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Net Foreign Assets, Real Exchange Rates and Net Exports Revisited

by

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Abstract

Theory suggests a significant positive relationship in long-run equilibrium between net foreign assets (NFA) as a proportion of GDP and real exchange rates. Empirical tests have ignored two issues: the large variation in cross-country trade/GDP ratios, which is likely to induce substantial cross-country differences in coefficients, and the reverse causality associated with valuation effects. A real exchange rate appreciation reduces the absolute value of NFA denominated in foreign currency relative to domestic GDP, because of the sizeable component of non-tradable goods in domestic GDP. This endogeneity biases the test results. New tests are implemented that address these issues. The valuation effect bias is found to be significant. The new tests support the existence of a long-run positive relationship between NFA and real exchange rates. The long-run negative relationship between NFA and net exports that existed before 1992 has broken down in the period of persistent global imbalances.

Keywords: current account, exchange rates, net foreign assets, trade balance

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Outline

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1 Introduction

The publication of a data set of foreign assets and liabilities for a substantial number of countries by Lane and Milesi-Ferretti (2001) has stimulated empirical research on the implications of large net foreign asset (*NFA*) positions. If, as discussed below, the rate of return on foreign assets exceeds the growth rate of *GDP*, in the long run a larger *NFA* position should be associated with a more appreciated real exchange rate and lower net exports, or in other words a worse current account balance, net of property income (Blanchard *et al.*, 2005; Devereux and Sutherland, 2010; Tille and van Wincoop, 2010). This effect has been investigated empirically for real exchange rates by Lane and Milesi-Ferretti (2004) and Christopoulos *et al*. (2012). Both find that the effect varies across countries, being most evident in poorer economies and more or less absent in rich countries. The same pattern of less (or in-) significant coefficients in richer countries appears in Durdu *et al*.'s (2013) analysis of the long-run relationship between *NFA* and net exports. Christopoulos *et al*. (2012) suggest that this difference reflects whether countries are or are not credit-constrained in international markets.

Here we argue that the differences in coefficients across countries can be at least partly explained by the feedback effect of real exchange rate movements on the relative valuations of foreign assets and liabilities denominated in foreign and domestic currencies, as highlighted by Gourinchas and Rey (2007) and Lane and Shambaugh (2010a). These valuation effects (VE) mean that countries whose foreign currency exposure (*FXE*) is positive (i.e. whose assets denominated in foreign currencies exceed their liabilities denominated in foreign currencies) experience a fall in their *NFA/GDP* ratio as the real exchange rate appreciates. This is the effect of the large weight in *GDP* of non-tradable goods and services, whose price rises in terms of foreign currency. This group generally comprises richer countries. In the opposite case (negative *FXE*), the valuation effects tend to imply a rise in the *NFA/GDP* ratio as the real exchange rate appreciates, as *FXE* gets less negative. This is typically the case in poorer countries. In the long-run steady state the valuation effects are zero, but in time series estimation any exogenous changes in real exchange rates that are not associated with the accumulation or decumulation of net foreign assets have feedback effects on the *NFA/GDP* ratio that bias the estimated coefficient in a way that varies systematically across countries.

In addition, the real exchange rate affects the net export to *GDP* ratio more strongly in countries for which trade represents a larger proportion of *GDP*, and this needs to be taken into account. In this paper an amended test is developed to address these issues. The results confirm the existence of a significant valuation effect, but also provide robust support for the underlying hypothesis of a positive correlation between net financial assets and the real exchange rate.

2 Theory

The starting point is the identity:

$$NFA_t = (1 + r_t)NFA_{t-1} + NX_t + VE_t + APM_t \tag{1}$$

where NFA_t denotes net foreign assets at the end of period t; r_t is the total return (income plus capital) on these net assets during period t; *NX* is net exports; *VE* is the valuation effects of exchange rate movements; and *APM* is the effect of asset price changes in whatever currencies assets are denominated.[1] Converting this identity to a ratio of *GDP*, which grows at a rate g_t, equation (1) becomes:

[1] Equation (1) assumes equal rates of return on assets and liabilities. The analysis of US data by Curcuru *et al*. (2008) suggests that this is a reasonable approximation.

$$\left(\frac{NFA}{GDP}\right)_t = \left(\frac{1+r}{1+g}\right)_t \left(\frac{NFA}{GDP}\right)_{t-1} + \left(\frac{NX}{GDP}\right)_t + \left(\frac{VE}{GDP}\right)_t + \left(\frac{APM}{GDP}\right)_t \quad (2)$$

In the long-run steady state the ratio of *NFA* to *GDP* is constant, and *VE* and *APM* are zero, so in long-run equilibrium:

$$\left(\frac{r-g}{1+g}\right)\left(\frac{NFA}{GDP}\right) = -\left(\frac{NX}{GDP}\right) \quad (3)$$

What is called net exports here is in fact the sum of the trade balance and all other items of the current account apart from net property income flows (which are already included in the *rNFA* term), such as workers' remittances. Assuming that these other components of the current account are relatively insensitive to the real exchange rate, the main mechanism for changing net exports is the negative relationship between the real exchange rate and the trade balance. Thus if ($r - g$) is positive, then a higher value of *NFA/GDP* should be associated with a higher real exchange rate, in order to induce lower net exports. Another possible mechanism is increased absorption relative to output as the additional income is consumed, at an unchanged real exchange rate; Rowthorn and Solomou (1991) argue that this is what happened in the United Kingdom in the 1870-1913 period.

