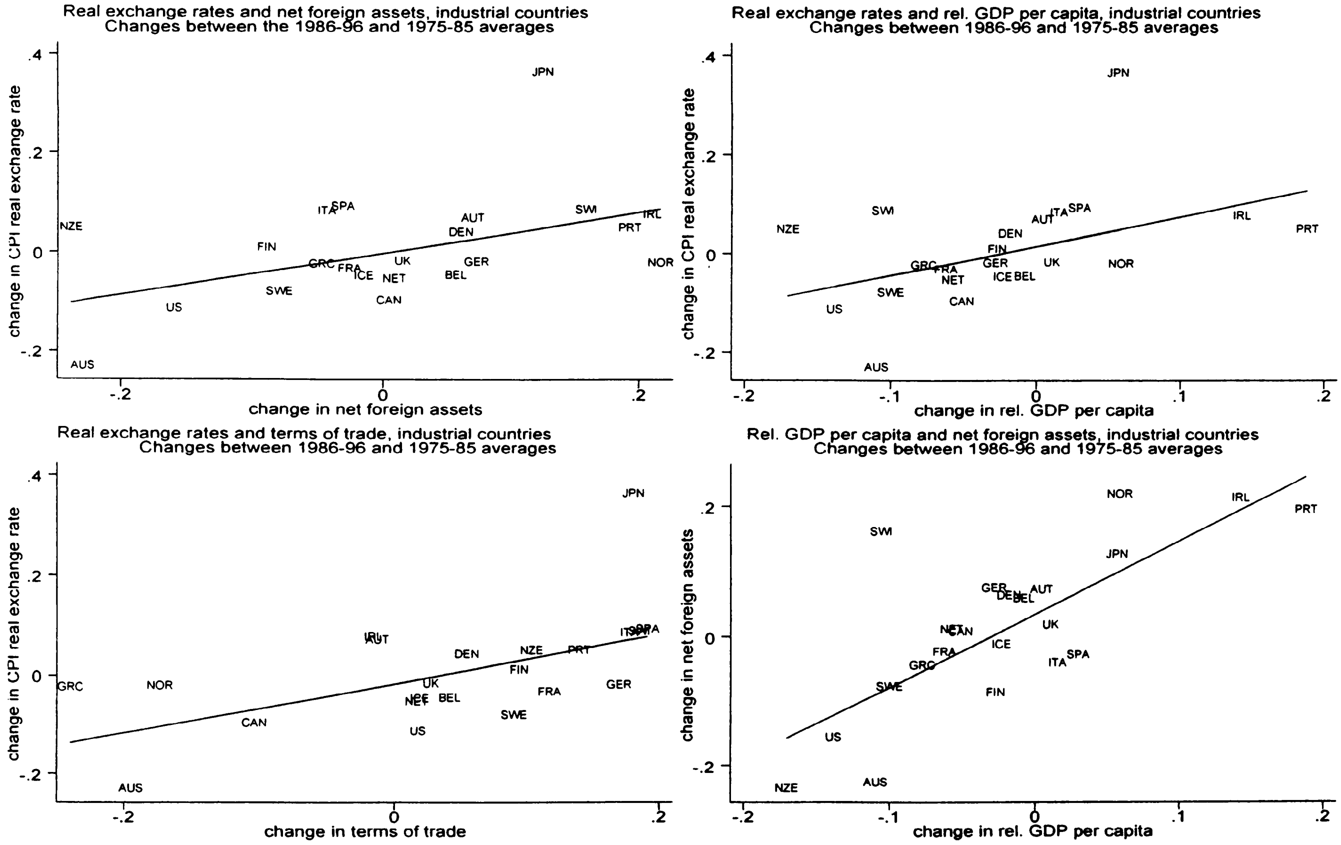
In this paper we do not attempt to model the determinants of *NFA*, but our findings 3 and 4 are interesting empirical regularities.

Multivariate Regressions: The results of multivariate cross-country regressions based on the specification in equation (23) are presented in table 2. Panel A reports regressions using the CPI-based real exchange rate as the dependent variable, panel B using the WPI-based real exchange rate, and panel C using the difference between the CPI- and the WPI-based measures. We report results of regressions using ΔNFA as explanatory variable [columns (1), (3), and (7)], as well as results using ΔNFA (IV) [columns (2), (4), (6), and (8)]. As argued above, we consider the terms of trade to have an important exogenous component, especially for developing countries; we therefore include them in the regressions. Omitting the terms of trade does not alter the economic and statistical significance of the link between real exchange rates and *NFA*. In addition to its theoretical motivation, controlling for relative output per capita strips out any indirect effects of *NFA* on the real

[16] Obstfeld and Rogoff (1995, 1996) find a positive bivariate relation between changes in the WPI-based real exchange rate and *NFA* in a sample of 15 industrial countries. We compare our findings with theirs below.

[17] On the link between growth and terms of trade in developing countries, see, for example, Mendoza (1997).

FIGURE 1.—REAL EXCHANGE RATES, NET FOREIGN ASSETS, AND RELATIVE GDP PER CAPITA, INDUSTRIAL COUNTRIES



exchange rate via its impact on relative growth performance. Similarly, by controlling for the terms of trade, any transfer effect we obtain must operate via the relative price of nontradables.[18]

For the whole sample, changes in the CPI-based real exchange rate (panel A) are positively correlated with changes in *NFA* but uncorrelated with changes in relative income in both OLS and IV regressions.[19] For industrial countries, *NFA* is significantly positively correlated with the CPI-based real exchange rate in OLS regressions, but the coefficient is less precisely estimated using IV. The colinearity between changes in *NFA* and in relative GDP per capita (see table 1) explains why the positive and significant bivariate correlations of these variables with real-exchange-rate changes do not survive in a multivariate regression. For developing countries, changes in *NFA* are strongly correlated with changes in the CPI-based real exchange rate in both OLS and IV regressions. The terms of trade have a statistically and economically significant impact on the real exchange rate in industrial countries, but, somewhat surprisingly, not in developing countries. Excluding countries with large changes in the black-market premium over the sample period does not alter results substantially.

