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Exchange Rates and Trade Balance Adjustment: A Multi-Country Empirical Analysis

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Abstract

This study assesses the response of the trade balance to exchange rate fluctuations across a large number of countries. Fixed-effects regressions are estimated for 87 countries on annual data from 1994 to 2010. The trade balance improves significantly after a real depreciation, and to a similar degree, in the long run for all countries, but the adjustment is significantly slower for industrial countries. Emerging markets and developing countries display relatively fast adjustment. Disaggregation into exports and imports shows that the delayed adjustment in industrial countries is almost entirely on the export side. The rate of adjustment in emerging markets is slowing over time, consistent with their eventual graduation to high-income status. The ratio of trade to GDP is also highly sensitive to the real effective exchange rate, with a real depreciation of 10% raising the trade/GDP ratio across the sample by approximately 4%. This result, which presumably reflects movements in the prices of tradables relative to non-tradables, raises questions about the widespread use of the trade/GDP ratio as a trade policy indicator, without adjustment for real exchange rate effects.

Keywords: exchange rate, trade balance, exports, imports, terms of trade.

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Introduction

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Introduction

The response of an economy's trade balance to currency depreciation is traditionally believed to follow a J-curve, *i.e.* a depreciation of the domestic currency results initially in a deterioration of the trade balance because of adverse terms-of-trade effects, but eventually the trade balance improves as demand and supply adjust. The requirements for a depreciation to improve the trade balance are known as the Bickerdike-Robinson-Metzler condition or more particularly the Marshall-Lerner condition (Harberger, 1957; Krugman *et al*., 1987; Rose and Yellen, 1989).

Under pegged exchange rates the trade response to real exchange rate changes can have a policy dimension, in the form of the size of the devaluation required to correct a given current account deficit (although how much of a nominal depreciation translates into a real depreciation is another matter). With the shift to floating exchange rates amongst the advanced countries, research interest in the issue has somewhat declined. This is partly because floating rates have not had the expected tight relationship with current account flows and have been surprisingly volatile (compared with most economists' previous expectations). Although there have been numerous studies of trade balance adjustment for individual countries, some using aggregate trade flows, but many of them using disaggregated data, there are few systematic comparisons across countries (for useful surveys, see Goldstein and Khan, 1985; Bahmani-Oskooee and Ratha, 2004; Bahmani-Oskooee and Hegerty, 2010). Boyd *et al*. (2001) examine quarterly data for eight advanced countries and conclude that the Marshall-Lerner conditions generally hold in the long run, with some evidence of J-curve effects in the short run.

The International Monetary Fund, in its exchange rate assessments for individual countries, does not require the use of a common set of price elasticities in translating an estimated current account disequilibrium into an estimate of real exchange rate misalignment, although it does offer some default parameters based on US data (Isard, 2007). This agnostic position is indicative of uncertainty about these issues in the profession.

As Crucini and Davis (2013) point out, macroeconomists and trade specialists tend to differ in their assumptions about the elasticity of substitution between home and foreign goods, with macroeconomists choosing much smaller values, mainly because these are required to match the volatility of the real exchange rate observed in the data. These relatively small values are consistent with empirical studies on aggregate data (e.g. Bayoumi and Faruqee, 1998), but these estimates may be affected by aggregation bias if the elasticity of substitution varies across sectors (Imbs and Mejean, 2009).

Empirical work, such as that by Hooper *et al*. (1998) and Gallaway *et al*. (2003), suggests much higher import demand elasticities in the long run than in the short run, at least for advanced countries. Consequently, recent theoretical work has focused on developing models that explain why the elasticity of substitution does not reach the high values assumed by trade economists in the short run. Part of this may be due to delayed pass-through of exchange rate changes into import prices (Campa and Goldberg, 2005). Drozd and Nosal (2012) develop a model in which exporters sell to retailers rather than directly to consumers, and must build up their marketing capital in a given country before they can sell to new retailers, which results in short-run pricing-to-market effects. Crucini and Davis (2013) assume that the distribution of imported goods requires specific non-traded capital that is sluggish to adjust. Engel and Wang (2011) stress the empirical importance of durable goods in international trade, and durable goods stocks cannot be adjusted quickly in response to relative price changes.

On a slightly different tack, it is generally recognized that the macroeconomics of emerging markets and low-income economies is somewhat different. Industrial economies tend to have milder economic fluctuations, while developing economies have less solid macroeconomic fundamentals and less mature institutions, resulting in procyclical and more volatile behaviour of macroeconomic variables during certain periods of time (Frankel, 2010). In particular, the production side of some small open developing economies may be subject to export price booms and slumps, so that their external balances and economic volatility (and even political instability) are substantially correlated with commodity (e.g. oil) prices (Matsuyama, 1992; Sachs and Warner, 2001; Aguiar and Gopinath, 2007). Emerging markets have been subject to periodic "sudden stops" in capital inflows, resulting in large devaluations and sharp contractions in income (Frankel, 2005; Calvo *et al.*, 2006). These differences are likely to mean that the real effective exchange rate displays different patterns across the world; research has shown that exchange rates are more volatile in poorer, less open economies with volatile terms of trade and inflationary problems (Bleaney and Francisco, 2010). The question that we address here is a different one: whether there are systematic differences in the dynamics of the trade balance in response to a *given* real exchange rate change.

The contribution of the present paper is to present some stylized facts on aggregate trade balance adjustment across a wide range of countries. We investigate whether the short-run and long-run responses are similar across countries, and how the dynamics differ between exports and imports. We also consider how real exchange rate movements affect the ratio of trade to GDP. Our main result is that trade flows adjust much more slowly in richer countries, and relatively fast (within a year) in poorer ones. The sluggish adjustment in the value of trade flows in the richer countries seems to be concentrated on the export side. Real exchange rate appreciation markedly reduces the value of international trade relative to domestic GDP.

The paper is organised as follows. Section 1 discusses the theoretical background. Section 2 specifies the empirical methodology and describes the data issues. Econometric results are presented in Section 3. Section 4 concludes.

1 Theoretical Background

Denote the consumer country by using a subscript and the producer country by a superscript. The trade balance of country i vis-à-vis the world w can be written as the difference between exports $X_w^i = P_w^i C_w^i$ and imports $M_i^w = P_i^w C_i^w$, where P denotes a price and C a quantity.

