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A Model of Aid and Dutch Disease in Sub-Saharan Africa

by

David Fielding and Fred Gibson

Abstract

International aid has an ambiguous effect on the macro-economy of the recipient country. To the extent that aid raises consumer expenditure, there will be some real exchange rate appreciation and a shift of resources away from traded goods production and into non-traded goods production. However, aid for investment in the traded goods sector can mitigate this effect. Also, a relatively high level of productivity in the non-traded goods sector combined with a high level of investment will tend to depreciate the real exchange rate. We examine aid inflows in 26 Sub-Saharan African countries, and find a variety of macro-economic responses. Some of the variation in the responses can be explained by variation in observable country characteristics; this has implications for donor policy.

JEL classification: F41, O56

Key words: aid, Dutch Disease, Africa

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A Model of Aid and Dutch Disease in Sub-Saharan Africa

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1. Introduction

The effect of aid inflows on the recipient economy depends partly on the response of relative prices and the corresponding adjustment in the sectoral composition of output. Any increase in foreign exchange income is likely to affect relative prices. There is a concern that the effectiveness of foreign aid might be reduced if it leads to a fall in the relative price of internationally traded goods (a real exchange rate appreciation), and if this fall has an adverse effect on the efficiency of production (Doucouliagos and Paldam, 2009). In other words, aid could have a 'Dutch Disease' effect. Modelling real exchange rate responses is therefore an essential part of a comprehensive analysis of the economic impact of foreign aid.

There are already several empirical studies of the impact of aid on the real exchange rate, and these are surveyed in the next section. The existing empirical research on real exchange rate responses comprises both single-country studies and econometric analyses of cross-country panel data. These studies are informative, but do not explicitly quantify the extent of cross-country heterogeneity in the impact of aid inflows, or identify the country-specific characteristics that cause the real exchange rate response to be large or small. Our paper fills this gap by quantifying the macroeconomic responses to aid inflows in 26 Sub-Saharan African countries, allowing for heterogeneity in the responses from one country to another. There is a great deal of variation in these responses, and a substantial part of this variation turns out to be correlated with observable country characteristics. These correlations have implications for aid effectiveness. The next section reviews the existing empirical literature on Dutch Disease effects in order to provide a context for our own econometric model, presented in Sections 3-4.

2. Theory and Evidence on Aid and Dutch Disease

Theory

The theoretical analysis of real exchange rate effects is simplest in a small open economy with a fixed nominal exchange rate. Higher domestic expenditure will raise only non-traded goods prices, because the price of internationally traded goods is exogenous. To the extent that the price change induces a reallocation of resources between production sectors, output of traded goods will fall and output of non-traded goods will rise. This does not necessarily entail lower social welfare. However, income distribution could worsen, if the poor own resources used exclusively in traded goods production. Moreover, the existence of positive externalities in traded goods production could mean that the resource reallocation reduces aggregate productivity.[1]

In a simple macroeconomic model, these effects are invariant to the exchange rate regime. This is easiest to see in a model with a single input (labour) and two goods, only one of which is internationally traded. There are two market clearing conditions (one for the labour market and one for the non-traded goods market), and a Balance of Payments equilibrium condition. However, there are only two endogenous relative prices: the ratios of the wage and of the non-traded goods price to the traded goods price. The three equilibrium conditions can be satisfied simultaneously only with an adjustment of real money balances. This can occur either through a change in the nominal exchange rate or, under a fixed exchange rate regime, through a change in foreign exchange reserves.

[1] See Corden (1984), van Wijnbergen (1984), Salehi-Esfahani (1988), Sachs and Warner (1995), Gylafson *et al*. (1997), Elbadawi (1999) and Adam and O'Connell (2004) for further elaboration of these ideas.

The effects of a resource inflow are less straightforward when some of the increased expenditure is in the form of capital investment (Adam and Bevan, 2006). This can raise labour productivity in the non-traded goods sector, and the corresponding increase in supply can offset the usual relative price effect, at least in the steady state. Moreover, any contraction of traded goods production due to a relative price change can be mitigated by higher investment in this sector. In general, a higher propensity to spend the aid on capital goods and a higher level of capital productivity will lessen any Dutch Disease effect. The overall effect of the resource inflow on welfare will depend on the speed of transition to the steady state, the magnitude of the real exchange rate appreciation during the transition, and magnitude of the productivity loss during transition. If there is some inertia in domestic factor prices, then the exchange rate regime can affect this transition process. Exchange rate flexibility (in the form of a float or an adjustable peg) will allow quicker relative price adjustment and a shorter transition period. If productivity is lower during the transition, then a fixed exchange rate is likely to be associated with a larger real exchange rate appreciation.

Evidence

Most existing econometric studies point to a significant correlation between the real exchange rate and aid inflows. However, there is substantial variation in the estimated elasticity of the real exchange rate with respect to aid. Using data from francophone West Africa, Adenauer and Vagassky (1998) find that an increase in aid inflows leads to a large real exchange rate appreciation, as predicted by the standard Dutch Disease model. This is also the conclusion of White and Wignaraja (1992), using Sri Lankan data, of Ouattara and Strobl (2008), using data from the CFA Franc Zone, and of Prati *et al*. (2003), using a cross-country panel dataset. Bourdet and Falck (2006), using data from the Cape Verde Islands, also report a positive elasticity,

although the magnitude of the effect is much smaller. Similarly, Kang *et al*. (2010) find that the responses of exports and GDP to global aid shocks are positively correlated, and that the size of both responses is negatively correlated with the real exchange rate, which can be interpreted as evidence for Dutch Disease. However, Nyomi (1998) and Sackey (2001), using data from Tanzania and Ghana, find a *negative* elasticity, even within the first year following an increase in aid. This implies either that the offsetting productivity effects come into play almost immediately, or that the standard Dutch Disease model is not applicable. There are similarly mixed results among papers exploring the Dutch Disease hypothesis by looking at the effect of aid on traded goods output. For example, Rajan and Subramanian (2011) find a negative effect, but Selaya and Thiele (2010) find a positive one.

CGE models of the macroeconomic impact of aid inflows also produce a wide variety of results. Papers by Bandara (1995), Jemio and Jansen (1993), Jemio and Vos (1993) and Vos (1998) indicate that in countries such as Mexico, Sri Lanka and Thailand, traded goods sector investment is likely to be high enough to guarantee an expansion of this sector following an increase in aid inflows. By contrast, in countries such as Pakistan and the Philippines, there is a standard Dutch Disease effect: an increase in aid inflows leads to a real exchange rate appreciation and a fall in traded goods production. Such heterogeneity is consistent with Adam and Bevan's (2004) model, calibrated to Ugandan data, in which the composition of aid expenditure makes a large difference to the response of sectoral output and relative prices. This dynamic CGE model also suggests that there will often be some real exchange rate overshooting, with a larger appreciation in the short run than in the steady state. Overshooting is a feature of other dynamic CGE models, for example that of Laplagne *et al*. (2001).

Taken together, the existing evidence suggests that there is substantial heterogeneity in the macroeconomic effects of aid inflows across developing countries. However, there is little econometric evidence concerning the factors underlying this heterogeneity. In the next section, we present a time-series econometric model designed to quantify the effect of variations in aid inflows in an individual country. Applying this model to a range of Sub-Saharan African countries allows us to characterize the cross-country variation in aid effects. Section 4 then presents evidence on the factors that explain this variation.

3. The Time-Series Model

3.1 Model structure

Many Sub-Saharan African countries are lacking in detailed high-frequency macroeconomic data. Nevertheless, it is still possible to model annual African time-series data using a vector-autoregression (VAR); in such a model, the effect of aid on relative prices and output is estimated in reduced form. Interpretation of the effects is left to the next section.