As the bivariate correlations suggest, the WPI-based real exchange rate shows a weaker relation with *NFA*, both statistically and economically (panel B).[20] This suggests that the relative price of nontraded to traded goods is an important channel of transmission from *NFA* to the real exchange rate. To investigate this hypothesis further, we regressed changes in the log difference between the CPI and WPI-based real exchange rates (*DIFF*)—a proxy for the relative price of nontraded to traded goods across countries—on changes in *NFA* and relative GDP per capita (panel C).[21] The correlation between *DIFF* and ΔNFA is positive and significant in the full sample and for developing countries, but not for industrial countries, where we find instead a positive and significant correlation between *DIFF* and relative growth, as

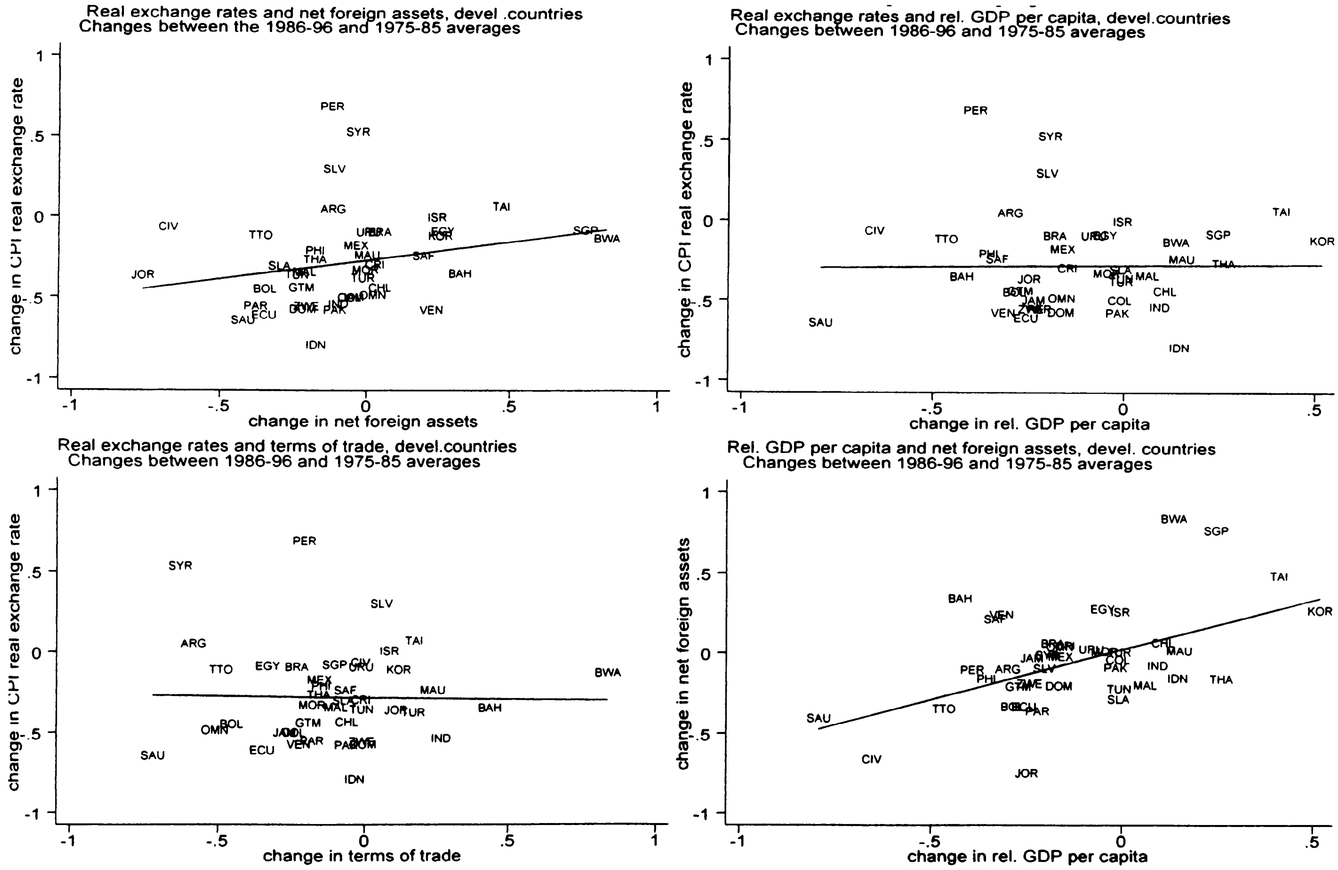
[18] As a matter of logic, the transfer mechanism may systematically affect deviations from the law of one price in tradables. Engel (1999) provides evidence that such deviations are important in explaining the *volatility* of the U.S. real exchange rate. However, the deviations may contribute little to shifts in the long-run real exchange rate. That the transfer effect is stronger for the CPI-based real exchange rate than the WPI-based measure suggests that this channel is not as important as the relative price of nontradables.

[19] The improvement in the fit of the regression and the difference in the statistical importance of the terms of trade between the IV and OLS specifications are due to sample differences between the two sets of regressions.

[20] The difference between the results for *RERCPI* and *RERWPI* is even stronger for a balanced sample for which both CPI and WPI data are available.

[21] Adding the terms of trade to the regression does not alter the results in any way.

FIGURE 2.—REAL EXCHANGE RATES, NET FOREIGN ASSETS, AND RELATIVE OUTPUT, DEVELOPING COUNTRIES



would be suggested, for example, by the Balassa-Samuelson hypothesis or by a higher income elasticity of demand for nontraded goods. Results in the regressions using the instrumented change in *NFA* are broadly similar, but, not surprisingly, the coefficient on ΔNFA is in general less precisely estimated.

Overall, the cross-sectional evidence we presented suggests the presence of a transfer effect, acting both through the relative price of nontraded goods across countries and through the relative price of traded goods; but the overall fit of cross-sectional regressions is relatively weak, especially for developing countries. We turn now to time-series fixed-effect panel evidence.

B. *Panel Evidence*

Rather than characterizing real-exchange-rate determinants country by country, we pool countries according to various criteria and present panel data analysis. The difficulty in establishing whether variables are I(0) or I(1) is well known. Rows (1)–(4) of table 3 present results for the stationarity test developed by Hadri (2001): these indicate that stationarity of each of our regressors is rejected. Row (5) of table 3 reports the panel cointegration test of Pedroni (1999). The test clearly indicates that the null hypothesis of nonstationarity of the residual is rejected, suggesting a stationary relationship between real exchange rate, *NFA*, relative output per capita, and the terms of trade.