By using the notation $\tilde{Z} = \ln Z - \ln \bar{Z}$ to represent the deviation of variable Z from its steady state $\bar{Z}$, the log-linearised version of trade balance (relative to trade) around the steady state is

$$\begin{aligned} TB_w^i &= \mu_{X_w^i}\left(\tilde{P}_w^i + \tilde{C}_w^i\right) - \mu_{M_i^w}\left(\tilde{P}_i^w + \tilde{C}_i^w\right) \\ &= \mu_{M_i^w}\left[\left(\tilde{P}_w^i + \tilde{C}_w^i\right) - \left(\tilde{P}_i^w + \tilde{C}_i^w\right)\right] - \left(\mu_{X_w^i} - \mu_{M_i^w}\right)\left[\left(\tilde{P}_w^i + \tilde{C}_w^i\right) - \left(\tilde{P}_i^w + \tilde{C}_i^w\right)\right] \end{aligned} \tag{1}$$

, where $\mu_X = \frac{\bar{X}}{\bar{X}+\bar{M}} = 1 - \frac{\bar{M}}{\bar{X}+\bar{M}} = 1 - \mu_M$ is the steady-state proportion of exports relative to the total trade value. Note that if the trade is close to being balanced in the steady-state ($\mu_X \approx \mu_M$),[1] the second part can be ignored, *i.e.*

$$TB_w^i \approx \mu_{M_i^w}\left[\left(\tilde{P}_w^i + \tilde{C}_w^i\right) - \left(\tilde{P}_i^w + \tilde{C}_i^w\right)\right] \tag{2}$$

If one defines the log-differenced (log-linear) demand of country j for the goods produced in country i in the form of

$$\tilde{C}_j^i = \eta_j \tilde{I}_j - \theta_j \tilde{P}_j^i + \psi_j \tilde{P}_j \tag{3}$$

, where I represents the income of the consumer country j and the latter two price terms jointly capture the relative price changes of goods produced in country i in the consumption basket of country j.

Substituting the demand term, yields

$$TB_w^i = \mu_{M_i^w}\left\{\left[(1-\theta_w)\tilde{P}_w^i - (1-\theta_i)\tilde{P}_i^w\right] - \left(\psi_i \tilde{P}_i - \psi_w \tilde{P}_w\right) + \left(\eta_w \tilde{I}_w - \eta_i \tilde{I}_i\right)\right\} \tag{4}$$

[1] In general, a country can possess an asymptotic trade surplus (deficit) in complement with a negative (positive) net property income position.

Under symmetric assumption across countries,

$$TB_w^i = \mu_{M_i^w}\left[(1-\theta)\left(\tilde{P}_w^i - \tilde{P}_i^w\right) - \psi\left(\tilde{P}_i - \tilde{P}_w\right) + \eta(\tilde{I}_w - \tilde{I}_i)\right] \tag{5}$$

The first bracket indicates the changes of the relative price of exports to imports, i.e. the terms of trade variations. The second bracket indicates the relative changes of the overall consumption basket prices, i.e. the real exchange rate changes. In the presence of substantial non-tradable price fluctuations, real exchange rate fluctuations can be very different from the terms of trade changes. The third bracket represents the relative income changes.

This functional form is not unusual in many stylised models with symmetric CES preferences and monopolistic competition settings.

Traditional models assume that a country's exports sell for the same price everywhere. In recent years it has been recognized that oligopolistic firms may employ country-specific pricing (see Dornbusch, 1987 for a theorectical model). In these circumstances the relative price of home-produced and imported goods may not respond much to the exchange rate, in which case the exchange rate has more of a supply-switching than a demand-switching effect, and full adjustment may take considerable time. Campa and Goldberg (2005) examine import price behaviour in 23 OECD countries using quarterly data. They find that for manufactured goods on average 43% of an exchange rate change is reflected in the local-currency price of imports in the short run (one quarter), rising to 62% in the long run (four quarters). The figures are closer to 100% for raw materials and energy. These results suggest that country-specific pricing is empirically significant for the manufactured sector in the advanced countries. They also imply that the adjustment process is different for different types of goods, and therefore by extension for countries that differ in the product composition of their exports and imports.

2 Empirical Methodology

This study aims to assess trade balance adjustments in response to real exchange rate fluctuations across country groups by conducting fixed-effects regressions on annual data for 87 countries over the years 1994 to 2010. Recent empirical research on trade balance adjustment has concentrated overwhelmingly on single countries or a small collection of advanced countries, and consequently does not investigate differences across countries of different types. The empirical model begins with the standard specification used in many analyses for individual economies and industries (Bahmani-Oskooee and Ratha, 2004; Bahmani-Oskooee and Hegerty, 2010):

$$\text{dTB} = \sum_{s=1}^{n} \beta_{it-s} dlnREER_{it-s} + \gamma X_{it} + \delta D_{it} + \epsilon_{it} \qquad (5)$$

where the dependent variable is the change in the trade balance, scaled by the total value of trade. The major variables of interest are log-changes of the consumption-based real exchange rate (*dlnREER*) with lags. The vector X includes a set of economy's characteristic variables that cover terms of trade, GDP size, *etc.*; D represents the two-way (time and country) fixed effect dummies. The data include as many economies as the WDI database permits. Summary statistics of variables can be found in Table 1.

The dependent variable is defined as the change in the trade balance scaled by the total value of trade (exports plus imports). An alternative measure, the log-change in the ratio of exports to imports, produces very similar results.

The first explanatory variables are the current and lagged changes in the logarithmic real effective exchange rate (REER). A rise in the value represents an appreciation. Empirical studies suggest an adjustment period of 1-3 years (Goldstein and Khan, 1985; Bahmani-Oskooee and Ratha, 2004). The REER is calculated using 2002 trade weights derived from the IMF DOT database, combined with exchange rate and price data from IMF *International Financial Statistics*. For countries with significant quantities of missing trade data, the WDI series for REER is preferred unless the correlation between the two is 90% or greater.

The control variables that we use are real GDP growth and the change in the logarithm of the terms of trade. The GDP data in constant (2000) US dollars are from the WDI database. The terms of trade variable is from the WDI database with the series name "net barter terms of trade" index.