Lane and Milesi-Ferretti (2004) and Christopoulos *et al*. (2012) investigate the long-run time-series relationship between *NFA/GDP* and the real exchange rate (*R*) for a panel of countries, assuming constant coefficients across countries.[2] Thus they estimate regressions of the form $\ln R = a + b(NFA/GDP) + u$. There are at least two reasons why the assumption of constant coefficients is problematic in this context.

One is the point made above: the accumulation of *NFA* tends to raise the real exchange rate, but for countries with positive *FXE* this has the accounting effect of devaluing

[2] Obviously a cross-country analysis is meaningless because the real effective exchange rate is an index with an arbitrarily selected base year.

existing foreign assets denominated in foreign currency relative to *GDP*, thus diluting the impact. The "signal" of accumulation of *NFA* will thus be more difficult to detect, as the noise associated with other factors causing changes in *NX* will dominate the data. The opposite is the case for countries with negative *FXE,* for which the accounting effect will reinforce the upward shock to *NFA*, so the signal is reinforced. More importantly, any exogenous changes in *R* (captured by *u*) will have feedback effects on *NFA/GDP* through *FXE,* so that the estimated coefficient in this regression is biased, with the direction of bias depending on the sign of *FXE*. The estimated coefficient of *NFA/GDP* for any particular country will therefore be of the form $\beta_1 - \beta_2 FXE$.

The second reason is that the elasticity of the response of trade flows to real exchange rate movements tends to be similar across countries, but this implies marked differences in the effect on net exports as a ratio of *GDP*, because of the enormous cross-country variation in the ratio of trade to *GDP* (Isard, 2007). Suppose that a 10% real depreciation raises exports by *x*% and reduces imports by the same *x*%. This implies that net exports increase by *x*% of total trade, which is about 0.25*x*% of GDP in the United States but more than *x*% of GDP in Belgium. Therefore it makes little sense to assume the same coefficients in a regression of *R* on *NFA/GDP* in these two countries; in other words β_1 and β_2 are likely to differ across countries.

The second point can be dealt with by dividing equation (1) by total trade (*XM*) instead of by *GDP*. Then equation (3) becomes:

$$\left(\frac{r-h}{1+h}\right)\left(\frac{NFA}{XM}\right) = -\left(\frac{NX}{XM}\right) \tag{4}$$

where *h* is the growth rate of *XM*. Moreover, because of the exclusion of non-tradables, total trade flows measured in *foreign* currency are likely to be relatively immune to real exchange rate movements. The accounting problem in this case is the opposite one: net assets denominated in domestic currency, or domestic currency exposure (*DXE*), will vary with the real exchange rate as a ratio of *XM*, because the real exchange rate affects *XM* measured in domestic currency. Specifically, the absolute value of net assets or liabilities denominated in domestic currency will rise as a ratio of *XM* as the currency appreciates. As we shall see later, *DXE* varies less than *FXE* across countries, and is in most cases negative (i.e. liabilities exceed assets). The feedback effect of real exchange rate appreciations on *NFA/XM* will be positive for $DXE > 0$ and negative for $DXE < 0$, so the expected coefficient of the real exchange rate is of the form $\beta_1 + \beta_2 DXE$. To capture this effect we interact the (*NFA/XM*) variable with lagged (*DXE/XM*), expecting a positive coefficient. We then estimate simultaneously the long-run and short-run effects of *NFA* on the real exchange rate using the following error correction model:

$$dlnR_{it} = a_i + z_t + b\, d\left(\frac{NFA}{XM}\right)_{it} + c\,\left(\frac{DXE}{XM}\right)_{it-1}\left[d\left(\frac{NFA}{XM}\right)_{it}\right] - e\, lnR_{it-1} + f\left(\frac{NFA}{XM}\right)_{it-1} + v\left(\frac{DXE}{XM}\right)_{it-1}\left[\left(\frac{NFA}{XM}\right)_{it-1}\right] + u_{it} \qquad (5)$$

In equation (5), the terms in (*DXE/XM*) control for valuation effects, and the long-run effect of *NFA* on the real exchange rate for $DXE = 0$ is estimated as $m = (f/e)$. The implicit long-run relationship is:

$$lnR = constant + \left(\frac{f}{e}\right)\left(\frac{NFA}{XM}\right) + \left(\frac{v}{e}\right)\left(\frac{DXE}{XM}\right)\left(\frac{NFA}{XM}\right) \qquad (6)$$

Net Exports

Alternatively, it is possible to test directly for a long-run negative relationship between *NFA* and *NX* as a measure of external solvency, i.e. whether debt is converging to a steady-state value or can potentially increase without bound, as in Durdu *et al*. (2013). Durdu *et al*. (2013) estimate (3) directly by regressing *NX/GDP* on *NFA/GDP*. At first sight this is immune to the second criticism (cross-country variation in trade/output ratios). It is not, however, immune to the first criticism: that the estimated relationship will be biased by *FXE*, because of the change in the real exchange rate involved. Moreover the degree of bias will be affected by *XM/GDP*, because this determines the relationship between *NX/GDP* and the changes in *R* that drive the feedback effect. Thus not only is the expected coefficient of the form $-(\beta_1 - \beta_2 FXE)$, but also β_2 is a function of *XM/GDP*. So the second criticism is in fact relevant here too.