Table 4 presents the result of panel regressions, based on the specification in equation (23). All regressions are DOLS(-1,1) specifications and include country fixed effects.[22] Country dummies are necessary because both the real exchange rate and the relative output are indices and hence not comparable in levels across countries. Moreover, the country dummies mean that the estimated coefficients pick up only the long-run time series variation in the data. In panels A and B, the dependent variables are the CPI-based and WPI-based real exchange rates, respectively. In panel C, the dependent variable is *DIFF*, the log ratio of the CPI *RER* to the WPI *RER*.

Overall, a number of stylized features of the data emerge clearly from these regressions:

1. There is a positive and strongly significant long-run relation between the real exchange rate and *NFA* for the full sample and in both subsamples, providing support for the existence of a powerful transfer effect. The coefficient magnitudes in the subsamples

[22] OLS estimation gives very similar estimates and levels of precision for the transfer effect.

TABLE 2.—DETERMINANTS OF REAL EXCHANGE RATES (CHANGE BETWEEN 1986–1996 AND 1975–1985 AVERAGES)

	(1) Full	(2) Full IV	(3) Industr.	(4) Industr. IV	(5) Develop.	(6) Develop. IV	(7) Develop. Low BMP.	(8) Develop. Low BMP. IV
	A. CPI-Based Real Exchange Rate							
ΔNFA	0.29 (1.90)*	0.35 (1.88)*	0.25 (2.01)*	0.25 (0.45)	0.39 (2.69)**	0.49 (2.24)**	0.34 (3.33)***	0.45 (2.09)**
ΔYD	−0.05 (0.23)	−0.14 (0.92)	0.22 (0.98)	0.30 (0.66)	−0.10 (0.47)	−0.14 (0.67)	−0.35 (1.51)	−0.26 (1.22)
ΔTT	0.11 (0.44)	0.67 (2.77)***	0.45 (2.61)**	0.47 (2.07)*	−0.32 (1.24)	0.22 (0.75)	0.06 (0.22)	0.21 (0.70)
Adj. R^2	0.04	0.27	0.41	0.38	0.05	0.13	0.09	0.08
Observations	64	54	22	22	42	32	31	28
	B. WPI-Based Real Exchange Rate							
ΔNFA	0.20 (1.77)*	0.28 (2.02)*	0.11 (0.98)	−0.16 (0.36)	0.21 (1.87)*	0.31 (1.80)*	0.18 (1.94)*	0.24 (1.63)
ΔYD	−0.36 (2.26)**	−0.31 (2.61)**	0.02 (0.08)	0.30 (0.58)	−0.26 (1.41)	−0.26 (1.58)	−0.28 (1.60)	−0.29 (1.78)*
ΔTT	0.39 (3.13)***	0.50 (2.95)***	0.37 (3.21)***	0.37 (2.96)***	0.07 (0.36)	−0.08 (0.55)	0.10 (0.36)	0.20 (0.66)
Adj. R^2	0.20	0.29	0.19	0.19	0.03	0.05	0.04	0.07
Observations	49	44	20	20	29	24	22	21
	C. Difference between CPI-based and WPI-based real exchange rate							
ΔNFA	0.26 (2.31)**	0.09 (0.82)	0.08 (0.63)	0.15 (0.37)	0.26 (2.23)**	0.15 (1.01)	0.24 (2.92)***	0.21 (1.23)
ΔYD	−0.14 (0.62)	0.11 (0.96)	0.48 (2.35)**	0.44 (1.01)	−0.06 (0.22)	0.08 (0.59)	−0.08 (0.41)	−0.03 (0.15)
ΔTT	−0.16 (0.79)	0.23 (0.98)	0.10 (0.93)	0.11 (0.88)	−0.43 (1.45)	0.12 (0.30)	−0.03 (0.08)	−0.00 (0.01)
Adj. R^2	0.02	0.05	0.17	0.21	0.00	−0.07	−0.04	−0.07
Observations	49	44	20	20	29	24	22	21

Notes: The t-statistics (robust errors) are in parentheses. *** (**, *) denotes significance at the 1% (5%, 10%) levels. "Low BMP" indicates countries with a change in the black-market premium of less than 20% between the two subperiods (1975–1985 and 1986–1996). "IV" indicates that the variable ΔNFA is replaced by its fitted value ΔNFA(IV). Construction of this variable is described in Appendix D.

TABLE 3.—STATIONARITY AND COINTEGRATION TESTS

1	Real exchange rate	30.26 (0.00)
2	Net foreign assets	29.14 (0.00)
3	Relative GDP per capita	36.91 (0.00)
4	Terms of trade	22.37 (0.00)
5	Cointegration test	6.47 (0.00)

Note: Rows (1)–(4) are z-statistics for Hadri (2001) stationarity tests (p-values in parentheses). Row (5) is standardized t-statistic for Pedroni (1999) cointegration test (p-values in parentheses).

are remarkably similar and in line with those obtained in the cross-sectional analysis. The size of the transfer effect is economically significant: according to the estimated point coefficient in column (1) of table 4, moving from the Danish average *NFA* (net liabilities equal to 26%) to the Dutch average (net assets equal to 24% of GDP) implies a long-run real appreciation of 14%.[23]

2. The relation between the CPI-based real exchange rate and *NFA* is stronger than the relation between the WPI-based real exchange rate and *NFA*, again confirming the cross-sectional results. This is confirmed in table 4, panel C: *NFA* has a significantly positive effect on *DIFF*, which is especially strong for the developing-country sample.[24]
3. For industrial countries, there is a significant positive effect of relative output on the CPI-based real exchange rate and on *DIFF*. For the full sample and for developing countries, the evidence is mixed. Although panel A also shows a significant positive relation, this is not true for the restricted sample for which WPI-based real exchange rates are also available: in fact, the relation turns negative and significant in the *DIFF* estimates in column (4) of panel C.
4. In industrial countries, terms-of-trade improvements are associated with real appreciations, and the relation is economically and statistically significant. In contrast, there is no clear relation between real exchange rates and terms of trade in the full sample or for developing countries.

As a robustness check, for a subsample of thirteen industrial countries we consider an alternative specification,

[23] The empirical estimates are in the range suggested by the theoretical model. For example, if we calibrate the share of the traded sector to be 1/3, the interest rate to be 5%, and the intertemporal and intratemporal elasticities of substitution each to be 0.5; the theoretical transfer coefficient is 0.38. As discussed in Appendix B, the transfer effect is quite sensitive to the openness parameter, and is proportional to the assumed interest rate.