Fixed effects for countries and years are included throughout. They are used to control for unidentified country fixed effects and for global cycles that are common to all economies. We have also experimented with including export-weighted growth rates of trading partners, to capture export demand effects, but this variable was never significant and is omitted from the results shown.

Countries are categorised into four groups: industrial countries (23), emerging markets (25) and other developing countries (39). Emerging markets are those listed as such by Morgan Stanley Capital International. Industrial economies are based on IMF definitions. Other developing countries comprise the remainder. Small financial economies and oil exporters were omitted. See the Appendix for a detailed list.

3 Empirical Results

Table 1 shows some summary statistics for different groups of countries. The year-to-year changes in the trade balance have a standard deviation of 2.3% of total trade in the industrial countries, 4.8% in emerging markets and 5.3% in other developing countries. The volatility of real effective exchange rates and of the terms of trade show exactly the same ordering, with industrial countries displaying the greatest stability and developing countries the least.

Table 1. Summary Statistics

	No._Obs.	N	T-bar	Mean	Std.
d (TB/(X+M))					
Industrial	367	23	15.96	-0.0011	0.02269
Emerging Market	397	25	15.88	0.0026	0.04761
Other Developing	537	39	13.77	-0.0001	0.05318
dlnREER					
Industrial	367	23	15.96	0.0039	0.04423
Emerging Market	397	25	15.88	0.0083	0.09121
Other Developing	537	39	13.77	0.0018	0.0954
dlnTOT					
Industrial	367	23	15.96	0.0006	0.0461
Emerging Market	397	25	15.88	0.0046	0.06938
Other Developing	537	39	13.77	-0.002	0.10242

Notes. TB = trade balance; X = exports; M=imports; REER = real effective exchange rate; TOT = terms of trade.

Table 2 shows the results of estimating equation (5) for the whole sample of countries (the first column), and for each individual group. Year and country dummies are included, and the standard errors are clustered at the individual economy level. For the whole sample the current change in the real effective exchange rate has a coefficient of -0.138, which is significant at the 1% level, indicating that a depreciation results in a fairly immediate improvement in the trade balance for the typical country. The estimated effect of the first lag of the change in the REER is about one-third of that, at -0.046, which is not significant even at the 10% level. The second lag has a very small coefficient of -0.002. As expected, the terms of trade change and GDP growth are highly significant, with positive and negative coefficients respectively. The test statistics at the bottom of the first column show that the three real exchange rate coefficients are jointly significant, and that the estimated long-run effect is different from zero. Thus for the typical country a depreciation improves the trade balance in the long run, and about three-quarters of the effect comes through in the first year. A 10% real depreciation is estimated to improve the trade balance in the long run by about 1.7% of total trade. We can compare this to a 10% worsening of the terms of trade, which is estimated to cause the trade balance to deteriorate by 1.2% of total trade, or to 1% extra GDP growth, which is estimated to cause a deterioration of 0.26%.

The other columns of Table 2 repeat this exercise for the Industrial, Emerging Market and Other Developing Countries groups separately. For the Industrial Countries, the estimated rate of adjustment to a real exchange rate change is much slower, with an insignificant coefficient of -0.039 in the current year, and a highly significant -0.124 in the following year, and +0.006 in the year after that. Emerging Markets show the most rapid adjustment, with a coefficient of -0.176 on the real exchange rate change in the current year, followed by small positive coefficients in the subsequent two years. Alessandria *et al*. (2010) explain this by significant fixed costs per trade transaction (such as bureaucratic procedures) that are particularly high in emerging markets and lead importers to keep substantial inventories to economize on these costs. In the event of a large devaluation, some import demand is absorbed by running down inventories, so short-run elasticities can be larger than long-run elasticities. Other Developing Countries are intermediate between these extremes, with a significant coefficient of -0.088 in the current year, -0.031 in the following year and -0.021 in the year after that. Summing the three coefficients suggests that the estimated long-run effect of real exchange rate changes is quite similar across country groups. The terms of trade effect is significant in all groups, but the GDP growth effect is particularly strong in emerging markets.

The statistics at the foot of Table 2 are tests of significance of the real effective exchange rate variables. The “Joint dlnREER =0” test statistic is a test of the null that all of the real exchange rate coefficients are zero. This is rejected at the 1% level for the full sample, and also for the Industrial Countries and Emerging Markets, but only at the 10% level for Other Developing Countries. The “Sum dlnREER =0” test statistic is a test of the null that these three coefficients sum to zero, or in other words that there is no significant long-run effect of real exchange rate changes on the trade balance. This is rejected at the 5% level for Other Developing Countries, and at the 1% level in the other cases. Thus the evidence suggests that real depreciation improves the trade balance significantly in the long run in all countries.

There may be a concern that some of the contemporary regressors are endogenous. Appendix Table A1 shows the results of estimating the Table 2 regression by system-GMM. The results are very similar to those shown in Table 2, which suggests that any endogeneity bias is small.

Table 2. Regressions on d (TB/(X+M))

	All	Industrial	EM	OthrDev
dlnREER	-0.138	-0.039	-0.176	-0.088
	(-5.38)***	(-1.47)	(-5.68)***	(-2.50)**
dlnREER(-1)	-0.024	-0.124	0.010	-0.031
	(-1.46)	(-3.88)***	(0.39)	(-1.67)
dlnREER(-2)	-0.002	0.006	0.034	-0.021
	(-0.13)	(0.12)	(1.21)	(-0.84)
dlnTOT	0.123	0.210	0.170	0.090
	(4.30)***	(3.20)***	(4.00)***	(2.64)**
dlnGDP	-0.256	-0.149	-0.564	-0.011
	(-2.85)***	(-1.83)*	(-3.85)***	(-0.11)
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1301	367	397	537
R2_Overall	0.17	0.28	0.39	0.15
R2_Within	0.20	0.29	0.43	0.16
R2_Between	0.01	0.09	0.00	0.05
RMSE	0.040	0.019	0.036	0.049
p-values of				
Joint dlnREER =0	0.000	0.000	0.000	0.064
Sum dlnREER =0	0.000	0.000	0.006	0.014

The dependent variable is the change in the trade balance as a proportion of exports plus imports. Robust t-statistics (clustered at the individual economy level) are included in the parentheses. Asterisks, ***, **, *, denote the significance level at 1%, 5% and 10% respectively. The Joint dlnREER test represents the joint significance test for all exchange rate variables (the contemporaneous and lagged variables). The Sum test represents the test for the sum of exchange rate variables' coefficients being equal to zero.