There are two versions of the time-series model, depending on the nature of the country's exchange rate regime. Some of the countries in our sample have some type of flexible exchange rate system – usually an adjustable (sometimes undeclared) peg to a basket of foreign currencies, or else a dirty float. There is no commitment to a hard peg, and the nominal exchange rate can adjust in response to external shocks. For a given real exchange rate, some domestic inflation is possible, through proportional growth in both the domestic price index and the domestic currency price of the US Dollar. For these countries, we fit a three-variable VAR.

$$B(L)\begin{bmatrix} y_t \\ r_t \\ \pi_t \end{bmatrix} = \delta + \varphi t + c(L)aid_t + \begin{bmatrix} u_t^1 \\ u_t^2 \\ u_t^3 \end{bmatrix} \quad (1)$$

Here, aid_t is the logarithm of the real value of foreign aid commitments for year t,[2] y_t is the logarithm of real GDP in year t, r_t is the logarithm of the real exchange rate in year t, π_t is the rate of growth of the GDP deflator, δ is a 3×1 vector of intercepts, φ is a 3×1 vector of trend coefficients, and u_t^i is a reduced form regression residual for the i^{th} dependent variable. $B(L)$ is a 3×3 matrix of lag polynominals quantifying the interaction between the three dependent variables (GDP, the real exchange rate, and inflation), and $c(L)$ is a 3×1 vector of lag polynomials quantifying the impact on the system of changes in our aid variable, aid_t. (It turns out that two lags are sufficient to ensure that the u_t^i terms are serially uncorrelated.) Equation (1) can be thought of as a reduced-form version of a structural model that contains contemporaneous interactions of y_t, r_t, and π_t. Aid commitments for year t may depend on past changes of y_t, r_t, and π_t, but we assume that they are weakly exogenous to (in other words, independent of the contemporaneous values of) these variables. For our purposes, it is not necessary to fit an aid equation. The assumption of weak exogeneity is based on the premise that international donors' foreign aid commitments are determined by a fiscal process that responds to changing conditions in the recipient countries only with a lag of at least one year.

In equation (1), the real exchange rate r_t is defined as the ratio of the domestic GDP deflator to the United States GDP deflator times the price of US Dollars in domestic currency (in logarithms, $p_t - p_t^* - s_t$). Ideally, the model would incorporate a real exchange rate based on the

[2] Aid is deflated using the GDP deflator.

relative prices of traded and non-traded goods. However, accurate and consistent time-series measures of such prices are not available for many African countries.[3]

Some Sub-Saharan African countries have a long history of a hard exchange rate peg that is not subject to discretionary adjustment. This group of countries includes the CFA Franc Zone, with a peg against the Euro (and formerly the French Franc) that has been adjusted only once since the Second World War, and some of South Africa's smaller neighbours, with a peg against the Rand. For each of these countries, the price of US Dollars in domestic currency is treated as strictly exogenous, so the response of π_t to the lagged dependent variables is constrained to be equal to the response of Δr_t,[4] and only the first two lines of the VAR need to be estimated. In the CFA Franc Zone countries, the regression equation for each variable also includes a dummy variable for the devaluation year (1994).

Given the relatively small sample that we will be using (40 years of annual observations), a test for the presence of a unit root in any of the individual country-specific time series (y_t, r_t, π_t, aid_t) will have very low power. The same is true of country-specific cointegration tests. Nevertheless, the cross-country panel unit root tests reported in the Appendix indicate that there

[3] One caveat to our results is that the use of a Purchasing Power Parity proxy for the real exchange rate does introduce some measurement error in one of our dependent variables, with a corresponding efficiency loss in our estimator. If traded and non-traded goods price data were available, then our estimates of the macroeconomic responses to aid inflows could be more precise. Other studies measure the real exchange rate using consumer price indices instead of GDP deflators; however, in many African countries the CPI is based on prices in just one or two cities, and may not be representative of the country as a whole.

[4] This restriction would be violated if foreign prices responded to changes in domestic GDP or domestic prices, which is theoretically possible. However, adding y_{t-1}, y_{t-2}, π_{t-1}, π_{t-2}, and p_{t-1} to an AR model of $[s_t + p_t^*]$ does not produce statistically significant coefficients in our 13 hard peg countries, even if we assume that foreign and domestic prices are cointegrated ($\chi^2(65) = 1.33$).

is likely to be a mixture of stationary and difference-stationary variables across our sample of countries. We therefore remain agnostic about the order of integration of the individual time series, and about the presence of cointegration. Consequently, we cannot assume that any of our test statistics – such as the t ratio – will have the conventional distribution. Applying a conventional distribution is likely to lead to some Type-I errors (the spurious correlation problem). For this reason, the critical values used to compute the significance levels of regression coefficients need to be adjusted. The adjustments are based on a Monte Carlo simulation with a null in which all four of the variables of interest are independent random walk processes. That is,

$$x_{jt} = x_{jt\text{-}1} + v_{jt}, \qquad v_{jt} \sim \mathrm{N}(0,\sigma_j^2), \qquad x_{jt} \in \{y_t, r_t, \pi_t, aid_t\} \tag{2}$$

The critical values are based on 10,000 replications, fitting equation (1) to artificial data generated using equation (2) in order to construct distributions for the regression t ratios and R^2s under the null. For example, the 5% critical value of the t ratio on the c_0 coefficients in equation (1), which measure the immediate effect of a change in aid, is 2.20 instead of 1.96.[5] This means that if the variables of interest are in fact stationary then the significance level of our estimates will be somewhat understated. In other words, our results will be presented with a lower-bound estimate of their significance.

[5] The difference between the conventional and adjusted critical values here is smaller than in test statistics used to determine the significance of long-run relationships (as for example in Pesaran *et al.*, 2001). This is because our alternative hypothesis is only that a change in aid has some immediate effect on GDP (or the real exchange rate, or inflation). The alternative hypothesis is agnostic about whether this effect persists, and our analysis will not involve estimating effects at the infinite horizon.

3.2 The fitted model

The time-series model is fitted to data for 26 Sub-Saharan African countries listed in Table 1 below, 13 of which have a hard peg. These are all the countries with available data that did not experience a large civil war between 1970 and 2009.[6] The variables are constructed using real and nominal GDP and nominal exchange rate data taken from the United Nations Statistical Yearbook (UNSY) for 1970-2009, and using data on total overseas development assistance from the OECD Development Assistance Committee database. (The time series for each country comprises only 40 annual observations; nevertheless, we will see that in many countries there are statistically significant responses to changes in aid.) Descriptive statistics for the four key time-series variables are reported in the Appendix; these statistics reveal substantial heterogeneity among the countries. The most marked differences include higher inflation rates in most of the flexible exchange rate countries, higher real growth in the Indian Ocean countries (Mauritius, Seychelles) and in Southern Africa (Botswana, Lesotho, Swaziland), and higher real exchange rate growth in mineral exporters with a hard peg (Congo Republic, Gabon, Niger). Given this

[6] Classification is based on battle deaths reported in the Correlates of War Project Intra-State War Database 4.1.

heterogeneity, it is not surprising to find that the parameters of the fitted model vary substantially from one country to another.[7]

The estimated parameters for each country are reported in the Appendix. These estimates are produced by fitting equation (1) to the data using OLS, with two lags in the VAR. There is no significant autocorrelation in the residual series u_t^i. However, the null that u_t^i is normally distributed can be rejected in some cases; this is the result of a number of large outliers, listed in the Appendix. For this reason, we estimate a further set of parameters using regression equations that include dummy variables for the outlier years. In the next section, these estimates will be used to check the sensitivity of our results to the treatment of atypically large reduced-form shocks.