[24] Data availability for the WPI-based real exchange rate implies that the samples for the *RERWPI* and *DIFF* regressions are smaller than for the *RERCPI* regressions. If the same sample is used, the transfer coefficients on *NFA* in the *RERCPI* regressions are in general larger—they equal the sums of the coefficients on *NFA* in the *RERWPI* and *DIFF* regressions.

TABLE 4.—REAL EXCHANGE RATES AND NET FOREIGN ASSETS: PANEL DATA REGRESSIONS

	(1) Full	(2) Industrial	(3) Developing	(4) Developing Low BMP
	A. CPI-based real exchange rates			
NFA	0.28 (7.98)***	0.19 (3.97)***	0.29 (6.56)***	0.19 (4.46)***
YD	0.14 (3.15)***	0.22 (3.13)***	0.14 (2.57)**	0.14 (2.53)**
TT	0.04 (1.21)	0.17 (4.12)***	0.02 (0.51)	0.05 (1.1)
Adj. R^2	0.52	0.44	0.42	0.39
Obs.	1558	548	1010	702
	B. WPI-Based Real Exchange Rates			
NFA	0.10 (2.84)***	0.07 (1.61)	0.11 (2.14)**	0.14 (2.7)***
YD	−0.03 (−0.74)	−0.03 (−0.42)	−0.03 (−0.41)	−0.13 (2.06)**
TT	0.06 (1.71)	0.14 (4.02)***	0.03 (0.66)	−0.01 (0.20)
Adj. R^2	0.42	0.38	0.32	0.58
Obs.	1086	500	586	450
	C. Panel *DIFF* Regressions			
NFA	0.26 (8.94)***	0.08 (2.35)**	0.28 (6.86)***	0.28 (7.03)***
YD	−0.03 (−0.72)	0.28 (5.55)***	−0.05 (−1.04)	−0.14 (2.75)***
TT	−0.06 (−2.06)**	0.04 (1.37)	−0.08 (−1.97)*	0.003 (0.94)
Adj. R^2	0.43	0.42	0.43	0.61
Obs.	1086	500	586	450

Note: Estimation by dynamic OLS (one lead and one lag). Heteroskedasticity-consistent *t*-statistics in parentheses. *F*-test for exclusion of time dummies (probability in parentheses). Dependent variable is *DIFF* = log(*RERCPI* / *RERWPI*). ***, **, * denote significance at the 1%, 5%, and 10 % levels, respectively.

TABLE 5.—ROBUSTNESS: CONTROLLING FOR PRODUCTIVITY

Parameter	(1) CPI	(2) CPI	(3) WPI	(4) WPI	(5) *DIFF*	(6) *DIFF*
NFA	0.78 (8.86)***	0.56 (5.69)***	0.45 (6.39)***	0.36 (4.49)***	0.33 (6.11)***	0.20 (3.35)***
YD		0.58 (4.34)***		0.27 (2.43)**		0.32 (3.88)***
RPROD	0.06 (1.87)*	0.07 (2.08)**	−0.04 (1.54)	−0.03 (1.1)	0.10 (5.05)***	0.10 (4.83)***
TT	0.16 (2.74)***	0.13 (2.31)**	0.09 (1.93)*	0.09 (1.88)*	0.07 (1.95)*	0.04 (1.27)
Adj. R^2	0.51	0.54	0.49	0.51	0.45	0.49
Obs.	307	307	307	307	307	307

Note: Estimation by dynamic OLS (one lead and one lag). Heteroskedasticity-consistent *t*-statistics in parentheses. *DIFF* = log(*RERCPI* / *RERWPI*). ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

which includes relative sectoral productivity, in order to directly control for a Balassa-Samuelson effect (table 5).[25] The transfer effect remains very significant. Also, relative productivity and output per capita are both individually significant, suggesting that an increase in output operates through a demand effect, in addition to the productivity channel.

Panel Splits: The panel data regressions in the previous section impose cross-country homogeneity of the coefficients on the variables we employ to model the behavior of the real exchange rate. In this sub-subsection, we run the panel regressions for country subgroups, where the sample is split according to country characteristics that may plausibly affect the magnitude of the transfer effect (see table 6).[26] In table 6, panel A, the sample is first split into three groups, according to levels of trade openness. As is derived in Appendix B, the theoretical model predicts that (for most parameter values) the transfer effect should be smaller, the more open an economy. This is clearly supported in Table 6A: the transfer effect is decreasing in openness. For the least open group, the point estimate is 1.57, but for the most

[25] This variable is the ratio of labor productivity in the tradable sector to labor productivity in the nontradable sector; taken from the OECD's ISDB data set. The manufacturing sector is taken to represent the tradable sector; the nontraded sector is proxied by an aggregate of construction, community, social, and personal services, and producers of government services.

[26] We do sample splits rather than introduce interaction terms because these country characteristics may plausibly affect all coefficients in the specification. For instance, openness affects all coefficients in the theoretical model [equation (19)]. In addition, there is clearly overlap between the categories: for example, small economies are likely to be more open than larger economies, all else equal.

TABLE 6.—SAMPLE SPLITS

A. Openness and Income

Parameter	Open: Low	Open: Medium	Open: High	Income: Low	Income: Medium	Income: High
NFA	1.57 (7.76)***	0.30 (3.99)***	0.11 (3.77)***	0.30 (4.68)***	0.25 (3.77)***	−0.07 (−1.4)
YD	−1.49 (−8.39)***	−0.03 (−0.32)	0.22 (5.77)***	−0.35 (−4.46)***	0.011 (0.13)	0.76 (14.02)***
TT	0.10 (1.06)	0.001 (0.01)	0.051 (1.44)	0.06 (1.04)	−0.17 (−2.57)**	0.16 (3.94)***
Adj. R^2	0.61	0.61	0.62	0.62	0.52	0.75
Obs.	349	583	601	454	612	492

B. Equity and Size

Parameter	Equity: Low	Equity: Medium	Equity: High	Size: Low	Size: Medium	Size: High
NFA	0.60 (7.39)***	0.11 (1.85)	0.09 (1.80)*	0.38 (7.96)***	0.15 (2.03)**	1.41 (8.40)***
YD	−0.23 (−2.44)**	0.15 (2.23)**	0.016 (0.19)	−0.24 (−3.13)***	0.045 (0.72)	−0.23 (−1.24)
TT	−0.11 (−1.59)	0.125 (2.52)**	0.21 (3.89)***	0.03 (0.61)	0.011 (0.18)	−0.10 (−1.24)
Adj. R^2	0.49	0.633	0.54	0.59	0.57	0.50
N	535	613	392	642	523	375