An alternative way of estimating long-run effects is with an error correction specification. Appendix Table A2 shows such a specification with country-specific time trends included. As in Table 2, the short-run adjustment is much smaller for the Industrial Countries. The estimated long-run real exchange rate effects (equal to minus one times coefficient of lnREER(-1) divided by the coefficient of [TB/(X+M)](-1)) are similar to those in Table 2.[2] Since the dynamics are much more readily visible in the Table 2 specification than in the error correction specification, we stick to this specification in the remainder of the paper.

Table 3 tests whether the real exchange rate effect is significantly different for industrial countries, by interacting the current and lagged real exchange rate change with a dummy that is equal to one for the industrial countries and zero otherwise (this dummy is labelled *IND* in Table 3). The first column uses the whole sample, and the second compares industrial economies just with emerging markets. In the first column we can reject at the 1% level the hypothesis that the real exchange rate coefficients are the same for industrial countries as for the rest of the sample (the "Joint" test at the foot of the table) but we cannot reject the hypothesis that they sum to the same value (the "Sum" test). In other words, the long-run effect is not significantly different for industrial countries, but the time pattern is: for industrial countries, less than 25% of the total effect of a real exchange rate change comes through in the current year, and the rest in the following year, whereas for the other countries 80% of the effect is observed in the current year. The second column of Table 3 repeats the exercise without the Other Developing Countries, just comparing Industrial Countries with Emerging Markets, with similar but even more statistically significant results.

[2] For example they are equal to -0.088/0.518 = -0.170 for the whole sample. The similarity also suggests that extra lags of the real exchange rate are not required in Table 2.

Table 3. Are Industrial Economies Different?

Dependent Variable: d(TB/(X+M))

	All	Ind with EM
dlnREER	-0.148	-0.191
	(-5.28)***	(-6.58)***
dlnREER * IND	0.118	0.170
	(3.18)***	(4.38)***
dlnREER(-1)	-0.017	0.011
	(-1.00)	(0.43)
dlnREER(-1) * IND	-0.092	-0.138
	(-2.23)**	(-3.36)***
dlnREER(-2)	0.000	0.036
	(0.02)	(1.32)
dlnREER(-2) * IND	-0.001	-0.045
	(-0.03)	(-0.88)
dlnTOT	0.124	0.173
	(4.29)***	(4.75)***
dlnGDP	-0.253	-0.495
	(-2.83)***	(-4.55)***
Country Dummy	Yes	Yes
Year Dummy	Yes	Yes
N_Economies	87	48
N_Obs.	1301	764
R2_Overall	0.18	0.33
R2_Within	0.20	0.39
R2_Between	0.01	0.01
RMSE	0.040	0.030
p-values of		
Joint Ind =0	0.002	0.000
Sum Ind =0	0.639	0.793

See notes to Table 2. IND =1 for industrial countries and =0 otherwise. The Joint Ind =0 test represents the joint significance test for IND dummy interacted with all exchange rate variables (the contemporaneous and lag variables). The Sum Ind =0 test represents the test for the sum of interaction variables' coefficients equal to zero.

There is reason to expect some positive correlation between the terms of trade and the real exchange rate, although the mechanism will depend on the nature of trade. For most countries in the sample, exports consist of rather different commodities to imports, and often primary products are a significant component. In this case the terms of trade will primarily reflect movements in the relative world price of the export and import baskets. An improvement in the terms of trade will tend to raise the equilibrium real effective exchange rate, and is therefore quite likely to cause an appreciation of the actual rate as well.

For the Industrial Countries, intra-industry trade is much more significant. For these countries a rise in the real exchange rate will cause a rise in the cost of home-produced relative to foreign-produced varieties, which with cost-plus pricing will cause the terms of trade to improve; indeed this is the original insight behind the Marshall-Lerner conditions. Thus for the Industrial Countries the terms of trade may be capturing the relative price effects of real exchange rate changes, so that the real exchange rate variable reflects only the quantity effects – recall that the J-curve effect depends on terms-of-trade effects that are not initially offset by quantity adjustments.

Accordingly Table 4 repeats the regressions shown Table 3 with the terms-of-trade variable omitted. The coefficient of the current real exchange rate change will now capture the terms-of-trade effect for manufactured exports as well as the quantity effects, so its coefficient should get less negative for countries that export significant quantities of manufactures. Table 4 shows that this does indeed happen, although the effect is not quantitatively very large. For Industrial Countries the coefficient of the current change in the real exchange rate is -0.018, compared with -0.039 in Table 2, and the coefficient of the first lag is -0.101, compared with -0.124 in Table 2. Thus both these coefficients become less negative by approximately 0.02. The coefficient of the second lag becomes *more* negative by a similar amount (-0.023 instead of +0.006).

For Emerging Markets the coefficients of the current and first lag of the real exchange rate change become less negative by 0.01, while the second lag is unaffected; for Other Developing Countries only the coefficient of the current change is altered, again becoming less negative by 0.01. Thus the effect of not separating out the terms-of-trade effect is most marked for the Industrial Countries, as expected.

Table 4. Regressions on d (TB/(X+M)) Omitting Terms of Trade

	All	Industrial	EM	OthrDev
dlnREER	-0.130	-0.018	-0.166	-0.078
	(-5.02)***	(-0.60)	(-5.33)***	(-2.13)**
dlnREER(-1)	-0.029	-0.101	-0.001	-0.032
	(-1.74)*	(-3.38)***	(-0.04)	(-1.62)
dlnREER(-2)	-0.003	-0.023	0.032	-0.020
	(-0.16)	(-0.43)	(1.11)	(-0.80)
dlnGDP	-0.235	-0.268	-0.540	0.013
	(-2.61)**	(-3.11)***	(-3.74)***	(0.13)
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1301	367	397	537
R2_Overall	0.14	0.13	0.35	0.13
R2_Within	0.16	0.14	0.38	0.13
R2_Between	0.02	0.00	0.04	0.09
RMSE	0.041	0.021	0.038	0.050
p-values of				
Joint dlnREER =0	0.000	0.000	0.000	0.144
Sum dlnREER =0	0.000	0.000	0.002	0.027

See notes to Table 2.