To carry out the solvency tests suggested by Durdu *et al*. (2013), we estimate an equation exactly analogous to (5), except with *R* replaced by *NX/XM*. One difference is that, since *NX* is not an index, it is possible also to exploit the cross-country dimension of the data, by estimating a pooled regression:

$$d\left(\frac{NX}{XM}\right)_{it} = a - b\, d\left(\frac{NFA}{XM}\right)_{it} - c\left[\frac{DXE}{XM}\right]_{it-1}\left(\frac{NFA}{XM}\right)_{it} - e\left(\frac{NX}{XM}\right)_{it-1} - f\left(\frac{NFA}{XM}\right)_{it-1} - v\left[\frac{DXE}{XM}\right]_{it-1}\left(\frac{NFA}{XM}\right)_{it-1} + u_{it} \qquad (7)$$

There are some advantages in estimating (7) rather than (5). One is that it avoids problems of omitted variable bias associated with other factors that might influence the equilibrium real exchange rate, such as oil discoveries, prices of commodity exports, emigrants' remittances, or the Balassa-Samuelson effect, any of which might shift the long-run relationship between the real exchange rate and net exports. These factors should be automatically adjusted for in (7), but not in (5). Another is that data are available for a larger number of countries.

3 Data

Except where otherwise indicated, data are taken from the World Bank World Development Indicators (WDI) database. Net financial assets and domestic and foreign currency exposure are from the Lane and Shambaugh (2010a) data set. Data from 1992 to 2006 are used (lack of information on the composition of NFA precludes the use of more recent data). The countries in the sample are listed in the Appendix. Real effective exchange rates are trade-weighted averages of the bilateral nominal end-of-month exchange rates against the US dollar from IMF International Financial Statistics, adjusted by the consumer price index. The trade weights used are those for the year 2002. The WDI real effective exchange rate series was preferred where bilateral trade data were missing or where the correlation between the two series was not high. Per capita GDP data are in constant 2005 international dollars.

Table 1 gives some summary statistics for the components of *NFA*. All components have more between-country than within-country variation. For industrial countries foreign-currency assets tend to exceed foreign-currency liabilities, whereas for other countries it is the other way around. Domestic-currency liabilities tend to exceed domestic-currency assets, consisting mainly of foreign direct investments in poorer countries and financial securities in richer ones.

Table 1. Summary Statistics on Net Foreign Assets

	N	N_C	T-bar	Mean	SD	SD within	SD between
FAFC/(X+M)							
Overall	1060	88	12.05	0.833	0.836	0.293	0.765
Industrial	264	21	12.57	1.512	1.239	0.478	1.163
Emerging	251	19	13.21	0.572	0.259	0.137	0.227
Other Dev	421	37	11.38	0.523	0.414	0.205	0.338
FLFC/(X+M)							
Overall	1060	88	12.05	1.087	0.800	0.460	0.660
Industrial	264	21	12.57	0.978	0.637	0.289	0.571
Emerging	251	19	13.21	0.838	0.483	0.237	0.443
Other Dev	421	37	11.38	1.374	0.984	0.604	0.801
FXE/(X+M)							
Overall	1060	88	12.05	-0.254	1.001	0.450	0.874
Industrial	264	21	12.57	0.533	0.877	0.333	0.827
Emerging	251	19	13.21	-0.266	0.489	0.274	0.418
OthrDev	421	37	11.38	-0.850	0.933	0.565	0.754
FADC/(X+M)							
Overall	1060	88	12.05	0.137	0.414	0.261	0.326
Industrial	264	21	12.57	0.483	0.595	0.423	0.439
Emerging	251	19	13.21	0	0	0	0
Other Dev	421	37	11.38	0	0	0	0
FLDC/(X+M)							
Overall	1060	88	12.05	0.636	0.663	0.361	0.542
Industrial	264	21	12.57	1.260	0.854	0.573	0.630
Emerging	251	19	13.21	0.437	0.281	0.162	0.241
Other Dev	421	37	11.38	0.349	0.264	0.156	0.204
DXE/(X+M)							
Overall	1060	88	12.05	-0.499	0.442	0.224	0.376
Industrial	264	21	12.57	-0.776	0.652	0.349	0.570
Emerging	251	19	13.21	-0.437	0.281	0.162	0.241
Other Dev	421	37	11.38	-0.349	0.264	0.156	0.204

Notes. FAFC: foreign assets denominated in foreign currencies; FLFC: foreign liabilities denominated in foreign currencies; FXE: foreign currency exposure (= FAFC – FLFC); FADC: foreign assets denominated in domestic currency; FLDC: foreign liabilities denominated in domestic currency; DXE: domestic currency exposure (= FADC – FLDC); (X+M): exports plus imports. Data period: 1992-2006.

4 Empirical Results

4.1 Real Exchange Rates

Table 2 shows the results of an error correction model of the bivariate relationship between the real exchange rate and *NFA/GDP* of the sort estimated by Lane and Milesi-Ferretti (2004) and Christopoulos *et al*. (2012) for three country groups separately: industrial economies, emerging markets and developing economies. To allow for coefficients across countries to differ, the regression is estimated separately for each country, and the figures shown in Table 2 are for the cross-country mean of each coefficient, using the mean group estimator of Pesaran and Smith (1995). The last row of the table gives the estimated long-run coefficient of *NFA*, which is equal to the lagged *NFA* coefficient divided by the lagged real exchange rate coefficient multiplied by –1.