Using the parameters of the fitted model, it is possible to plot the response of each dependent variable in the system to a percentage point increase aid. These plots are not included in the paper, but are available on request. Instead, Figures 1-3 and Table 1 summarize our results. The figures depict the estimated size of the response of r_t in each country over the first year (or first two years, or first three years) following a permanent percentage point increase in aid_t, along with the standard error of each estimate. The table lists the first-year responses of both y_t and r_t, along with the corresponding t ratios. These estimates are based on the original model

[7] This heterogeneity is the reason why our attempt to fit a dynamic panel model to the data was unsuccessful. In a dynamic panel model, the lagged dependent variables are not independent of the error term (Nickell, 1981), and it is necessary to use some type of Instrumental Variables estimator. In the absence of any other instruments, higher-order lags of the dependent variables can be used (Anderson and Hsiao, 1982). However, cross-country heterogeneity in the dynamics creates a weak instruments problem, and consequently coefficients on the lagged dependent variables are very imprecisely estimated. In our case, none of the regression coefficients in the dynamic panel model is individually significant, even assuming universal stationarity, and the coefficients are not jointly significant. Further details are available on request.

without outlier adjustments; outlier-adjusted results appear in the Appendix. The responses in the table are measured as percentage changes; those significantly different from zero at the 5% level (using the adjusted critical value of for the t ratio of 2.20) appear in bold type.

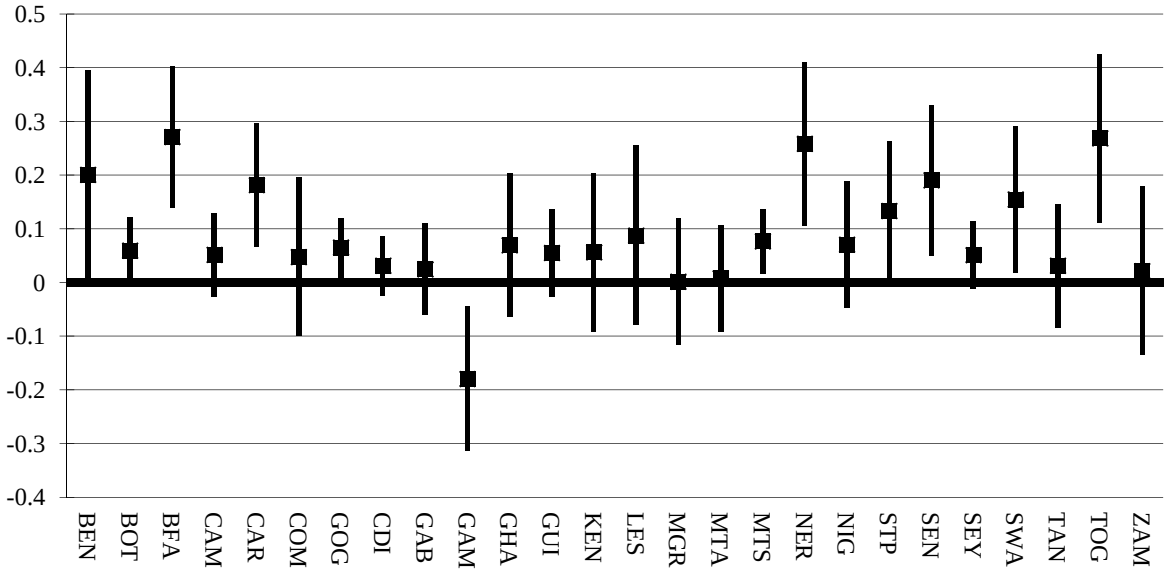

Figure 1: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first year following a permanent percentage point increase in aid (aid_t), unadjusted model

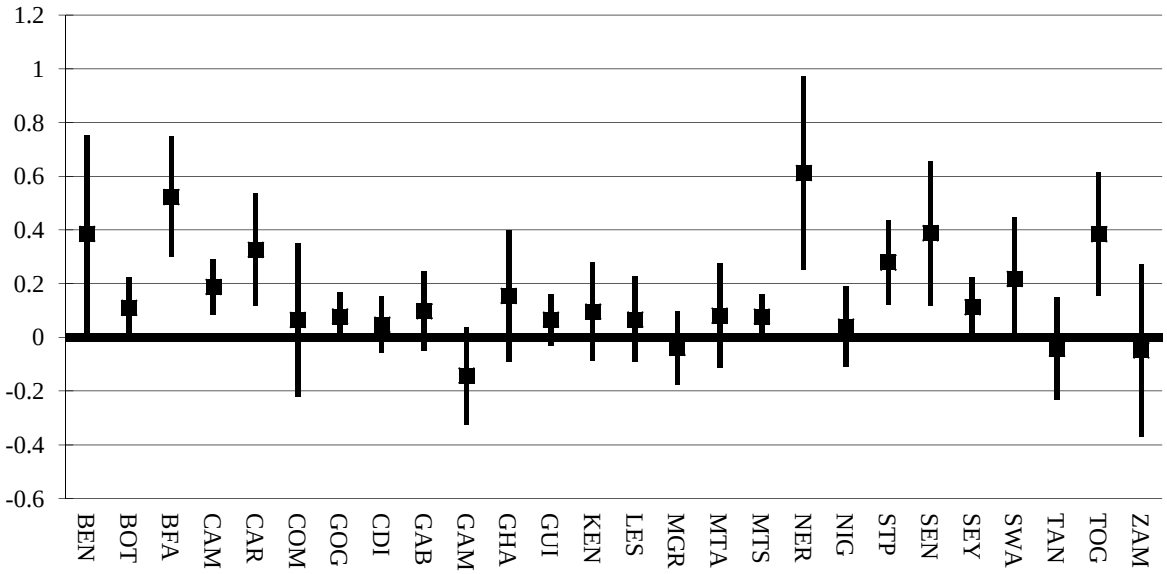

Figure 2: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first two years following a permanent percentage point increase in aid (aid_t), unadjusted model

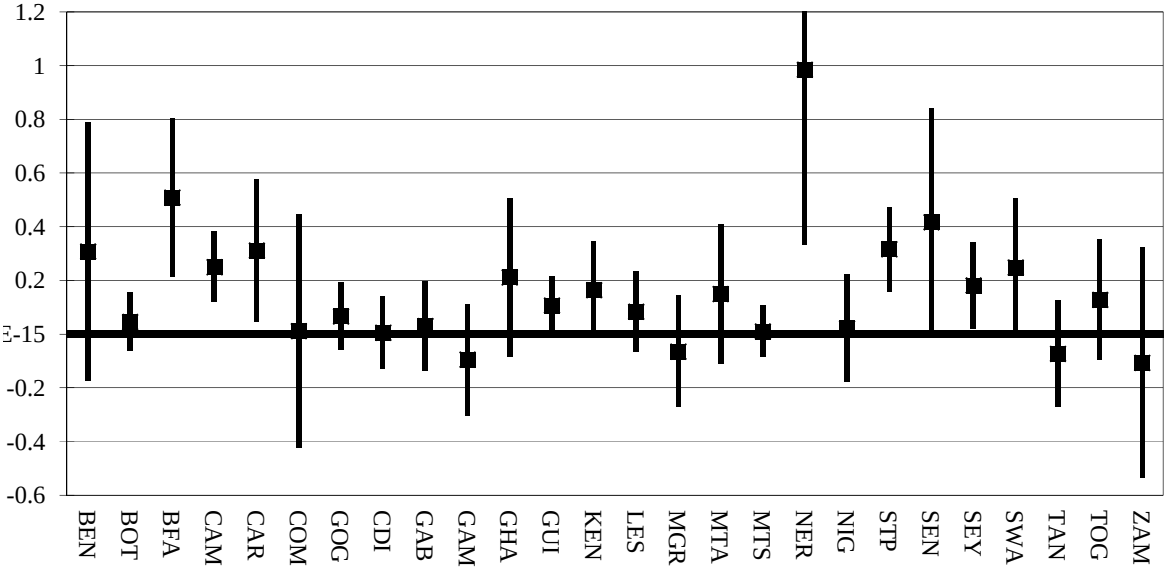

Figure 3: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first three years following a permanent percentage point increase in aid (aid_t), unadjusted model