Exports and Imports

Is the adjustment rate of imports and exports the same? Most theoretical models do not offer any obvious reason why they should differ, except possibly as a result of commodity composition. This is investigated in Table 5. The dependent variable is the rate of change in the total value of exports (or imports). The real exchange rate coefficients should therefore be interpreted as the effect on the value of exports (or imports), measured in a common currency, relative to countries that have had unchanged real effective exchange rates, after allowing for country and year effects. [3]

The top half of Table 5 gives the results for exports and the bottom half shows the results for imports. For exports, the real exchange rate effects tend to be positive in the current year, and thereafter negative. The effect is particularly strong for Industrial Countries, and weakest for Emerging Markets. The "Sum" test shows that the long-run effect of real exchange rate movements on the value of exports, relative to those of other countries, is insignificantly different from zero. The "Joint" test indicates that the short-run increase in the relative value of exports is significant at the 1% level for Industrial Countries and at the 5% level for Other Developing Countries. This is the sort of pattern one would expect to see according to the traditional model, with infinite elasticities of supply and no pricing to market – export prices in foreign currency would adjust immediately to their new equilibrium level, whilst volumes adjust to this relative price change more slowly.

For imports, the immediate effect of real exchange rate movements is very marked in all countries. A 10% real appreciation is estimated to raise the relative value of imports by about 4% in the current year, with no significant change in the subsequent two years, unlike for exports. In the traditional model, this can only be explained by the short-run demand elasticity for imports being virtually as high as the long-run elasticity. With pricing to market, one would also expect a delayed effect, since import prices measured in domestic currency would not immediately adjust to

[3] The data are in US dollars, but the fixed country and time effects imply that the results would be the same for any currency.

the exchange rate change. Thus the marked difference between export and import behaviour for the Industrial Countries is a puzzle, particularly since so much of their trade is with each other.

An interesting point is that, adding together the import and export effects, real exchange rate appreciation tends to raise the total value of trade, relative to that of other countries, with an elasticity of about 0.2.

The terms of trade are significant for exports in all country groups, but not at all significant for imports. A possible reason for this is that exports are less diversified than imports, and the averaging effect over many products means that export price volatility is much greater than import price volatility, and so dominates terms-of-trade movements. The growth rate of GDP is, perhaps surprisingly, significantly positive in the export equation, although its coefficient is larger in the import equation, as expected. In the export equation, GDP growth may be capturing a productivity effect: when productivity growth is faster, exports become more competitive at a given real exchange rate, and so grow faster. To the extent that the effect is cyclical, it may reflect the importance of cyclically sensitive durable goods in international trade (Engel and Wang, 2011).

Table 6 tests whether the real exchange rate effects are significantly different in the Industrial Countries for exports and imports separately, as was done in Table 3 for the trade balance. For imports the "Joint" tests and "Sum" tests are insignificant, whether Industrial Countries are compared with all other countries or just with Emerging Markets. Thus both the total effect and the time pattern of import responses is similar across country groups. For exports, the "Sum" test is insignificant, indicating similar long-run effects, but the "Joint" test is significant at the 5% level for the comparison of Industrial Countries with all other countries and at the 1% level for the comparison just with Emerging Markets. Thus the slower adjustment of trade flows to real exchange rate movements in the Industrial Countries is concentrated virtually entirely on the export side.

Table 5. Separate Analysis of Exports (EX) and Imports (IM)

	All	Industrial	EM	OthrDev
Dependent Variable: d lnEX				
dlnREER	0.145	0.319	0.071	0.203
	(2.91)***	(4.36)***	(1.23)	(2.52)**
dlnREER(-1)	-0.010	-0.185	-0.019	0.009
	(-0.24)	(-3.12)***	(-0.47)	(0.14)
dlnREER(-2)	-0.063	-0.067	-0.022	-0.087
	(-1.95)*	(-0.92)	(-0.55)	(-1.53)
dlnTOT	0.298	0.372	0.348	0.254
	(3.31)***	(2.58)**	(5.46)***	(2.12)**
dlnGDP	1.189	1.233	0.835	1.466
	(7.04)***	(4.48)***	(4.80)***	(4.85)***
R2_Overall	0.57	0.83	0.74	0.44
R2_Within	0.58	0.84	0.76	0.44
R2_Between	0.46	0.45	0.37	0.42
RMSE	0.090	0.043	0.066	0.121
p-values of				
Joint dlnREER =0	0.010	0.001	0.615	0.027
Sum dlnREER =0	0.313	0.537	0.747	0.380
Dependent Variable: d lnIM				
dlnREER	0.428	0.396	0.435	0.379
	(10.12)***	(6.55)***	(8.31)***	(6.06)***
dlnREER(-1)	0.040	0.067	-0.044	0.077
	(1.08)	(0.88)	(-1.01)	(1.37)
dlnREER(-2)	-0.059	-0.079	-0.095	-0.043
	(-1.53)	(-0.86)	(-2.65)**	(-0.59)
dlnTOT	0.039	-0.056	0.002	0.059
	(0.71)	(-0.60)	(0.04)	(0.80)
dlnGDP	1.710	1.537	1.972	1.488
	(8.47)***	(6.10)***	(6.87)***	(4.77)***
R2_Overall	0.68	0.87	0.80	0.55
R2_Within	0.69	0.87	0.81	0.56
R2_Between	0.46	0.61	0.43	0.38
RMSE	0.084	0.040	0.075	0.107
p-values of				
Joint dlnREER =0	0.000	0.000	0.000	0.000
Sum dlnREER =0	0.000	0.002	0.000	0.003
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1301	367	397	537

See notes to Table 2. The dependent variable is the log change in the value of exports (EX) or imports (IM).