C. Foreign Exchange Restrictions

Parameter	Curr. Acc.: No	Curr. Acc.: Yes	Cap. Acc.: No	Cap. Acc.: Yes	Overall: Low	Overall: High
NFA	0.22 (6.23)***	0.585 (4.54)***	0.21 (4.09)***	0.31 (6.54)***	0.15 (4.75)***	0.47 (4.58)***
YD	0.03 (0.63)	−0.49 (−3.28)***	0.05 (0.73)	−0.132 (−2.12)**	0.14 (3.48)***	−0.71 (−5.54)***
TT	0.015 (0.44)	−0.03 (−0.29)	0.08 (1.80)*	−0.06 (−1.27)	0.03 (1.01)	−0.02 (−0.18)
Adj. R^2	0.59	0.53	0.586	0.58	0.62	0.561
Obs.	1222	311	808	725	1075	458

Note: In panel A, "Open" refers to average trade openness during the period 1970–1997, "Income" to GDP per capita in 1970. In panel B, "Equity" refers to the average gross equity ratio (*FDI* assets + liabilities + portfolio equity assets + liabilities divided by GDP) during 1970–1997. Size refers to GDP in 1970. In panel C, 1 and 2 split the sample between countries without and with current account restrictions, respectively; 3 and 4 refer to restrictions on the capital account; 5 and 6 refer to an overall restrictions index that averages the indices of current-account restrictions, capital-account restrictions, surrender of export proceeds, and multiple exchange rates. Estimation by dynamic OLS (one lead and one lag). Heteroskedasticity-consistent *t*-statistics in parentheses. ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

open group it is only 0.11.[27] The effect of relative output also varies with openness—it is significantly positive for the most open group, but significantly negative for the least open group.

Panel A also presents results for a sample split according to the level of GDP per capita in 1970 (a split based on the 1985 GDP gives similar results). This is essentially a refinement of the industrial–developing-country split and allows for different estimates between lower middle and upper middle income groups (low-income countries are excluded from our sample). Output per capita may proxy for differences in economic structure: it is well known, at least from Chenery's work, that the size of the nontraded sector has a U-shaped relationship with the level of development. It may also proxy for variation in the composition of *NFA* (Lane & Milesi-Ferretti, 2001). Also, the quality of data varies with the level of development. The results show that the transfer effect weakens as output per capita increases. Indeed, the point estimate turns negative for the highest income group. In contrast, the relative output effect is strongest for that group. Finally, a positive effect for the terms of trade is found only for the highest income group.

In the first three columns of panel B we turn to the composition of *NFA*, splitting countries according to the average gross equity position relative to GDP. The impact of a high equity ratio is ambiguous. On the one side, the existence of an equity premium would mean that a given *NFA* position is associated with higher average investment income flows and hence a larger transfer effect. On the other side, Albuquerque (2003) argues that the required return on *FDI* is actually lower than on debt. In his model, *FDI* is "inalienable" and hence is protected from expropriation risk, whereas debt investors are more exposed to default risk. Moreover, equity investment may be associated with faster productivity growth, allowing the generation of trade surpluses without major relative price

[27] Note that, among the industrial countries, (unreported) country-by-country regressions yield the largest transfer coefficients with respect to Japan and the United States, which have the lowest trade-to-GDP ratios.

TABLE 7.—ERROR CORRECTION EQUATIONS: FULL SAMPLE

	(1) *RER*	(2) *NFA*	(3) *YD*	(4) *TT*
		A. Full Sample		
ECM	−0.14 (11.35)***	−0.01 (1.16)	−0.012 (2.31)**	0.015 (1.07)
Adj. R^2	0.15	0.20	0.08	0.06
Obs.	1628	1622	1685	1628
		B. Industrial Country		
ECM	−0.23 (11.05)***	0.011 (0.59)	−0.015 (1.49)	0.06 (2.14)**
Adj. R^2	0.30	0.21	0.14	0.18
Obs.	571	570	592	571
		C. Developing Country		
ECM	−0.13 (8.55)***	−0.01 (1.21)	−0.012 (1.82)**	0.013 (0.71)
Adj. R^2	0.15	0.20	0.08	0.06
Obs.	1057	1052	1093	1057

Note: ECM is the residual from the estimated cointegration equation linking *RER, NFA, YD, TT.* Dependent variable is in first differences. Each regression also includes one lag of the dependent variable, plus the contemporaneous first differences of the other regressors. White-corrected *t*-statistics in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

changes.[28] Results show that the transfer effect is much larger for countries with a low equity ratio, the point estimate being six times greater than for those countries with a high equity ratio. This finding runs counter to the equity-premium approach, but is consistent with the latter group of hypotheses suggested above.

In the last three columns of panel B, the sample is split according to country size (total GDP) in 1970 (once again, a split based on 1985 income makes little difference). The theoretical model strictly refers to small economies, providing one justification for running this experiment. More generally, size may proxy for "natural" openness. We see that the transfer effect is positively related to country size: the largest countries have the biggest transfer effect. This may just reflect that these countries are the most closed in the sense of having the largest nontraded sectors. To the extent that our measure of the terms of trade is imperfect, the positive effect of country size may also reflect an impact on international relative prices: the largest countries may experience a decline in relative export prices in addition to the relative price of nontradables. As in the openness split in panel A, the difference in coefficient size is economically large: for instance, all else equal, a long-run net foreign liability position of 30% of GDP requires the real exchange rate to depreciate by 42% in a large economy but only by 11% in a small economy.

Finally, in panel C we examine various foreign exchange restrictions—current-account restrictions, capital-account restrictions, multiple exchange rates, and obligations to surrender export revenues. The first two columns focus on current-account restrictions, the following two on capital controls, and the last two on an overall restrictions index that averages across the four individual categories (see Appendix D). The results show clearly that countries with restrictions experience much larger transfer effects—quantity restrictions magnify the size of the required relative price adjustment to achieve the same improvement in the trade balance.