Table 1: Initial Responses of *y* and *r* to a Unit Increase in aid

hard fixed peg countries	***y* response**	**t ratio** §	***r* response**	**t ratio** §
Benin (BEN)	**-0.071**	**-2.50**	0.201	2.06
Burkina Faso (BFA)	**0.062**	**2.47**	**0.271**	**4.12**
Cameroon (CAM)	0.006	0.39	0.052	1.32
Central African Republic (CAR)	0.015	0.66	**0.181**	**3.15**
Comoros (COM)	-0.006	-0.46	0.047	0.64
Congo Republic (RCO)	0.006	0.44	**0.065**	**2.35**
Côte d'Ivoire (CDI)	-0.002	-0.17	0.031	1.13
Gabon (GAB)	-0.015	-0.58	0.025	0.58
Lesotho (LES)	-0.022	-0.51	0.087	1.05
Niger (NER)	0.057	1.46	**0.258**	**3.39**
Senegal (SEN)	0.004	0.16	**0.190**	**2.72**
Swaziland (SWA)	-0.015	-0.51	**0.155**	**2.27**
Togo (TOG)	**0.102**	**2.45**	**0.268**	**3.43**
average response	*0.009*		***0.141***	
joint significance of responses (p-value)	*0.999*		***0.014***	

flexible rate countries	***y* response**	**t ratio** §	***r* response**	**t ratio** §
Botswana (BOT)	0.018	1.59	0.059	1.91
Gambia (GAM)	0.006	0.31	**-0.180**	**-2.67**
Ghana (GHA)	-0.044	-1.81	0.069	1.04
Guinea (GUI)	**-0.019**	**-2.43**	0.055	1.35
Kenya (KEN)	**0.042**	**2.76**	0.056	0.76
Madagascar (MGR)	0.047	1.72	0.001	0.02
Mauritania (MTA)	0.016	0.43	0.008	0.16
Mauritius (MTS)	-0.002	-0.17	**0.077**	**2.59**
Nigeria (NIG)	0.030	1.17	0.070	1.20
São Tomé (STP)	**-0.061**	**-2.62**	0.133	2.06
Seychelles (SEY)	0.020	0.82	0.051	1.63
Tanzania (TAN)	-0.013	-1.63	0.031	0.54
Zambia (ZAM)	-0.028	-1.54	0.021	0.27
average response	*0.001*		*0.035*	
joint significance of responses (p-value)	*0.996*		*0.238*	

§ Under the null that Δy, Δr, $\Delta \pi$ and Δaid are uncorrelated I(0) series, the 5% critical value of the t ratio is 2.20. The joint significance values are based on the same null, and are computed from the change in the cross-country average R^2 when the initial effect of aid in each country is constrained to be zero.

It can be seen that in all of the hard exchange rate peg countries there is estimated to be an immediate real exchange rate appreciation following an increase in aid. There is some variation in the size of the estimated appreciation: the largest immediate effect is in Togo (0.27%) and the smallest is in Côte d'Ivoire (0.03%). Nevertheless, the effects are jointly significant at the 5% level, and individually significant in the majority of countries. These results contrast with those for the flexible exchange rate countries, among which there is one significant appreciation (in Mauritius) and one significant depreciation (in the Gambia). In the other countries, the real exchange rate responses are statistically insignificant. The average response among the flexible exchange rate countries is only 0.04%, compared with 0.14% among the hard peg countries. This difference is consistent with the discussion of the effect of the nominal exchange rate regime in Section 2: with sticky factor prices, a fixed peg is likely to cause a larger real appreciation. In the next section, we explore whether this exchange rate regime effect is still apparent when we allow for other country-specific characteristics that might explain the magnitude of the real appreciation.

There are few significant immediate responses of real GDP to an increase in aid in either group of countries, and the cross-country average is very close to zero. In this sense, there is little direct evidence of a reduction in aggregate productivity following an increase in aid. However, for the flexible exchange rate countries there is a negative cross-country correlation between the size of the appreciation and the size of the change in GDP (ρ = –0.28), which might be interpreted as indirect evidence for a Dutch Disease effect among this group.

4. Modelling the Cross-Country Variation in Responses to Aid

In this section, we present results from regression equations designed to explain the cross-country variation in the size of the real exchange rate responses apparent in Figures 1-3. The

explanatory variables in these regressions are designed to capture some of the features of an aid recipient that might be associated with the magnitude of the real exchange rate appreciation. The definitions and values of all explanatory variables, along with their raw correlation statistics, appear in the Appendix; they are defined to capture the following country characteristics.

• ***Whether the country has a hard exchange rate peg***. As noted in Section 2, with some domestic factor price stickiness a flexible nominal exchange rate peg may facilitate more rapid transition to the steady state following an increase in aid. If the real exchange rate appreciation is not a characteristic of the steady state, then countries with a hard peg may exhibit a larger and more persistent appreciation in the short run. Our first explanatory variable is a dummy variable for the existence of a hard exchange rate peg through the sample period.

• ***The propensity to invest***. As noted in Section 2, aid that raises capacity in the non-traded goods sector is likely to cause some real exchange rate depreciation. (Aid that raises capacity in the traded goods sector has no direct effect on relative prices.) The effect of aid on the real exchange rate will depend on the marginal propensity to invest in non-traded goods production. Disaggregated aid figures are not available for long enough to measure the average proportion of aid invested directly in the non-traded goods sector over our sample period; moreover, if some aid is fungible then direct investment figures will not necessarily represent the overall effect of aid on investment. Nevertheless, national accounts statistics do include data on the annual proportion of GDP invested in fixed capital in each country. If the average proportion invested is correlated with the marginal propensity to invest income in capital specific to non-traded goods production, then it should also be associated with a relatively small real exchange rate appreciation following an increase in aid. Our second explanatory variable is the average ratio of

gross fixed capital formation to GDP, constructed from data in the UNSY for the same sample period as that used in the time-series analysis.

• ***Capital productivity***. As noted in Section 2, any investment following an increase in aid will be more productive, and mitigate the real exchange rate appreciation to a greater extent, the higher the marginal return to capital. Accurate capital productivity figures are not available for very many African countries. For this reason, we use measures of three country characteristics that are likely to be correlated with capital productivity. These are as follows.

(i) *Real per capita GDP*. For a given propensity to invest (and therefore a given capital-labour ratio in the steady state), higher *per capita* GDP will reflect a higher level of capital productivity. For this reason, countries with a higher average level of real *per capita* GDP should experience a smaller real exchange rate appreciation following an increase in aid. The average *per capita* GDP figures also come from the UNSY.

(ii) *Openness to international trade*. It has been argued that countries which are more open to international trade can more readily absorb new productivity-enhancing technologies (Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995). Among many papers discussing evidence for a link between openness and productivity are Edwards (1998) and Alcalá and Ciccone (2004). With limited data for Africa, it is not possible to construct many of the openness indicators discussed in this literature. Here we restrict our attention to two basic characteristics likely to be correlated with greater openness to international trade and therefore higher capital productivity and less real exchange rate appreciation following an aid inflow:

(a) The average ratio of the value of imports plus exports to GDP over the sample period, calculated from UNSY data.

(b) Whether the country has a maritime coastline. The range of goods in an economy that are internationally traded will depend on transport costs. Total transport costs are difficult to measure, but countries with direct access to sea ports are likely to face lower transport costs and therefore be more open to trade.

(iii) *Institutional quality*. The theoretical and empirical case for a link between formal political institutions and productivity is presented by Acemoglu *et al*. (2005). The extensive literature on institutions, productivity and growth incorporates a wide range of institutional characteristics. The characteristics most likely to have a direct impact on capital productivity are those relating to the regulation and taxation of businesses and the formation of public economic policy. The data source on relevant dimensions of institutional quality with the broadest country coverage is the World Bank's *Worldwide Governance Indicators* (http://info.worldbank.org/governance/wgi/index.asp). We use two alternative indicators from this source: *government effectiveness*, which measures 'the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies,' and *regulatory quality*, which measures 'the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.' For each country in our dataset, these two variables are measured as averages since 1996, the earliest year of available data.[8] We expect better

[8] Of the alternative data sources, Transparency International measures for African countries begin only in 2003, and World Bank *Doing Business* measures begin only in 2004. Freedom House data are available for the whole sample period, but incorporate only measures political and civil rights, which are likely to be less directly connected to capital productivity. When *government effectiveness* and *regulatory quality* are replaced by one of the Freedom House measures, the corresponding regression coefficients are always statistically insignificant.

institutional quality to be associated with higher capital productivity and therefore less real exchange rate appreciation following an increase in aid.