Table 6. Exports and Imports: Are Industrial Countries Different?

	d lnEX		dlnIM	
	All	Ind with EM	All	Ind with EM
dlnREER	0.125	0.085	0.428	0.479
	(2.29)**	(1.53)	(9.38)***	(10.45)***
dlnREER * IND	0.229	0.300	-0.013	-0.052
	(2.39)**	(3.18)***	(-0.16)	(-0.63)
dlnREER(-1)	0.002	-0.019	0.038	-0.047
	(0.05)	(-0.45)	(0.93)	(-1.24)
dlnREER(-1) * IND	-0.159	-0.169	0.028	0.116
	(-2.24)**	(-2.26)**	(0.34)	(1.41)
dlnREER(-2)	-0.057	-0.026	-0.057	-0.102
	(-1.59)	(-0.67)	(-1.36)	(-3.07)***
dlnREER(-2) * IND	-0.024	-0.054	-0.026	0.040
	(-0.28)	(-0.64)	(-0.27)	(0.46)
dlnTOT	0.300	0.350	0.039	-0.002
	(3.31)***	(5.79)***	(0.70)	(-0.04)
dlnGDP	1.195	0.867	1.710	1.866
	(7.05)***	(5.93)***	(8.41)***	(8.29)***
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	48	87	48
N_Obs.	1301	764	1301	764
R2_Overall	0.57	0.77	0.68	0.81
R2_Within	0.58	0.78	0.69	0.82
R2_Between	0.46	0.54	0.46	0.62
RMSE	0.090	0.057	0.084	0.061
p-values of				
Joint Ind =0	0.032	0.009	0.977	0.535
Sum Ind =0	0.703	0.548	0.928	0.350

See notes to Table 2. The dependent variable is the log change in the value of exports (EX) or imports (IM). IND =1 for industrial countries and =0 otherwise. The Joint Ind =0 test represents the joint significance test for 1(IND) dummy interacted with all exchange rate variables (the contemporaneous and lag variables). The Sum Ind =0 test represents the test thatthe sum of interaction variables' coefficients is equal to zero.

Time trends

Table 7 investigates whether there is any evidence of the pattern of trade balance adjustment changing over time. This is of particular interest for Emerging Markets, whose gradual ascent of the product quality ladder should bring their trade structure more into line with that of the Industrial Countries. To do this, a time trend (equal to zero in the year 2000) is interacted with each coefficient in Table 2. The results are shown in the odd-numbered columns of Table 7. The "Joint" test refers to the null hypothesis that the coefficients of the time trend interacted with the three real exchange rate variables are all zero. This hypothesis is rejected at the 5% level only for Emerging Markets, for which the coefficient of the current change in the real exchange rate is estimated to be getting significantly less negative over time.

The "Sum" test refers to the null hypothesis that the long-run effect of real exchange rate changes has no significant time trend, i.e. that the three coefficients used in the "Joint" test sum to zero. This test is rejected at the 1% level for Emerging Markets and at the 5% level for the whole sample. For Emerging Markets there is a strong trend of the coefficient of the current change in the real exchange rate becoming less negative over time, with little trend in the coefficient of the lagged real exchange rate changes.

In the even-numbered columns of Table 7, the interactions of the real exchange rate movements with the trend are constrained to sum to zero, which means that the estimated long-run effects are constrained to remain the same over time, but that within this constraint the time pattern can change. The insignificant time trends for the terms of trade and GDP growth are also omitted. For the Emerging Markets, there is a strong trend towards slower adjustment that is significant at the 1% level; for the Industrial Countries there is a weaker trend towards faster adjustment that is significant at the 5% level. Thus there appears to be some convergence in the adjustment speed of the trade balance of these two country groups, which is consistent with the

Emerging Markets increasingly exporting more complex and differentiated products. Our findings may in part reflect, however, the decreasing frequency of currency crises, which are usually associated with sudden and dramatic falls in imports, in Emerging Markets.

Table 7. Time Trends in Trade Balance Adjustment
Dependent variable: dTB/(X+M)

	ALL		IND		EM		OthrDev	
dlnREER	-0.143	-0.141	-0.025	-0.013	-0.220	-0.207	-0.085	-0.087
	(-5.39)***	(-5.40)***	(-0.64)	(-0.31)	(-6.88)***	(-6.98)***	(-2.36)**	(-2.47)**
dlnREER*	0.007	0.004	-0.003	-0.008	0.031	0.020	0.002	0.001
Trend	(2.00)**	(1.14)	(-0.39)	(-1.31)	(6.60)***	(4.76)***	(0.39)	(0.26)
dlnREER(-1)	-0.030	-0.024	-0.123	-0.124	0.001	0.015	-0.028	-0.030
	(-1.83)*	(-1.41)	(-4.65)***	(-4.67)***	(0.02)	(0.49)	(-1.41)	(-1.65)
dlnREER(-1)*	0.003	-0.001	-0.004	-0.009	0.003	-0.005	-0.002	-0.003
Trend	(0.93)	(-0.20)	(-0.58)	(-1.15)	(0.78)	(-0.94)	(-0.33)	(-0.53)
dlnREER(-2)	-0.005	0.002	0.002	0.000	0.048	0.065	-0.024	-0.022
	(-0.30)	(0.11)	(0.04)	(0.01)	(1.65)	(2.06)*	(-0.93)	(-0.86)
dlnREER(-2)*	0.002	-0.003§	0.018	0.017§	-0.006	-0.015§	0.003	0.002§
Trend	(0.57)		(2.55)**		(-0.97)		(0.70)	
dlnTOT	0.120	0.124	0.264	0.219	0.189	0.179	0.081	0.089
	(3.98)***	(4.32)***	(3.52)***	(3.61)***	(3.90)***	(4.26)***	(2.53)**	(2.66)**
dlnTOT*	0.001		-0.012		-0.003		0.004	
Trend	(0.33)		(-1.89)*		(-0.57)		(0.73)	
dlnGDP	-0.273	-0.256	-0.232	-0.146	-0.532	-0.537	0.022	-0.007
	(-2.59)**	(-2.85)***	(-2.60)**	(-1.71)	(-3.76)***	(-3.94)***	(0.16)	(-0.07)
dlnGDP *	0.006		0.018		-0.005		-0.014	
Trend	(0.54)		(1.09)		(-0.29)		(-0.67)	
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N_Economies	87	87	23	23	25	25	39	39
N_Obs.	1301	1301	367	367	397	397	537	537
R2_Overall	0.18	0.18	0.33	0.32	0.44	0.42	0.16	0.15
R2_Within	0.20	0.20	0.35	0.33	0.49	0.47	0.16	0.16
R2_Between	0.02	0.01	0.09	0.08	0.00	0.01	0.04	0.06
RMSE	0.040	0.040	0.019	0.019	0.035	0.035	0.049	0.049
p-values of								
Joint Trend	0.136	0.364	0.077	0.021	0.000	0.000	0.891	0.840
Sum Trend	0.031		0.205		0.000		0.801	

See notes to Table 2. § denotes coefficient determined by the imposed constraint that the coefficients of the three variables interacted with the trend sum to zero.