Although the sample used here differs from that of previous authors, with more countries and a shorter maximum time dimension, the pattern across country groups is the same as they found. For industrial economies, the long-run effect of *NFA/GDP* on *R* is estimated to be negative and significant, but positive and significant for the rest. The issue which we wish to address is whether this is a genuine difference in coefficients, or whether it simply reflects the bias caused by ignoring valuation effects.

Table 2. Error Correction Model: Real Effective Exchange Rates and NFA/GDP by Country Group

	Industrial	Emerging	Developing
	(1)	(2)	(3)
Dependent Variable: dlnREER			
dNFA	-0.104	0.466	0.316
	(-1.72)*	(3.21)***	(4.55)***
Time trend (=0 in 2000)	0.001	-0.001	-0.003
	(0.68)	(-0.18)	(-0.81)
lnREER(-1)	-0.483	-0.424	-0.540
	(-9.42)***	(-6.42)***	(-7.72)***
NFA (-1)	-0.183	0.489	0.227
	(-2.43)**	(2.89)***	(2.92)***
Constant	0.234	0.676	1.245
	(1.65)*	(2.44)**	(4.26)***
No_Economies	22	25	29
No_Observations	330	359	393
RMSE	0.0321	0.0640	0.0546
Pesaran CADF	0.000	0.000	0.000
Calculated Long-Run			
NFA	-0.378	1.155	0.421
	(-2.39)**	(2.43)**	(3.32)***

Notes. NFA is a ratio of GDP. The coefficients are unweighted averages of coefficients in separate regressions for each individual country, with standard errors calculated using the mean-group procedure of Pesaran and Smith (1995). RMSE is the root mean square error of the residuals. “Pesaran CADF” is the residual unit root test of Pesaran (2006). REER – real effective exchange rate; NFA – net foreign assets.

Table 3 shows what happens if we take into account countries' average foreign currency exposure. In columns (1) and (2), the regression is exactly the same as in Table 2, again estimated separately for each country, but with a different categorisation of countries. In column (1), the sample consists of the 28 countries whose average *FXE* is positive (i.e. with assets denominated in foreign currency exceeding liabilities on average). The majority, but not all, of these countries are industrial countries. The estimated long-run coefficient for this sample is positive, but very small and highly insignificant.

For the 48 countries with negative *FXE*, which are mostly emerging markets and developing countries, the regression is shown in column (2). The coefficient is positive, highly significant and more than 30 times as large as in column (1).

These results suggest that valuation effects may be playing a substantial role in the results shown in Table 2. In the final column of Table 3, we explore this further by allowing individual countries' *NFA* coefficients, in both in the long and the short run, to vary with *FXE*, by introducing an interaction term between *FXE* and *NFA*. If we just estimated this country-by-country, as in columns (1) and (2), the cross-country variation in *FXE* would not come into play. At the other extreme, to force all coefficients to be identical across countries may be too restrictive. Accordingly we use the Pesaran *et al*. (1999) Pooled Mean Group (PMG) estimation procedure, in which only the long-run coefficients are constrained to be equal across countries, and the short-run coefficients (including the error correction term) are country-specific. For these country-specific coefficients the figures shown in column (3) are the unweighted averages of those in the individual-country regressions, like those in columns (1) and (2). The long-run *NFA*FXE* coefficient is highly significant and negative, as our previous analysis of valuation effects suggested that it would be.

Table 3. Real Exchange Rates and NFA/GDP by Foreign Exchange Exposure

	MG Estimation FXE_Avg>0	MG Estimation FXE_Avg<0	PMG Estimation
	(1)	(2)	(3)
Dependent Variable: dlnREER			
dNFA	0.002	0.385	0.127
	(0.02)	(5.42)***	(0.89)
Trend	0.003	-0.004	-0.537
	(1.28)	(-1.27)	(-0.78)
FXE(-1)*dNFA			-0.003
			(-1.42)
lnREER(-1)	-0.441	-0.511	-0.397
	(-7.33)***	(-10.68)***	(-10.34)***
NFA (-1)	0.007	0.304	
	(0.05)	(3.82)***	
Constant	0.420	0.967	0.549
	(1.80)*	(4.81)***	(4.08)***
No_Economies	28	48	76
No_Observations	407	675	1082
RMSE	0.0400	0.0588	0.0543
Log-Likelihood			1940.53
Pesaran CADF	0.000	0.000	0.000
Calculated Long-Run			
NFA	0.016	0.595	0.103
	(0.05)	(4.05)***	(7.30)***
NFA*FXE			-0.560
			(-12.77)***

See notes to Table 2. FXE_Avg represents the mean value of FXE for each individual country. Both FXE and NFA are ratios of GDP. Columns (1) and (2) are estimated using the mean-group procedure of Pesaran and Smith (1995); column (3) uses pooled mean-group estimation (Pesaran *et al*., 1999), in which only the long-run coefficients are constrained to be equal across countries. REER – real effective exchange rate; NFA – net foreign assets; FXE – foreign currency exposure.