• ***The magnitude of aid dependence***. There might be non-linearities in the effect of changes in aid: a 1% increase in aid to a recipient which is heavily aid-dependent could have more impact on the macro-economy (in terms of percentage changes) than a 1% increase in a less aid-dependent recipient. Our final explanatory variable is therefore the ratio of aid to GDP, averaged over the whole sample period.

There are three alternative dependent variables in our cross-country regression equations – the three sets of real exchange rate responses in Figures 1-3 – and six explanatory variables: the hard exchange rate peg dummy, the investment-GDP ratio, the log of average GDP *per capita*, trade openness (measured either by the volume of trade as a fraction of GDP or the maritime coastline dummy), institutional quality (measured either by *government effectiveness* or *regulatory quality*), and the aid-GDP ratio. With three alternative dependent variables and four alternative sets of regressors, there are 12 regressions in total, all of which are reported in Table 2. The regression equations are fitted by OLS; one alternative is to use Weighted Least Squares, with weights inversely proportional to the size of the standard errors in Figures 1-3. Weighted Least Squares estimates are reported in the Appendix, as are estimates using the outlier-adjusted real exchange rate responses. The results in the Appendix are broadly similar to those in Table 2.

Table 2: Determinants of the Cross-Sectional Variation in the Response of the Real Exchange Rate to an Increase in Aid

(OLS estimates using responses from the unadjusted time series model; $N = 26$)

response in first year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.643	-2.89	0.01	-0.484	-2.18	0.04	-0.667	-2.66	0.02	-0.550	-2.22	0.04
log average GDP per capita	-0.017	-0.92	0.37	-0.014	-0.67	0.51	-0.031	-1.50	0.15	-0.029	-1.36	0.19
hard exchange rate peg	0.137	4.21	<0.01	0.120	3.59	<0.01	0.147	4.24	<0.01	0.132	3.98	<0.01
trade openness	0.058	1.90	0.07	0.050	1.49	0.15	0.038	0.75	0.46	0.050	0.96	0.35
Governance	-0.079	-2.51	0.02	-0.060	-1.71	0.10	-0.079	-2.27	0.04	-0.069	-1.93	0.07
aid-GDP ratio	0.299	2.15	0.04	0.243	1.64	0.12	0.240	1.63	0.12	0.190	1.27	0.22
R^2		0.67			0.62			0.62			0.60	
joint significance p value		<0.01			<0.01			<0.01			<0.01	

response in second year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-1.067	-2.58	0.02	-0.732	-1.76	0.09	-0.919	-2.04	0.06	-0.629	-1.38	0.19
log average GDP per capita	-0.036	-1.03	0.32	-0.030	-0.78	0.45	-0.041	-1.10	0.29	-0.035	-0.90	0.38
hard exchange rate peg	0.289	4.77	<0.01	0.257	4.09	<0.01	0.321	5.14	<0.01	0.281	4.59	<0.01
trade openness	0.083	1.45	0.16	0.062	0.98	0.34	-0.067	-0.73	0.47	-0.039	-0.41	0.69
Governance	-0.174	-2.97	0.01	-0.144	-2.18	0.04	-0.193	-3.10	0.01	-0.166	-2.52	0.02
aid-GDP ratio	0.483	1.88	0.08	0.357	1.29	0.21	0.430	1.63	0.12	0.306	1.10	0.28
R^2		0.67			0.62			0.65			0.60	
joint significance p value		<0.01			<0.01			<0.01			<0.01	

Table 2 (continued)

response in third year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.742	-1.09	0.29	-0.356	-0.53	0.60	-0.522	-0.72	0.48	-0.183	-0.25	0.81
log average GDP per capita	-0.076	-1.30	0.21	-0.065	-1.06	0.30	-0.080	-1.33	0.20	-0.072	-1.14	0.27
hard exchange rate peg	0.295	2.95	0.01	0.248	2.46	0.02	0.339	3.35	<0.01	0.285	2.91	0.01
trade openness	0.108	1.16	0.26	0.094	0.92	0.37	-0.105	-0.71	0.49	-0.069	-0.45	0.66
Governance	-0.184	-1.91	0.07	-0.127	-1.19	0.25	-0.213	-2.10	0.05	-0.161	-1.52	0.15
aid-GDP ratio	0.086	0.20	0.84	-0.042	-0.09	0.93	0.019	0.05	0.97	-0.118	-0.27	0.79
R^2		0.44			0.38			0.41			0.36	
joint significance p value		0.06			0.13			0.09			0.17	

Table 2 shows that the significant difference between the hard exchange rate peg countries and the flexible exchange rate countries noted in the previous section remains when we allow for other fixed country characteristics. In fact, the difference is larger, with the hard peg countries experiencing a real exchange rate appreciation that is nearly 0.15 percentage points higher in the first year, *ceteris paribus*, and about 0.3 percentage points higher in the subsequent two years. These effects are robust to different model specifications, significant at the 1% level, and consistent with the theoretical discussion in Section 2.

A second significant characteristic in Table 2 is governance, measured either by *government effectiveness* or by *regulatory quality*. The effect of governance is most precisely estimated in the second year of an aid increase. At this point, a country with a governance level that is higher by one unit (that is, by one worldwide standard deviation in the *Worldwide Governance Indicators* dataset) can be expected to have a real exchange rate appreciation that is at least 0.15 percentage points lower; the effect is significant at the 5% level. In the first year the effect is somewhat smaller, and in both the first and third years it is of more marginal statistical significance. Again, the sign of the effect is consistent with the theoretical discussion in Section 2: better governance promotes capital efficiency and mitigates the real exchange rate appreciation following an increase in aid.

A third significant characteristic in Table 2 – though only in the first year or two following the aid increase – is the investment-GDP ratio. A country in which this ratio is one percentage point higher can be expected to have a real exchange rate appreciation that 0.5-0.6

percentage points lower in the subsequent year. That a higher propensity to invest mitigates the real exchange rate appreciation is again consistent with the theoretical discussion in Section 2.[9]

Of the other regressors in Table 2, GDP *per capita* and trade openness are never significant at the 5% level. (When both the maritime coastline dummy and the ratio of trade volume to GDP are included in a single regression equation, they are both still statistically insignificant.) It would be imprudent to conclude that openness has no role in conditioning the macroeconomic impact of an increase in aid, but the available proxies do not provide any evidence for such an effect. The aid-GDP ratio is significant at the 5% level in one regression, where the coefficient has the expected positive sign, which could be interpreted as evidence that aid-dependent economies are more sensitive to proportional changes in aid levels.

5. Summary and Conclusion

Our time-series estimates of the impact of aid inflows on the real exchange rate and output reveal a considerable degree of heterogeneity across Sub-Saharan Africa. An aid inflow causes a real exchange rate appreciation in most countries, but the size of the effect varies substantially, and in one country there is a real exchange rate depreciation. This heterogeneity reflects the variation in previous single-country studies using both econometric and calibrated general equilibrium models.

[9] We do not report corresponding regression results for the cross-country variation the response of GDP to an increase in aid. With GDP, none of the country characteristics is ever statistically significant. If the effect of governance and the investment-GDP ratio on the response of the real exchange rate to aid are to be explained in terms of productivity and capital intensity effects, why is no corresponding effect detected in the response of GDP? One possibility is that the GDP deflator is a more sensitive measure of aggregate prices than GDP is of aggregate output. For example, higher productivity in household production might not be reflected in GDP figures, because the National Accounts do not capture household production very well, but changes in household production prices might be quite highly correlated with changes in the prices of substitutes that are included in the National Accounts.