Convergence to the Long Run: By the Granger representation theorem, the residual from the cointegration equation must forecast the growth rate of at least one of the four variables *RER, NFA, YD, TT.* For instance, if the residual is positive (the real exchange rate is appreciated relative to its long-run value), either the real exchange rate must depreciate or one of the regressors must shift in order to drive the relation back to its long-run value. Accordingly, by inspecting the error correction mechanism (ECM), insight is gained into which variables endogenously adjust to ensure convergence to the long-run relation.

Table 7, reports the dynamic impact of the error correction term on the growth rates of each of the variables in the cointegrated vector.[29] For each sample, it is the real exchange rate that is the predominant adjusting variable. For the full sample, the speed of adjustment implies a half-life for real exchange rate misalignments of 4–5 years, which is in line with other estimates in the literature (Rogoff, 1996). With respect to the other variables, the ECM variable has no explanatory power for the dynamics of the *NFA* position, plays a minor role in relative output per capita, and actually has a positive sign in the terms-of-trade equation.

[28] This is especially the case with respect to *FDI,* but in principle productivity gains may come from portfolio equity investment as well. Of course, a large equity component in liabilities may also proxy for other positive characteristics in an economy.

[29] The error correction term is the residual from the OLS estimate of the cointegration equation. The dynamic equation regresses the growth rate of each variable in turn on the error correction term, the lagged dependent variable, and the growth rates of the other regressors. For clarity, these other terms are not reported in table 7.

V. Relation to Other Studies

We turn now to a comparison of our results with those obtained by the few studies that have addressed the link between real exchange rates and *NFA* of countries.[30]

Using a sample of fifteen industrial countries, Obstfeld and Rogoff (1995, 1996) estimated a cross-sectional bivariate regression of the WPI-based multilateral real exchange rate on *NFA,* with the variables expressed as changes between 1981–1985 and 1986–1990 averages. They obtained a significantly positive coefficient, around unity. In this paper, we have estimated the transfer effect for a longer time period, for a wider range of countries, and controlling for relative output per capita and the terms of trade. This is important, especially in view of the significantly positive correlation between changes in *NFA* and in relative output per capita. In table 2, we found the magnitude of the transfer effect on the CPI-based real exchange rate to be in the 0.25–0.35 range, and the effect on the WPI-based index to be much weaker.[31]

With respect to time series analysis, Faruqee (1995) estimates real-exchange-rate equations for the United States and Japan, including in the cointegrating vector the real exchange rate, the terms of trade, the CPI-to-WPI ratio, and *NFA* (as a fraction of GDP) (see also Clark & McDonald, 1998). He finds a positive and significant impact of *NFA* on real exchange rates. However, this finding is difficult to interpret, given that the two channels through which *NFA* can have an impact on the real exchange rate (the terms of trade and the relative price of nontraded to traded goods) are both controlled for, albeit imperfectly, in the regression. Broner et al. (1997) estimate real-exchange-rate cointegrating regressions for the largest Latin American countries. According to their theoretical model, *NFA* affects the real exchange rate through its effect on the terms of trade. Their dependent variable is the CPI-based real exchange rate, and among their explanatory variables they include the ratio between the CPI and WPI indices (relative to the same ratio in partner countries) in addition to the ratio of *NFA* to the GNP. Their findings suggest a statistically significant relation between *RER* and *NFA* for some but not all the countries in their sample. Alberola et al. (1999) use a similar specification to estimate equilibrium exchange rates in their industrial-country study, after establishing cointegration using panel data techniques. The key issue is of course the degree of endogeneity of the terms of trade for developing countries and for small open economies. Moreover, by holding fixed the relative price of nontradables, these papers rule out the very mechanism that we emphasize.

The only other paper that directly studies the long-run relation between the real exchange rate and *NFA* (expressed as a fraction of trade flows) in a panel data context is Gagnon (1996). That paper focuses on industrial countries and uses a cruder *NFA* estimate, namely, the unadjusted cumulative value of the current account. Using panel regressions in error-correction form, with explicit allowance for short-term dynamics, along the lines of Phillips and Loretan (1991), Gagnon finds a positive short- and long-run relations between both the CPI-based and the WPI-based real exchange rate and *NFA,* of similar orders of magnitude. These effects are obtained holding fixed, among the other explanatory variables, the ratio of CPI to WPI, so as to proxy for Balassa-Samuelson effects. We argue instead that the relative price of nontraded to traded goods can itself be related to *NFA,* and therefore find our empirical specification preferable.

Finally, Lane and Milesi-Ferretti (2002b) show for a panel of industrial countries that the relation between *NFA* and real exchange rates is related to the rates of return earned on foreign assets and liabilities (relative to output growth). This is in line with the evidence in panel B of table 6 that the composition of the international balance sheet influences the relation between *NFA* and the real exchange rates. It would be useful to extend this line of research to developing countries, but the task is complicated by patchy rate-of-return data.

VI. Conclusions

In this paper we have presented evidence supporting the existence of a significant transfer effect. Even controlling for relative output levels and the terms of trade, cross-country and time series empirical evidence suggests the existence of a long-run relation between net foreign assets and real exchange rates, with debtor countries having more-depreciated real exchange rates. The evidence also suggests that the relative price of nontraded to traded goods plays an important role in this long-run relation, and hence that an exclusive focus on the terms of trade as the key relative price in the transfer effect is unsatisfactory. Furthermore, we show that the magnitude of the transfer effect varies with country characteristics such as openness, size, level of development, and presence of foreign exchange restrictions. An especially interesting finding is that equity financing reduces the size of the transfer effect relative to debt financing.

This evidence is relevant to a number of current theoretical and policy debates. Although our theoretical framework is quite stylized, our evidence suggests that a more general dynamic general equilibrium model should incorporate features that allow for the operation of a wealth effect. With respect to policy, the existence of a long-run relation between net foreign asset positions and real exchange rates suggests that a persistent net foreign liability position will eventually require a real depreciation, with the magnitude of

[30] Masson, Kreiners, and Horne (1994) study the postwar behavior of net foreign assets in Germany, Japan, and the United States, and find some evidence of long-run comovements between net foreign assets, public debt, and demographic variables. They do not investigate the relationship between net foreign assets and real exchange rates.

[31] For the Obstfeld-Rogoff sample, using our data and time periods, a simple regression of the CPI-based real exchange rate on net foreign assets yields a significantly positive point coefficient of 0.64, but net foreign assets are not individually significant once we control for output per capita. Moreover, for this subsample the transfer effect is not individually significant in any of the WPI-based real-exchange-rate regressions.

the adjustment positively related to country size. Issues pertaining to the timing, speed, and smoothness of the adjustment process have major policy relevance and rank high in the priority list for future research efforts.