The Ratio of Trade to GDP

Table 8 examines the effect of real exchange rate changes on the ratio of total trade to GDP. This effect is potentially substantial, because real exchange rate movements affect the price of tradables relative to that of non-tradables, and the value of the output of the latter is included in GDP but not in trade. The first column shows results for the whole sample. The estimated exchange rate effect is quite large, with a 10% real appreciation reducing the trade/GDP ratio by approximately four percentage points. The pattern is relatively similar across the individual country groups, including the industrial countries. This suggests that there is quite a good match between the real exchange rate as conventionally measured, as the ratio of consumer price indices at home and abroad, and the theoretical definition of it as the ratio of the price of non-tradables to tradables. The interpretation of this result as a relative price effect is consistent with Drozd and Nosal's (2012) finding of a positive correlation between export and import prices in real terms (i.e. deflated by the consumer price index) in twelve OECD countries – when the real exchange rate appreciates, both export and import prices fall relative to the prices of non-traded goods.

This result has implications for the use of changes in the trade/GDP ratio as an aggregate measure of trade policy. Without adjusting for real exchange rate movements, such an interpretation of changes in the trade/GDP ratio could easily mistake real exchange rate effects for changes in trade policy.

Table 8. The Ratio of Trade to GDP

Dependent variable: d((X+M)/GDP)

	All	Industrial	EM	OthrDev
dlnREER	-0.382	-0.338	-0.327	-0.398
	(-11.61)***	(-6.43)***	(-6.96)***	(-7.05)***
dlnREER(-1)	-0.046	-0.083	-0.096	-0.001
	(-2.10)**	(-2.62)**	(-2.65)**	(-0.05)
dlnREER(-2)	-0.029	-0.038	-0.005	-0.056
	(-1.13)	(-1.17)	(-0.28)	(-1.16)
dlnTOT	-0.013	0.029	-0.023	-0.019
	(-0.44)	(0.53)	(-0.66)	(-0.48)
dlnGDP	0.149	0.158	-0.045	0.219
	(1.47)	(0.42)	(-0.48)	(1.15)
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1301	367	397	537
R2_Overall	0.37	0.59	0.41	0.33
R2_Within	0.39	0.60	0.45	0.35
R2_Between	0.00	0.03	0.04	0.00
RMSE	0.058	0.035	0.054	0.072
p-values of				
Joint dlnREER =0	0.000	0.000	0.000	0.000
Sum dlnREER =0	0.000	0.000	0.000	0.000

See notes to Table 2.

4 Conclusions

This paper has attempted to fill a gap in the literature by estimating the aggregate short-run and longer-run response of the trade balance to real effective exchange rate changes across a wide range of countries.

There is a wide dispersion in the year-to-year volatility of the trade balance, the real exchange rate and terms of trade across different groups of countries. In our sample of 87 countries over the years 1994 to 2010, developing countries show the greatest volatility, with emerging markets displaying greater stability. Industrial countries have the smallest volatility for all three variables. Despite these differences, the estimated long-run effect of real exchange rate movements on the trade balance, measured using a lag of up to two years, is remarkably similar across these groups of countries. A 10% real depreciation is estimated to improve the trade balance in the long run by about 2% of total trade, or 4% of imports. This is a relatively low figure, but not untypical of aggregate studies.

These long-run results are consistent with the notion that the real exchange rate is the key link in the negative cointegrating relationship between net foreign assets and net exports found by Durdu *et al.* (2013). A stronger net foreign asset position tends to push up the real exchange rate (Christopoulos *et al*., 2012; Lane and Milesi-Ferreti, 2004), and our results confirm that this causes the trade balance to deteriorate.

There are significant differences in the short run, however; adjustment in industrial countries is slower than in the rest. This can be explained by a number of factors: industrial countries are less likely to export undifferentiated products and to be price-takers in world markets, and are also likely to use local-currency pricing to some degree in their exports to other industrial countries, and export fewer primary commodities. The slower adjustment was shown to occur almost entirely on the export side – this is a major puzzle, since industrial countries' exports are to a large degree other industrial countries' imports.

Are emerging markets starting to resemble industrial economies? Our results suggest that they are. There is a significant trend towards less rapid adjustment of trade flows to exchange rate movements, so that in time they may be quite similar to industrial countries in this respect. An alternative explanation is that this result is driven by the decreasing frequency of currency crises, during which sharp depreciations have tended to be associated with particularly large and rapid falls in imports. Of course, these two explanations are not mutually exclusive: both could have elements of truth.

One definition of the real exchange rate is as the ratio of the price of non-tradables to tradables. The ratio of total trade to GDP is a good indicator of the inverse of this price. We have shown that in all countries there is a strong negative correlation between the trade/GDP ratio and the consumer-price-based measure of real effective exchange rates. This implies that the common practice of treating changes in the trade/GDP ratio as an index of trade policy is misleading unless real exchange movements are also taken into account.