Our analysis of the cross-country variation in the response of the real exchange rate to aid inflows indicates the importance of country characteristics reflecting the propensity to invest in fixed capital, and of institutional quality measures that are likely to be associated with capital productivity. This result is also consistent with recent general equilibrium studies discussed in the literature review: a high propensity to invest and a high level of productivity mitigate the real exchange rate appreciation caused by an aid inflow. However, conditional on these effects, and subject to a caveat about small sample size, we do not find that the variation in real exchange rate responses is significantly correlated with standard measures of trade openness.

Finally, aid inflows cause a much larger real exchange rate appreciation in countries with a hard fixed exchange rate peg than in countries with a more flexible exchange rate regime. This suggests some stickiness in domestic factor prices. The hard exchange rate peg in the CFA Franc Zone has some substantial advantages, for example lower inflation (Bleaney and Fielding, 2002). However, the results here suggest that the hard peg might not be without costs.

In the light of this evidence, there is a case for including measures to mitigate real exchange rate appreciation as part of an aid package. Whatever the wider benefits of general reforms to improve institutional quality and macroeconomic policy, such reforms will not reduce the magnitude of the appreciation unless they have an effect on investment and capital productivity in the non-traded goods sector. This is especially true of countries with a hard fixed exchange rate peg. Without this component of development assistance, aid inflows are likely to generate macroeconomic imbalances in the short run, except in the least developed countries where the marginal return to capital investment is very high.

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APPENDIX

A1. Panel Unit Root Tests

For each variable (y_t, r_t, π_t, aid_t,), and for each variable in differences (Δy_t, Δr_t, $\Delta \pi_t$, Δaid_t,), Table A1 reports two types of panel unit root test statistic, along with the corresponding p-values.

• The Im *et al*. (2003) W_{tbar} statistic. Here, the null hypothesis is that the time series is difference-stationary (order of integration I(1)) in every country, and the alternative is that it is stationary in levels (order of integration I(0)) in at least one country.

• The Hadri (2000) test statistic (which is normally distributed). Here, the null hypothesis is that the time series is stationary in levels in every country, and the alternative is that it is difference-stationary in at least one country.

In each case, there are two versions of the hypothesis with stationarity in levels: one with a deterministic linear trend and one without.

For the variable in differences (Δy_t, Δr_t, $\Delta \pi_t$, Δaid_t,), the results are clear. The Hadri null of stationarity in levels cannot be rejected at the 5% level (though with Δy_t this requires a deterministic trend in the model), and the Im *et al*. null of difference-stationarity can be rejected. This provides our justification for assuming that the levels series (y_t, r_t, π_t, aid_t,) have an order of integration no greater than I(1).

For the un-differenced variables (y_t, r_t, π_t, aid_t,), the results are less straightforward. For all variables except y_t, the Im *et al*. null of difference-stationarity can be rejected at the 5% level, but for all variables, the Hadri null of stationarity in levels can also be rejected. This indicates that we have a mixture of I(0) and I(1) series. However, with such a small number of observations in each country, the power of scalar unit root tests is not great enough for us to be able to identify which of the individual time series are I(0).

A2. Descriptive Statistics for the Time Series

The means and standard deviations of the regression time series in each country are presented in Table A2.

A3. Outliers in the Time Series Regressions

The observations with atypically large values of u_t^i are listed in Table A3. The adjusted time series model includes dummy variables for each of these observations.

A4. Time Series Regression Coefficients

Tables A4-A5 include individual time series regression coefficients from the unadjusted model.

A5. Real Exchange Rate Responses in the Adjusted Time Series Model

Figures A1-A3 show the estimates of the response of the real exchange rate to a percentage increase in aid using the adjusted time series model (including dummy variables for the observations listed in Table A3). These figures correspond to Figures 1-3 of the main text, which show responses using the unadjusted model.

A6. Fixed Country Characteristics

The first part of Table A6 lists the values of the different fixed country characteristics in each country, while the second part reports the cross-country correlations for each characteristic. The final part of the table provides details about the definition of each characteristic.

A7. Alternative Cross-Country Regression Results

Tables A7-A9 report results from additional cross-country regression equations, including results using the outlier-adjusted real exchange responses in Figures A1-A3, and results using Weighted Least Squares instead of OLS (with weights inversely proportional to the log of the standard errors in Figures 1-3 or Figures A1-A3). Results in Tables A7-A9 are similar to those in Table 2.

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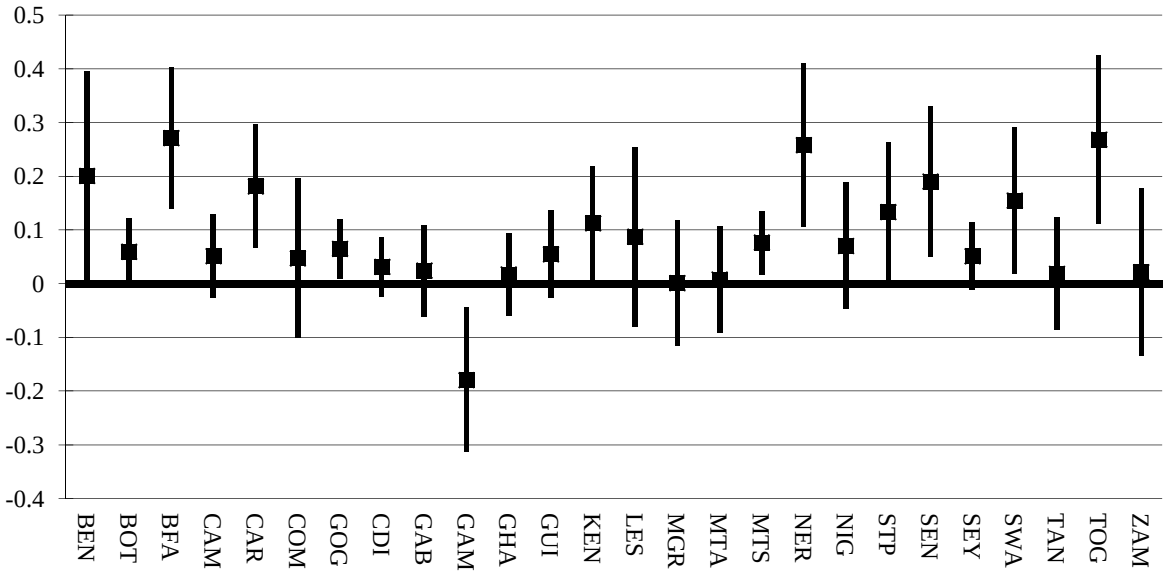

Figure A1: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first year following a permanent percentage point increase in aid (aid_t), adjusted model

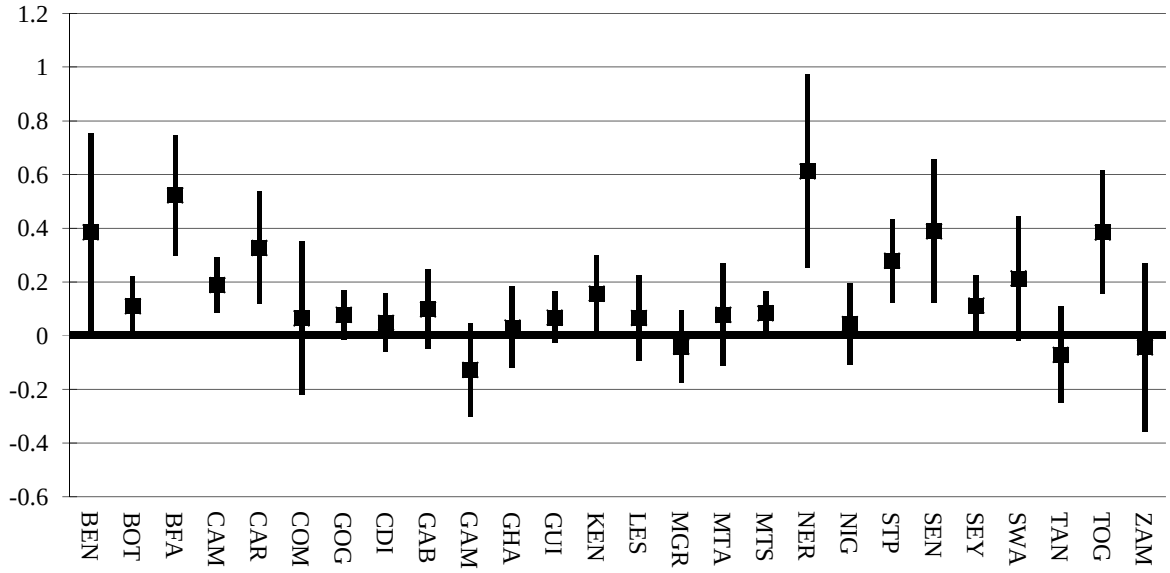

Figure A2: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first two years following a permanent percentage point increase in aid (aid_t), adjusted model