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APPENDIX A

CPI-Based and WPI-Based Real Effective Exchange Rates

Empirically, we primarily examine the CPI-based real exchange rate. The CPI of the home country and the trade-weighted average of partner countries' CPIs are

$$\log(CPI) = \phi_1 \log(P_N) + \phi_2 \log(P_T^h) + \phi_3 \log(P_T^f), \tag{A1}$$

$$\log(CPI^*) = \phi_1^* \log(P_N^*) + \phi_2^* \log(P_T^{*h}) + \phi_3^* \log(P_T^{*f}), \tag{A2}$$

where $\phi_1, \phi_2, \phi_3 > 0$, $\Sigma\phi_i = 1$, P_T^h is the price of the domestically produced tradable and P_T^f is the price of the foreign-produced tradable, and * denotes the corresponding foreign values. The CPI-based based real exchange rate can be written as

$$\log(RER_C) = \phi_1[\log(P_N/P_T^f) - \log(P_N^*/P_T^{*f})] + (\phi_2 - \phi_2^*)\log(P_T^h/P_T^f) + (P_T^f - P_T^{*f}). \tag{A3}$$

where we assume $\phi_1 = \phi_1^*$ and $\log(P_T^h/P_T^f) = \log(P_T^{*h}/P_T^{*f})$. The first term represents the relative price of nontraded to traded goods in the domestic country relative to its trading partners, the second the relative price of home versus foreign traded goods, and the third deviations from the law of one price. If we assume similar consumption patterns across countries ($\phi_2 = \phi_2^*$) and no (long-run) deviations from the law of one price ($P_T^f = P_T^{*f}$), the CPI-based real exchange rate is determined by the relative price of nontradables (at home versus overseas).

We also consider the WPI-based real exchange rate. WPIs are constructed with domestic output prices, primarily in the tradables sector. Home and foreign WPIs can be written as

$$\log(WPI) = \phi_w \log(P_{wN}) + (1 - \phi_w)\log(P_{wT}^h), \tag{A4}$$

$$\log(WPI^*) = \phi_w \log(P_{wN}^*) + (1 - \phi_w)\log(P_{wT}^{*f}), \tag{A5}$$

where the subscript w denotes wholesale prices and we assume complete specialization in trade and the same WPI weight on nontraded goods in both countries. For a given set of commodities, the pattern of wholesale prices may differ from consumer prices on account of differences in the distribution sector. In addition, the WPI includes the prices of intermediate goods in addition to final goods: we ignore this complication here, for expositional purposes.

Assuming that wholesale and consumer prices for each item are proportional and that any (long-run) deviations in the law of one price are exogenous.[32] $[\log(P_T^f/P_T^{*f}) = \psi]$, we can write the WPI-based real exchange rate as

$$\log(RER_w) = \phi_w[\log(P_N/P_T^f) - \log(P_N^*/P_T^f)] + (1 - \phi_w)\log(P_T^h/P_T^f)\,\psi. \tag{A6}$$

Comparing the expressions for the CPI- and WPI-based real exchange rates, we expect the determinants of the relative price of nontradables to exert a larger effect on the CPI-based real exchange rate to the extent that $\phi_1 > \phi_w$. The exception is that the terms of trade may have a larger influence on the WPI-based real exchange rate, because it now has a direct influence, in addition to its indirect one on the relative price of nontradables. Finally, recall that our maintained assumption is that the terms of trade are exogenously determined. Under alternative models in which the transfer effect primarily operates via endogenous terms of trade, *NFA* would have a larger unconditional effect on the WPI-based than on the CPI-based real exchange rate.

APPENDIX B

Openness and the Transfer Effect

This appendix examines the impact of variations in openness on the magnitude of the transfer effect. Equation (17) in the main text shows the determinants of the (log) relative price of nontradables. The coefficient on net foreign assets can be rewritten as

$$T^N = \frac{r(1+\sigma)}{\gamma[\gamma(\sigma - \theta) + \theta(1+\sigma)]}. \tag{B1}$$

[32] For instance, long-run deviations in wholesale prices may be partly attributable to transport costs.

The parameter γ is the relative size of the traded sector. The sensitivity of T to γ is determined by the denominator of this expression,

$$D = \gamma[\gamma(\sigma - \theta) + \theta(1+\sigma)], \qquad \frac{\partial D}{\partial \gamma} = \theta(1+\sigma) + 2\gamma(\sigma - \theta). \tag{B2}$$

The derivative is unambiguously positive (a smaller transfer effect as openness increases) if $\sigma \geq \theta$. However, if $\sigma < \theta$, the second term is negative and the overall effect is potentially negative. Equation (19) in the main text shows the relation between the relative price of nontradables and the real exchange rate. The transfer coefficient in the *RER* equation can be written as

$$T^R = (1 - \gamma)T^N, \tag{B3}$$

so that

$$\frac{\partial T^R}{\partial \gamma} = -T^N + (1-\gamma)\frac{\partial T^N}{\partial \gamma}. \tag{B4}$$

Although the net effect of openness may still be positive if $\sigma < \theta$, the role of increased openness in shrinking the effect of the relative price of nontradables on the real exchange rate means that this is even more unlikely when looking at the real exchange rate than when looking at the relative price of nontradables. Simple simulations show that the transfer coefficient is very sensitive to the size of the traded goods sector γ and to the interest rate r, but less so to the elasticity of intertemporal substitution (σ) and to the elasticity of substitution between traded and nontraded goods (θ).

APPENDIX C

List of Countries

Industrial countries: Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

Developing countries: Argentina, Bahrain, Bolivia, Botswana, Brazil, Chile, Colombia, Costa Rica, Côte d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Guatemala, India, Indonesia, Israel, Jamaica, Jordan, Korea, Malaysia, Mauritius, Mexico, Morocco, Oman, Pakistan, Paraguay, Peru, Philippines, Saudi Arabia, Singapore, South Africa, Sri Lanka, Syria, Taiwan, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uruguay, Venezuela, Zimbabwe.

Developing countries are selected on the basis of having population above 1 million and GDP per capita (Summers-Heston measure) above \$1500 in 1985. The exceptions are Bahrain (population below 1 million) and India, Pakistan, and Zimbabwe (income per capita below threshold).