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Appendix 1 – GMM Estimation of Table 2

Appendix Table A1. GMM estimation of Table 2
Dependent variable: d(TB/(X+M))

	All	Industrial	EM	OthrDev
dlnREER	-0.108	-0.045	-0.177	-0.080
	(-4.01)***	(-1.88)*	(-5.13)***	(-2.25)**
dlnREER(-1)	-0.022	-0.119	0.011	-0.026
	(-1.26)	(-3.84)***	(0.42)	(-1.53)
dlnREER(-2)	0.005	0.007	0.039	-0.015
	(0.27)	(0.15)	(1.49)	(-0.64)
dlnTOT	0.133	0.200	0.163	0.089
	(4.15)***	(3.68)***	(4.46)***	(2.56)**
dlnGDP	-0.210	-0.152	-0.420	0.002
	(-2.65)***	(-2.16)**	(-3.59)***	(0.03)
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1301	367	397	537
Sargan p-Value	0.00	0.02	0.26	0.95
Hansen p-Value	1.00	1.00	1.00	1.00
No. Instruments	524	333	357	473

System GMM treating dlnREER dlnTOT dlnGDP as endogenous. See Roodman(2006)

Appendix 2

Appendix Table A2. Fixed Effect Regressions on d (TB/(X+M)):
ECM Form with Country-Specific Time Trends

	All	Industrial	EM	OthrDev
dlnREER	-0.128	-0.049	-0.164	-0.085
	(-4.60)***	(-2.29)**	(-5.48)***	(-1.81)*
dlnREER(-1)	0.000	-0.014	0.028	-0.015
	(0.00)	(-0.42)	(1.05)	(-0.57)
dlnREER(-2)	0.010	0.064	0.043	-0.016
	(0.54)	(1.72)*	(2.80)***	(-0.49)
dlnTOT	0.136	0.216	0.163	0.124
	(3.85)***	(3.01)***	(3.19)***	(2.52)**
dlnGDP	-0.331	-0.201	-0.565	-0.107
	(-4.02)***	(-2.19)**	(-4.50)***	(-1.11)
TB/(X+M) (-1)	-0.518	-0.458	-0.460	-0.569
	(-13.25)***	(-7.45)***	(-11.99)***	(-10.34)***
lnREER(-1)	-0.088	-0.147	-0.104	-0.047
	(-2.67)***	(-3.87)***	(-2.18)**	(-0.88)
lnTOT(-1)	0.058	0.123	-0.004	0.082
	(2.29)**	(2.94)***	(-0.16)	(2.03)**
lnGDP(-1)	-0.165	-0.063	-0.221	-0.122
	(-2.93)***	(-1.30)	(-2.69)**	(-1.27)
Country Dummy	Yes	Yes	Yes	Yes
Individual Trend	Yes	Yes	Yes	Yes
N_Economies	87	23	25	39
N_Obs.	1300	366	397	537
R2_Overall	0.00	0.00	0.01	0.00
R2_Within	0.43	0.44	0.59	0.40
R2_Between	0.03	0.02	0.05	0.06
RMSE	0.035	0.018	0.031	0.043
p-values of				
Joint dlnREER =0	0.000	0.121	0.000	0.173
Sum dlnREER =0	0.004	0.999	0.028	0.083
Pesaran CADF	0.000	0.000	0.000	0.000

The Pesaran CADF test is a test of the null that the residuals have a unit root in all cases.

Appendix 3

Country Year List

List of Country-Years

Names	Sample Period	Names	Sample Period
Names	Sample Period	Depreciation>0.2 Years	Appreciation>0.2 Years
Industrial			
Australia	1994-2010		
Austria	2001-2010		
Belgium	1994-2010		
Canada	1994-2010		
Denmark	1994-2010		
Finland	1994-2010		
France	1994-2010		
Germany	1994-2010		
Greece	1994-2010		
Iceland	1994-2007	2008	
Ireland	2001-2010		
Italy	1994-2010		
Japan	1994-2010		
Luxembourg	2001-2010		
Netherlands	1994-2010		
New Zealand	1994-2010		
Norway	1994-2010		
Portugal	1994-2010		
Spain	1994-2010		
Sweden	1994-2010		
Switzerland	1994-2010		
United Kingdom	1994-2010		
United States	1994-2010		
Emerging Market			
Argentina	1994-2010	2002	
Brazil	1994-2010	1999	2005
Bulgaria	2001-2010		
Chile	1994-2010		
China	1994-2010	1994	
Colombia	1994-2010		
Czech Republic	2001-2010		
Egypt	1994-2010	2003	
Hungary	1994-2010		
India	1994-2010		
Indonesia		1998	1999 2002
Israel	1994-2010		
Malaysia	1994-2010		
Mexico	1994-2010	1995	
Morocco	1994-2010		
Pakistan	1994-2010		
Peru	1994-2010		
Philippines	1994-2010		
Poland	1994-2010		
Russia	2001-2010		
South Africa	1994-2010		2003
South Korea	1994-2010	1998 2008	
Thailand	1994-2010		
Turkey	1994-2010	1994 2001	

Ukraine	2001-2010		
Uruguay	1994-2010	2003	
Other Developing			
Armenia	2001-2010		
Bolivia	1994-2010		
Burundi	1994-2010		
Cameroon[2]	1994-2010	1994	
Central African Rep.[2]	1994-2009	1994	
Costa Rica	1994-2010		
Cote d'Ivoire[1]	1994-2010	1994	
Croatia	2001-2010		
Dominica	2001-2010		
Dominican Republic	1994-2010	2003	2005
Fiji	2001-2010		
Gambia	1994-2010	2003	
Georgia	2001-2010		
Ghana	1994-2010	1994 2000	
Guatemala	1994-2010		
Guyana	2001-2005		
Honduras	1994-2010		
Jamaica	2006-2010		
Jordan	1994-2010		
Kenya	1994-2010		1994
Kiribati	2001-2004		
Lesotho	1994-2010	2002	2003
Macedonia	2001-2010		
Madagascar	1994-2009	2004	1996
Malawi	1994-2010	1994 1998 2003	1996
Moldova	2001-2010		
Nicaragua	1994-2010		
Papua New Guinea	2001-2010		
Paraguay	1994-2010		
Senegal[1]	1994-2010	1994	
Sierra Leone	2001-2010		
Slovak Republic	2001-2010		
Solomon Islands	2001-2010		
Sri Lanka	1994-1997 2001-2010		
Togo[2]	1994-2010	1994	1995
Tonga	2001-2010		
Tunisia	1994-2010		
Uganda	1994-2010		1994
Zambia	1994-2010		2005 2006

Economies with subscript 1 and 2 are belonging to CFA franc zones which experienced sharp devaluation in 1994