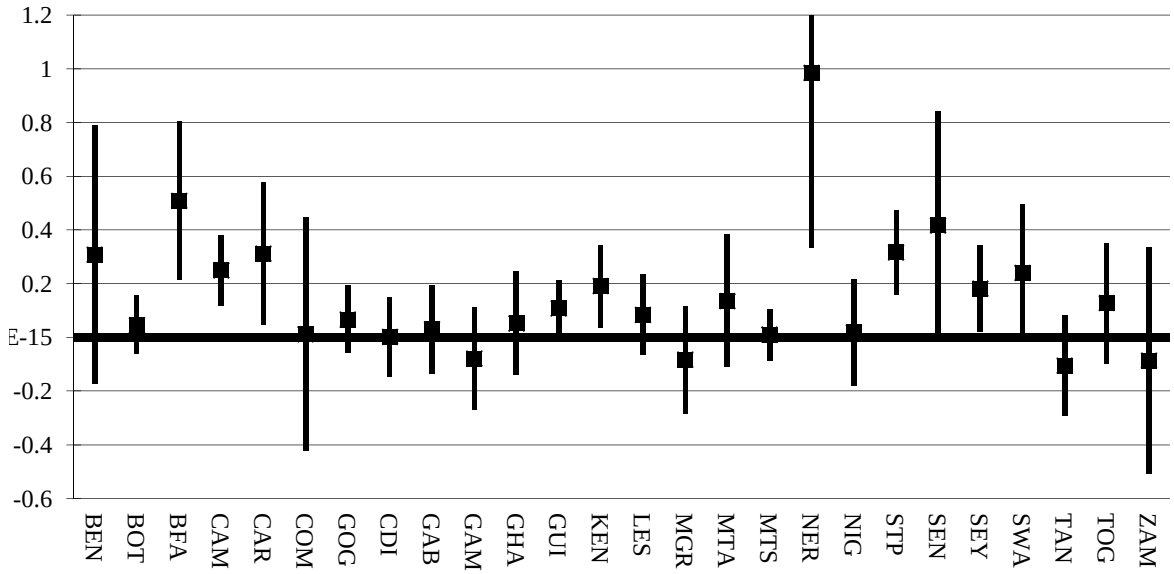

Figure A3: Percentage change in the real exchange rate (r_t) ± 2 standard errors, over the first three years following a permanent percentage point increase in aid (aid_t), adjusted model

Table A1: Panel Unit Root Tests

	IPS test (no trend)		IPS test (trend)		Hadri test (no trend)		Hadri test (trend)	
	W_{tbar}	*p value*	W_{tbar}	*p value*	*z*	*p value*	*z*	*p value*
y	6.36	1.000	1.50	0.933	50.84	0.000	34.84	0.000
r	-1.75	0.040	-1.37	0.085	27.71	0.000	22.56	0.000
π	-15.09	0.000	-14.70	0.000	7.53	0.000	20.32	0.000
aid	-5.04	0.000	-3.39	0.000	40.83	0.000	20.33	0.000
Δy	-20.68	0.000	-21.39	0.000	6.56	0.000	0.53	0.299
Δr	-21.68	0.000	-19.42	0.000	-0.56	0.711	1.06	0.145
$\Delta\pi$	-39.84	0.000	-38.28	0.000	-3.78	1.000	-3.54	1.000
Δaid	-31.88	0.000	-30.21	0.000	-1.46	0.928	-0.01	0.504

IPS tests use the Schwartz-Bayesian Information Criterion to determine the lag order of the regression equation. Hadri tests are adjusted to allow for first-order residual serial autocorrelation in the regression equation (using a Bartlett Kernel); results allowing for higher order lags are very similar.

Table A2: Descriptive Statistics (1971-2009)

Figures are in percentage points.

	GDP growth (Δy)		inflation (π)		real exch. rate growth (Δr)		aid growth (Δaid)		aid as a fraction of GDP	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Benin*	3.9	3.7	5.4	6.3	0.2	13.0	9.8	21.8	7.0	3.2
Botswana	8.7	5.5	9.7	6.3	0.0	10.1	7.6	44.2	3.3	2.1
Burkina Faso*	4.1	4.7	4.7	5.7	-0.5	14.0	10.0	24.8	10.8	4.1
Cameroon*	3.2	5.4	5.8	6.7	0.6	14.4	6.1	41.5	3.3	2.3
Cent. Afr. Rep.*	1.8	4.0	4.8	7.7	-0.5	13.1	7.2	28.9	11.2	6.1
Comoros*	2.7	2.6	6.4	5.3	2.0	13.0	4.8	29.7	12.0	4.5
Congo Rep.*	3.9	6.2	6.8	14.7	1.5	14.8	7.5	80.1	3.6	3.9
Côte d'Ivoire*	3.0	4.4	5.4	8.7	0.1	13.0	9.8	61.6	3.1	3.1
Gabon*	3.1	10.6	6.8	15.3	1.6	15.6	4.8	59.2	0.9	0.5
Gambia	3.5	3.7	8.8	8.2	-1.6	14.0	11.8	30.5	12.9	7.4
Ghana	3.0	4.4	26.4	14.8	-1.9	11.0	8.4	34.2	7.1	4.0
Guinea	3.3	2.1	12.1	11.2	-1.7	9.6	7.8	41.7	10.2	6.9
Kenya	3.8	2.4	9.0	4.5	-1.0	10.4	8.8	20.6	4.3	2.0
Lesotho*	4.3	7.4	10.0	4.9	-0.2	12.9	6.5	25.8	10.5	5.3
Madagascar	1.5	4.6	13.5	8.0	0.5	11.8	5.7	32.1	8.6	5.5
Mauritania	3.1	5.6	7.7	6.9	-0.1	8.2	9.3	36.4	17.2	6.3
Mauritius	5.1	4.2	9.2	7.4	0.8	10.0	7.9	44.2	1.4	0.8
Nigeria	3.6	6.6	17.1	16.4	-0.4	16.1	6.9	25.6	0.7	1.7
Niger*	1.6	6.4	6.2	7.4	1.0	14.7	7.0	58.7	11.3	4.8
São Tomé*	2.9	5.5	17.8	17.7	-2.3	16.4	10.6	58.9	28.6	21.2
Senegal*	2.9	4.2	5.1	5.1	-0.1	13.3	8.1	29.1	8.3	3.7
Seychelles	4.3	5.8	7.1	7.5	0.9	9.1	4.5	33.1	2.9	1.4
Swaziland*	5.4	8.0	9.2	9.2	-1.0	16.2	5.8	45.8	2.5	1.3
Togo*	1.7	5.5	6.1	7.9	0.8	12.9	10.4	21.1	52.5	28.4
Tanzania	4.2	2.3	15.6	9.9	-1.7	12.1	8.7	34.3	1.6	0.9
Zambia	1.9	3.9	25.8	24.6	-0.7	16.3	11.7	41.0	9.6	7.4

* Countries with a hard exchange rate peg.