Table 3 shows that the cross-country pattern of *NFA* coefficients may well reflect biases associated with valuation effects. To examine the issue more closely, we now look at year-to-year changes in *NFA* and *R*. The underlying effect of *NFA* on *R* is an equilibrium relationship that is unlikely to be detectable in the short run, in part because real exchange rates can be quite volatile. Even if there is a long-run correlation, it is unlikely to show up in year-to-year changes. By contrast the valuation effects of movements in *R* on *NFA*, through *FXE*, should be as strong in the short run as in the long run. If the real exchange rate changes by *x*%, this is immediately reflected in the valuation of net foreign assets denominated in foreign currency relative to *GDP*. To investigate this, we estimate the following regression for the change in *NFA/GDP*:

$$d\left(\frac{NFA}{GDP}\right)_{it} = a_i + bdlnREER_{it} - c\left(\frac{FXE}{GDP}\right)_{it-1} dlnREER_{it} + d\left(\frac{CA}{GDP}\right)_{it-1} + u_{it} \qquad (8)$$

Equation (8) expresses the change in *NFA/GDP* as a function of the change in the real exchange rate, and asset/liability accumulation through the current account balance (*CA*). The exchange rate coefficient is expected to vary with foreign exchange exposure. If valuation effects are important, the exchange rate coefficient should be a negative function of *FXE/GDP*.

The first column of Table 4 shows the results of estimating equation (8) with fixed country and time effects. As expected, the interaction term between *FXE* and real exchange rate movements is negative and significant at close to the 1% level. The remaining columns of Table 4 show how the real exchange rate coefficient varies by country group when the interaction term is omitted. Again as expected if valuation effects are important, real exchange rate appreciation is associated with a significant improvement in *NFA* in emerging and developing economies, for which *FXE* is typically negative, but not for the industrial economies.

Table 4. Short-Run Valuation Effects of Real Exchange Rate Movements on NFA/GDP

	All	Industrial	Emerging	Developing
	(1)	(2)	(3)	(4)
Dependent Variable: dNFA				
dlnREER	0.270	0.014	0.312	0.734
	(4.09)***	(0.14)	(2.58)**	(6.49)***
FXE(-1)*dlnREER	-0.536			
	(-2.61)**			
CA (-1)	0.209	0.789	0.464	-0.248
	(0.97)	(3.00)***	(3.27)***	(-0.74)
Country Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
No_Economies	75	22	25	28
No_Observations	1048	318	359	371
R-squared	0.169	0.081	0.326	0.250
RMSE	0.1248	0.1077	0.0670	0.1674

Notes. Estimation method is two-way fixed effects. Standard errors are clustered by individual country. Robust t-statistics are in parentheses. FXE, NFA and CA are all ratios of GDP. REER – real effective exchange rate; NFA – net foreign assets; FXE – foreign currency exposure; CA – current account balance. RMSE – root mean square residual.

So far we have shown that a regression of *R* on *NFA/GDP* is likely to display significant bias from valuation effects. We next estimate our preferred specification shown in equation (5), with *NFA* scaled by total trade, and with a correction for domestic currency exposure, which should absorb any endogeneity. The results for two-way fixed effects estimation are shown in Table 5. In column (1) of Table 5 the long-run equilibrium real exchange rate is assumed to be a constant apart from any *NFA* effects. The long-run *NFA*DXE* coefficient is positive, as expected, but with a *t*-statistic of only about one. The long-run *NFA* coefficient, which should now be free of bias from valuation effects, is likewise positive, but small and not statistically significant.

In the second and third columns of Table 5 we enrich the specification somewhat. In the second column we introduce per capita GDP relative to that of trading partners, to capture the Balassa-Samuelson effect. The coefficient is significant with the expected positive sign, but a disadvantage is that the sample is rather smaller (56 rather than 75 countries). Nevertheless the long-run coefficients are plausible. The Balassa-Samuelson effect is estimated to be significant at the 1% level, and the long-run coefficient of *NFA*DXE* is now close to the 5% level of significance. The long-run *NFA* coefficient is now estimated to be 0.146, and significant at 5%.[3]

In column (3) of Table 5, we include a country-specific time trend to capture unidentified factors that might shift the equilibrium real exchange rate; this adds flexibility to the specification without reducing the sample size. The long-run coefficients are significant and quite similar to those in column (2).

[3] We also tried adding the terms of trade. For exporters of primary products, this would capture relative price movements that are probably exogenous, but for exporters of manufactures, the terms of trade are likely to be endogenous to the real exchange rate. Since the terms of trade variable turned out to be most significant for the industrial countries, for which the endogeneity problem is likely to be more severe, we decided to omit it.

Table 5. Error Correction Model of Real Effective Exchange Rates and Net Foreign Assets, Allowing for Valuation Effects

	(1)	(2)	(3)
Dependent Variable: dlnREER			
dNFA	0.025	0.043	0.040
	(1.02)	(1.27)	(1.36)
DXE(-1)*dNFA	0.059	0.076	0.078
	(1.21)	(1.35)	(1.59)
dln(GDPpc/WGDPpc)		0.929	
		(3.43)***	
lnREER (-1)	-0.281	-0.273	-0.455
	(-10.10)***	(-7.67)***	(-11.96)***
NFA (-1)	0.011	0.040	0.056
	(1.02)	(2.50)**	(2.30)**
NFA (-1)*DXE(-1)	0.007	0.017	0.035
	(0.92)	(1.93)*	(2.52)**
ln(GDPpc/WGDPpc)(-1)		0.229	
		(2.98)***	
Country Dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
Country-Specific Time Trend	No	No	Yes
No_Economies	75	56	75
No_Observations	1060	818	1060
R-squared	0.178	0.251	0.331
RMSE	0.0792	0.0782	0.0741
Calculated Long-Run			
NFA	0.041	0.146	0.124
	(1.01)	(2.26)**	(2.32)**
NFA*DXE	0.026	0.061	0.077
	(0.95)	(1.92)*	(2.65)***
ln(GDPpc/WGDPpc)		0.836	
		(2.82)***	