APPENDIX D

Construction of Net Foreign Assets and Data Sources

As shown in section III, given an initial stock of net external assets, we can obtain a crude estimate of the current stock of *NFA* by cumulating the current account balance, net of capital transfers [equations (20)–(22)]. Details on how the initial net external position is estimated are in Lane and Milesi-Ferretti (2001). In our estimation of the stock of net external assets we implicitly count errors and omissions as changes in the debt asset position of the country abroad, $\Delta DEBTA$. To improve this estimate, we make several adjustments designed to allow for the impact of valuation changes, misreporting of capital flows, and debt reduction or forgiveness. These adjustments, as well as estimates of gross assets and liabilities, are briefly explained below:

Foreign direct investment assets (FDIA): Estimated by cumulating U.S. dollar flows, and adjusting past stocks for changes in relative capital goods' prices between the countries of destination of *FDI* and the United States (the unit of measurement).[33] The countries of destination of *FDI* are assumed to be the trading partners used in the calculation of the real effective exchange rate. For lack of consistent and reliable measures of the relative price of capital goods across countries, we assume that that relative price follows relative consumer prices.

Foreign direct investment liabilities (FDIL): Estimated by cumulating U.S. dollar flows, adjusting past stocks for changes in relative capital goods' prices between the home country and the United States. We assume that the relative price of capital goods between the home country and the United States follows the bilateral CPI-based real exchange rate.[34]

Portfolio equity investment assets (EQA): Estimated by cumulating U.S. dollar flows, adjusting past stocks to reflect year-on-year changes in the U.S. dollar value of a representative "world" portfolio (the Morgan Stanley Capital Index).

Portfolio equity investment liabilities (EQL): Estimated by cumulating U.S. dollar flows, adjusting past stocks to reflect year-on-year changes in the U.S. dollar value of the domestic stock market index.

Foreign exchange reserves (FX): Stock of foreign exchange reserves from the IMF's International Financial Statistics.

Net debt, industrial countries (DEBTA−DEBTL): Determined residually as $NFA - FX - (EQA - EQL) - (FDIA - FDIL)$.

Debt liabilities, developing countries (DEBTL): Stock of external debt from the World Bank's Global Development Finance database.

Debt assets, developing countries (DEBTA): Determined residually as $NFA - FX - (EQA - EQL) - (FDIA - FDIL) + DEBTL$. Note that the remaining difference between the change in the stock of external debt (*DEBTL*) and the underlying debt liability flows recorded in the balance-of-payments statistics (after adjusting for the impact of cross-currency fluctuations and debt reduction and forgiveness agreements) is attributed to mismeasurement of gross debt flows and hence implicitly recorded as a change in debt assets of the country. In Lane and Milesi-Ferretti (2001) we show that this is consistent with standard estimation methods for the stock of flight capital.

Net foreign assets (NFA): Cumulative current account net of capital transfers, adjusted for the effects of capital gains and losses on inward and outward *FDI* as well as on portfolio equity holdings, the difference between reserve flows and the change in the stock of reserves, the impact of debt reduction and forgiveness operations on developing countries' external debt, and the impact of cross-currency fluctuations on developing countries' external debt.

Data sources and definitions for other variables are as follows:

RERCPI: Real effective exchange rate (CPI-based). Trade weights based on trade patterns in 1990, calculated using the IMF's Information Notice System (described in Desruelle and Zanello, 1997). Source: authors' calculations based on CPI and exchange rate data from the IMF.

RERWPI: Real effective exchange rate (WPI-based). Trade weights based on trade patterns in 1990, calculated using IMF's Information Notice System. Source: authors' calculations based on WPI and exchange rate data from the IMF and from national sources for some WPI indices.

YD: GDP per capita relative to trading partners. Partner countries' weights are the same as those used in the construction of *RERCPI*. Source: Summers and Heston's Penn World Tables (http://pwt.econ.upenn.edu/) updated to 1997 using per capita GDP growth rate from the World Bank's World Development Indicators (WDI) database.

TT: Ratio of export prices (or export unit values) to import prices (or import unit values), both expressed in U.S. dollars. Primary source: IMF, *International Financial Statistics,* integrated with IMF's *World Economic Outlook* database and on the World Bank's WDI database.

ΔNFA(IV): Fitted change in the average *NFA*-to-GDP ratio between 1975–1985 and 1986–1996. Instruments used are public debt, demographics, and GDP per capita [see Lane and Milesi-Ferretti (2002a) for a description of these variables]. For full-sample and developing countries' regressions, ΔNFA(IV) is the difference between the fitted *NFA* obtained from the full-sample cross-sectional regression for 1986–1996 (adjusted $R^2 = 0.54$) and the fitted *NFA* from the full-sample regression for 1975–1985 (adjusted, $R^2 = 0.26$). For IND regressions, ΔNFA(IV) is the fitted ΔNFA from the IND sample regression of ΔNFA on changes in its instruments (adjusted $R^2 = 0.27$).

Black-market premium: Percentage difference between the black-market and the official exchange rates. Source: World Bank (http://www.worldbank.org/research/growth/GDNdata.htm), based on *Pick's Currency Yearbook.*

OPEN: Ratio of imports plus exports to GDP. Source: World Bank, WDI database.

Current-account restrictions: Dummy variable taking the value of 1 if the country imposes restrictions on payments for current-account transactions. Source: IMF, *Exchange Arrangements and Exchange Restrictions;* and Milesi-Ferretti (1998).

Capital-account restrictions: Dummy variable taking the value of 1 if the country imposes restrictions on payments for capital-account transactions. Source: IMF, *Exchange Arrangements and Exchange Restrictions;* and Milesi-Ferretti (1998).

Overall restrictions index: Sum of dummy variables for the presence of current-account restrictions, capital-account restrictions, multiple currency practices, and surrender of export proceeds. Source: IMF, *Annual Report on Exchange Arrangements and Exchange Restrictions;* and Milesi-Ferretti (1998).

[33] Suppose, for example, that Italy invests only in Germany and that the Deutsche mark appreciates vis-à-vis the U.S. dollar between the end of year $t - 1$ and the end of year t. In this case, the value of the stock of Italian capital in Germany at the end of t will exceed the cumulative U.S. dollar value of investment flows.

[34] Using alternative measures of relative price adjustment, such as the WPI-based real exchange rate, yields similar results.