Notes. Estimation method is two-way fixed effects. Standard errors are clustered by individual country. Robust t-statistics are in parentheses. DXE and NFA are ratios of exports plus imports. REER – real effective exchange rate; NFA – net foreign assets; DXE – domestic currency exposure; GDPpc/WGDPpc – ratio of per capita GDP to the trade-weighted average of per capita GDP of other countries (weights identical to those used in REER calculation); RMSE – root mean square residual.

The results shown in Table 5 suggest that there is a significant positive long-run effect of net foreign asset accumulation on real exchange rates. Moreover, because *DXE* tends to be negative for most countries, the positive coefficient of *NFA*DXE* implies that the true coefficient of *NFA* is likely to be underestimated if the interaction effect is not taken into account.

In Table 6 we repeat the same exercise as Table 5 but with fewer constraints on the coefficients. Instead of fixed effects estimation we use the Pesaran *et al*. (1999) Pooled Mean Group (PMG) estimation procedure, in which only the long-run coefficients are constrained to be equal across countries (i.e. the coefficients listed down to ln*REER(-1)* are country-specific, but the ratio of the coefficient of *NFA(-1)* to that of ln*REER(-1)* is the same across countries, yielding the same long-run estimate). The main effect is that the long-run coefficients have much smaller standard errors than in Table 5, and therefore much higher levels of significance.

In the simplest specification (column (1)), the long-run *NFA* coefficient is actually significantly negative, contrary to the theory, but in columns (2) and (3) it is positive and highly significant, as expected. The long-run *NFA*DXE* coefficient is always positive and not dissimilar in size to the Table 5 estimates, but more statistically significant.

Table 6. Real Exchange Rates and Net Foreign Assets Allowing for Valuation Effects: Pooled Mean-Group Estimation

	(1)	(2)	(3)
Dependent Variable: dlnREER			
dNFA	-0.136	-0.330	-0.186
	(-0.82)	(-7.66)***	(-1.06)
DXE(-1)*dNFA	-0.572	-0.133	-0.663
	(-1.06)	(-0.77)	(-1.35)
dln(GDPpc/WGDPpc)		-0.391	
		(-0.76)	
Time Trend			-0.002
			(-1.29)
Constant	0.297	0.591	0.832
	(2.46)**	(3.90)***	(4.57)***
Ln REER(-1)	-0.304	-0.330	-0.503
	(-8.99)***	(-7.66)***	(-13.84)***
Long-Run			
NFA	-0.058	0.077	0.233
	(-5.37)***	(5.06)***	(10.96)***
NFA*DXE	0.015	0.060	0.101
	(1.84)*	(5.81)***	(7.33)***
ln(GDPpc/WGDPpc)		1.558	
		(26.14)***	
No_Economies	75	55	74
No_Observations	1060	811	1053
Log-Likelihood	1722.46	1437.15	1844.20
RMSE	0.067	0.057	0.059
Pesaran CADF	0.000	0.000	0.000

Notes. Estimation method is Pesaran *et al.* (1999) pooled mean-group estimation, in which only the long-run coefficients are constrained to be equal across countries. DXE and NFA are ratios of exports plus imports. REER – real effective exchange rate; NFA – net foreign assets; DXE – domestic currency exposure; GDPpc/WGDPpc – ratio of per capita GDP to the trade-weighted average of per capita GDP of other countries (weights identical to those used in REER calculation); RMSE – root mean square residual; Pesaran CADF – Pesaran (2006) unit root test of residuals.

4.2 Are Industrial Countries Different?

An interesting question is whether, in these new tests, there is evidence of differences in the long-run effects of the accumulation of *NFA* on the real exchange rate across country groups of the kind suggested by Table 2. Christopoulos *et al*. (2012) present some theoretical arguments why the relationship should be stronger in credit-constrained economies. Does the empirical evidence support this claim after allowing for valuation effects? To test this, we interact the *NFA* coefficient with a dummy for the industrial countries (the group that is not likely to be credit-constrained). Table 7 repeats Table 5 with the addition of this interaction term, which should have a negative coefficient if the credit-constraint effect operates.

The results in Table 7 show that the interaction coefficient is significantly negative at the 5% level in all three specifications, as predicted by the Christopoulos *et al*. (2012) hypothesis.

Table 7. Testing for different long-run NFA effects in the industrial countries

	(1)	(2)	(3)
Dependent Variable: dlnREER			
dNFA	0.027	0.046	0.045
	(1.08)	(1.38)	(1.45)
DXE(-1)*dNFA	0.063	0.081	0.090
	(1.26)	(1.46)	(1.69)*
dln(GDPpc/WGDPpc)		0.914	
		(3.45)***	
lnREER (-1)	-0.282	-0.277	-0.454
	(-10.23)***	(-7.71)***	(-12.23)***
NFA (-1)	0.014	0.049	0.059
	(1.09)	(3.03)***	(2.22)**
NFA (-1)*DXE(-1)	-0.001	0.010	0.021
	(-0.14)	(1.12)	(1.34)
NFA(-1)* IND	-0.046	-0.051	-0.076
	(-2.55)**	(-2.98)***	(-2.01)**
ln(GDPpc/WGDPpc)(-1)		0.225	
		(3.01)***	
Country Dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
Individual Trend	No	No	Yes
N_Economies	75	56	75
N_Obs.	1060	818	1060
R^2	0.181	0.255	0.336
R^2_ Within	0.181	0.255	0.336
R^2_ Between	0.004	0.009	0.004
RMSE	0.0790	0.0780	0.0739
Calculated Long-Run			
NFA	0.050	0.176	0.130
	(1.08)	(2.66)**	(2.25)**
NFA*DXE	-0.005	0.036	0.047
	(-0.14)	(1.12)	(1.38)
NFA*IND	-0.164	-0.185	-0.167
	(-2.37)**	(-2.58)**	(-2.00)**
ln(GDPpc/WGDPpc)		0.813	
		(2.84)***	

See notes to Table 5. IND is an indicator variable for Industrial economies. In column (3) a country-specific time trend is included in the regression.

4.3 Net Foreign Assets and Net Exports

As discussed above, an alternative approach is to cut out the real exchange rate and to investigate the relationship between net foreign assets and net exports shown in (3) directly, as Durdu *et al*. (2013) do, but using the specification shown in (7), with variables scaled by total trade, to allow for valuation effects. Table 8 shows the results of the error correction model for net exports using three different forms of estimation. The estimated long-run coefficients are shown at the foot of the table.

The first column uses fixed effects estimation, which allows the intercept term to differ across countries. The long-run coefficients of *NFA* and *NFA*DXE* are very close to zero and highly insignificant. In column (2) we drop the country dummies. This brings the cross-country dimension into play: if countries with higher *NFA*, averaged over the sample, have lower average net exports, this will affect the *NFA* coefficient in column (2), whereas in column (1) this cross-country variation is entirely absorbed by the country fixed effects. The results in this case also are unfavourable to the hypothesis. Although the *NFA* coefficient is significant at the 1% level, it is positive rather than negative. This implies that countries with higher *NFA* have higher net exports, not lower as predicted by equation (3).

Finally, in column (3), we use Pooled Mean Group estimation, allowing the short-run coefficients to vary across countries, but imposing the same long-run coefficients. This produces quite different results. The estimated long-run *NFA* coefficient is now negative and highly significant, as predicted by equation (3), and the estimated long-run *NFA*DXE* coefficient is also negative and significant at the 1% level, as predicted by equation (7). Thus this form of estimation, unlike the other two, produces results that are consistent with the theoretical hypothesis. When we examine the long-run *NFA* coefficient for individual country groups, however, it turns out that this result is entirely driven by the 21 industrial countries. For the emerging markets (25 countries), the long-run *NFA* coefficient is -0.022, with a *t*-statistic of 0.88, and for developing countries (51), the estimated long-run *NFA* coefficient is +0.005. Because net exports are more stable in the industrial countries, PMG estimation will always weight them more highly than the rest, which (as here) can give a misleading picture.

Taking the limitations of the PMG estimates for the full sample into account, Table 8 provides little evidence of the expected long-run negative relationship between *NX* and *NFA*. The evidence is particularly unfavourable for pooled OLS estimation, because of the persistently positive cross-country correlation between *NX/(X+M)* and *NFA/(X+M)*, which varies between +0.25 and +0.48, averaging +0.37 over the fifteen years 1992-2006. This influences the pooled OLS result but not the other two, which allow the intercept term to differ across countries.

By contrast Durdu *et al*. (2013), using PMG estimation on data back to 1970 for 50 countries, find strong support for a long-run negative relationship between *NX* and *NFA* in both industrial and non-industrial countries (they estimate a restricted version of equation (7) without the *DXE* terms). This raises the question of structural breaks – was the period 1992-2006 very different from the previous twenty years? One reason could be the appearance of the much-discussed persistent current account imbalances in the latter period. If a significant minority of countries was running large surpluses or deficits, their net foreign assets would be rapidly rising or falling, and moving away from their previous long-run equilibrium, before perhaps settling at a new level. This would distort the normal negative *NX/NFA* relationship.

Table 8. Error Correction Model of Net Foreign Assets and Net Exports

	FE Estimation (1)	Pooled OLS Estimation (2)	PMG Estimation (3)
Dependent Variable: dNX			
dNFA	0.010	0.011	0.033
	(1.04)	(1.05)	(0.63)
dNFA*DXE(-1)	-0.029	-0.021	0.033
	(-1.51)	(-1.27)	(0.13)
NX (-1)	-0.399	-0.185	-0.498
	(-11.68)***	(-8.01)***	(-12.09)***
NFA (-1)	-0.001	0.009	
	(-0.10)	(2.87)***	
NFA (-1)*DXE(-1)	-0.002	0.003	
	(-0.20)	(0.75)	
Constant		0.001	-0.026
		(0.17)	(-4.05)***
Country Dummies	Yes	No	
Year Dummies	Yes	Yes	
No_Economies	99	99	97
No_Observations	1334	1334	1327
R-squared	0.223	0.120	
RMSE	0.0443	0.0481	0.0362
Log-Likelihood			2920.12
Calculated Long-Run			
NFA	-0.002	0.048	-0.055
	(-0.10)	(3.46)***	(-8.83)***
NFA*DXE	-0.004	0.017	-0.014
	(-0.20)	(0.77)	(-3.08)***

Notes. Estimation methods are two-way fixed effects (column (1)), pooled OLS (column (2)), and Pesaran *et al.* (1999) pooled mean-group estimation (column (3)). For columns (1) and (2), standard errors are clustered by individual country. Robust t-statistics are in parentheses. NX, DXE and NFA are ratios of exports plus imports. NX – current account balance minus net property income; NFA – net foreign assets; DXE – domestic currency exposure; RMSE – root mean square residual.

To test this hypothesis of a structural break, we estimate the Durdu *et al*. (2013) specification separately for 1971-91 and 1992-2007. Table 9 shows the estimated long-run *NFA* coefficients for the three groups of countries separately, using fixed effects, pooled OLS and PMG estimation (yielding nine estimates altogether for each period). The top panel shows the results for 1971-91 and the bottom panel shows those for 1992-2007. The other coefficients are omitted for clarity.

In the top panel, seven of the nine estimated coefficients are significantly negative at the 1% level, the eighth is significantly negative at the 10% level, and the ninth is slightly positive. Thus the 1971-91 results are strongly supportive of the hypothesis.

In the bottom panel, only three of the nine estimated coefficients are negative (those for the emerging markets in all three forms of estimation), and only one of those reaches the 10% level of significance. All the other estimated coefficients for 1992-2007 are positive.

This seems clear evidence of a breakdown of the normal negative *NX/NFA* relationship in the period of persistent global imbalances.

Table 9. The Long-Run *NX/NFA* Relationship 1971-91 and 1992-2007
Estimated Long-Run *NFA* Coefficient

Estimation Method	Industrial Countries	Emerging Markets	Other
	1971-91		
Fixed Effects	–0.094 (–3.10)***	–0.133 (–3.60)***	–0.011 (–3.48)***
Pooled OLS	–0.031 (–1.82)*	–0.071 (–3.68)***	0.003 (0.38)
Pooled Mean Group	–0.076 (–5.85)***	–0.221 (–9.77)***	–0.078 (–8.94)***
	1992-2007		
Fixed Effects	0.030 (0.85)	–0.111 (–1.66)	0.014 (1.40)
Pooled OLS	0.108 (1.54)	–0.025 (–0.90)	0.021 (2.16)**
Pooled Mean Group	0.104 (9.47)***	–0.141 (–4.73)***	0.001 (0.27)

Notes. The Table shows the estimated long-run coefficient for *NFA* in the error correction model *dNX = a +bdNFA + cNX(-1) + eNFA(-1) + u*, using three different forms of estimation. Both variables are scaled by total trade. Figures in parentheses are *t*-statistics. *, **, *** denote respectively statistically significant from zero at the 10, 5 and 1% levels.

5 Conclusions

So long as the real interest rate exceeds the growth rate, accumulation of net foreign assets as a proportion of GDP should be associated with real exchange rate appreciation in equilibrium. The effect is expected to be stronger in economies with lower trade/GDP ratios, because in these economies a 1% increase in *NFA/GDP* represents a larger increase relative to total trade. In addition, because foreign assets and liabilities are to some extent denominated in foreign currencies, valuation effects can distort the relationship, and can potentially explain previous findings that it appears to apply only to poorer countries, which mostly have negative foreign currency exposure. In this paper new tests have been developed to address these issues.

The results confirm the importance of valuation effects. The long-run real exchange rate effect of foreign asset accumulation as a proportion of total trade is positively correlated with domestic currency exposure, as predicted by the model. Nevertheless, as the hypothesis predicts, in the long run the real exchange rate is significantly positively correlated with net foreign assets at zero domestic currency exposure (when valuation effects are neutral) in appropriate specifications (allowing for relative productivity and/or country-specific time trends).

Christopoulos *et al*. (2012) argue that the relationship should be stronger in credit-constrained economies. Our results tend to support this hypothesis, even after valuation effects are taken into account.

The evidence for a negative long-run relationship between net financial assets and net exports is much thinner. Our investigation shows that there was a robust negative relationship in all groups of countries in the 1971-91 period, but that it broke down (probably temporarily) in the subsequent era of persistent global imbalances.

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Appendix

Table A. Country List

Industrial
Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
Emerging Markets
Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, South Korea, Thailand, Turkey, Ukraine, Uruguay
Other Developing
Albania, Armenia, Bangladesh, Belarus, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Burkina Faso, Cambodia, Cameroon, Chad, Cote d'Ivoire, Croatia, Dominican Republic, El Salvador, Estonia, Ethiopia, Fiji, Georgia, Ghana, Guatemala, Guinea, Haiti, Honduras, Jamaica, Jordan, Kenya, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Madagascar, Malawi, Mali, Moldova, Mozambique, Nepal, Nicaragua, Niger, Papua New Guinea, Paraguay, Rwanda, Senegal, Slovak Republic, Slovenia, Sri Lanka, Tanzania, Togo, Tunisia, Uganda, Zambia