Table A3: Years with Atypically Large Reduced-Form Shocks

Côte d'Ivoire	1980, 1989	Gambia	1979, 1981
Ghana	2000	Guinea	1986
Kenya	1975	Madagascar	2002
Mauritania	1993, 2006	Mauritius	1974, 1980
Nigeria	1995, 2004	Swaziland	1974 1975
Tanzania	1983, 1985, 1988	Zambia	1989, 1992

Table A4: Time-Series Regression Coefficients (Hard Peg Countries)

y equation	BEN	BFA	CAM	CAR	COM	COG	CDI	GAB	LES	NER	SEN	SWA	TOG
y (*t*-1)	0.567	0.675	1.221	0.852	0.917	1.148	0.916	0.759	0.873	0.699	0.681	0.947	0.928
y (*t*-2)	-0.266	0.094	-0.296	0.078	0.182	-0.272	-0.217	-0.231	-0.320	-0.177	0.029	-0.388	-0.532
r (*t*-1)	-0.035	0.023	0.048	-0.071	-0.040	0.003	-0.045	0.101	0.017	0.132	-0.051	0.039	0.036
r (*t*-2)	0.045	-0.066	-0.027	-0.009	0.068	0.062	0.048	-0.133	-0.043	-0.025	0.075	-0.189	0.034
π (*t*-1)	0.045	0.172	0.299	0.182	0.081	0.058	0.080	0.165	0.229	0.472	-0.020	0.273	-0.056
π (*t*-2)	-0.147	0.137	0.510	0.072	-0.050	0.013	0.128	0.204	-0.069	0.523	0.347	0.004	0.109
aid (*t*)	-0.071	0.062	0.006	0.015	-0.006	0.006	-0.002	-0.015	-0.022	0.057	0.004	-0.015	0.102
aid (*t*-1)	0.029	-0.038	-0.016	0.003	-0.003	0.004	0.008	0.061	-0.018	0.016	0.036	-0.043	-0.119
aid (*t*-2)	-0.023	-0.028	-0.021	-0.013	-0.036	-0.015	0.007	-0.020	0.028	-0.104	-0.067	0.076	0.013

r equation	BEN	BFA	CAM	CAR	COM	COG	CDI	GAB	LES	NER	SEN	SWA	TOG
y (*t*-1)	-0.173	0.823	0.070	1.198	-2.250	-0.515	1.029	0.103	0.310	1.171	0.359	-0.335	0.318
y (*t*-2)	-0.569	-0.684	-0.065	-1.215	2.390	0.086	-0.940	-0.129	-0.017	-0.882	-0.029	0.166	-0.990
r (*t*-1)	0.841	0.745	0.588	0.919	1.015	0.803	0.986	0.865	0.956	0.695	0.885	0.976	0.871
r (*t*-2)	-0.139	-0.115	-0.096	-0.089	-0.261	0.142	-0.268	-0.162	-0.398	-0.184	-0.141	-0.247	-0.036
π (*t*-1)	0.508	-0.063	-0.385	0.260	0.113	-0.256	0.316	-0.118	-0.498	0.321	0.365	-0.696	-0.278
π (*t*-2)	-0.487	-0.477	-0.730	-0.507	-0.051	-0.290	-0.142	-0.139	0.044	-0.456	-0.309	0.181	-0.460
aid (*t*)	0.201	0.271	0.052	0.181	0.047	0.065	0.031	0.025	0.087	0.258	0.190	0.155	0.268
aid (*t*-1)	-0.098	0.016	0.126	-0.087	-0.048	-0.020	-0.023	0.057	-0.054	0.025	-0.041	0.015	-0.075
aid (*t*-2)	-0.141	-0.046	0.056	-0.056	-0.054	-0.019	-0.049	-0.125	0.019	0.062	-0.073	-0.085	-0.157

Table A5: Time-Series Regression Coefficients (Flexible Exchange Rate Countries)

y equation	BOT	GAM	GHA	GUI	KEN	MGR	MTA	MTS	NIG	STP	SEY	TAN	ZAM
y (*t*-1)	1.419	0.680	1.195	0.429	0.919	0.739	0.667	0.970	0.801	0.797	1.083	1.188	0.740
y (*t*-2)	-0.379	-0.428	-0.389	0.376	-0.418	0.192	0.154	-0.064	-0.023	-0.123	-0.381	-0.161	0.320
r (*t*-1)	-0.045	0.059	0.052	0.050	0.009	-0.112	0.158	-0.027	0.213	0.008	-0.014	-0.049	0.017
r (*t*-2)	-0.002	-0.026	-0.035	0.061	-0.040	0.106	-0.212	-0.099	-0.169	0.125	-0.005	0.040	-0.046
π (*t*-1)	0.029	0.082	0.020	-0.075	0.018	-0.084	0.069	-0.192	0.031	0.058	-0.244	-0.016	-0.006
π (*t*-2)	-0.017	-0.038	-0.135	0.039	-0.042	0.004	0.132	0.380	0.012	-0.125	-0.007	0.090	-0.054
aid (*t*)	0.018	0.006	-0.044	-0.019	0.042	0.047	0.016	-0.002	0.030	-0.061	0.020	-0.013	-0.028
aid (*t*-1)	-0.021	0.051	0.017	0.015	0.015	-0.068	-0.007	-0.002	-0.015	0.011	0.013	0.018	0.030
aid (*t*-2)	-0.004	-0.049	-0.006	-0.024	-0.006	0.016	-0.025	-0.013	0.027	-0.035	-0.022	-0.025	-0.011
r equation	BOT	GAM	GHA	GUI	KEN	MGR	MTA	MTS	NIG	STP	SEY	TAN	ZAM
y (*t*-1)	0.676	-0.946	-0.054	-0.577	0.709	0.114	0.143	0.805	-0.482	1.513	0.231	-0.706	1.323
y (*t*-2)	-0.388	0.383	0.196	-1.593	-2.890	1.054	-0.047	0.117	1.115	-0.391	0.175	1.501	0.098
r (*t*-1)	0.955	0.783	0.922	0.316	0.657	0.446	1.076	0.746	1.096	0.398	1.173	1.044	0.911
r (*t*-2)	-0.258	-0.325	-0.280	0.023	0.105	0.138	-0.434	-0.352	-0.428	-0.015	-0.642	-0.266	-0.433
π (*t*-1)	-0.124	-0.752	0.103	-0.122	0.000	0.227	0.045	-0.291	-0.126	0.062	-0.888	0.047	-0.276
π (*t*-2)	0.337	0.307	0.137	-0.243	0.090	0.391	0.183	0.287	-0.114	-0.411	0.046	0.019	0.221
aid (*t*)	0.059	-0.180	0.069	0.055	0.056	0.001	0.008	0.077	0.070	0.133	0.051	0.031	0.021
aid (*t*-1)	-0.010	0.163	0.019	-0.019	-0.027	-0.036	0.057	-0.047	-0.079	0.180	0.004	-0.120	-0.046
aid (*t*-2)	-0.123	0.011	0.006	0.006	0.119	-0.050	-0.027	-0.047	0.017	0.038	-0.023	0.073	0.021
π equation	BOT	GAM	GHA	GUI	KEN	MGR	MTA	MTS	NIG	STP	SEY	TAN	ZAM
y (*t*-1)	-0.038	0.195	-1.185	-1.037	-0.806	-0.013	-0.276	0.051	-0.940	1.170	0.520	0.384	0.049
y (*t*-2)	0.031	0.178	0.889	-0.983	0.573	-0.417	0.039	0.061	0.871	-0.639	-0.511	-0.666	0.392
r (*t*-1)	0.034	-0.170	-0.145	-0.262	-0.028	0.168	0.250	0.045	-0.421	-0.199	-0.203	-0.290	-0.266
r (*t*-2)	-0.161	0.019	0.004	-0.237	0.005	-0.070	-0.242	-0.092	0.243	0.127	0.024	0.269	0.111
π (*t*-1)	0.033	0.711	-0.049	0.194	0.281	0.430	-0.080	-0.247	-0.058	0.667	0.494	0.625	0.790
π (*t*-2)	-0.208	-0.295	0.166	-0.148	-0.007	-0.285	-0.187	0.014	-0.166	-0.305	0.352	-0.380	-0.122
aid (*t*)	0.065	-0.027	0.010	-0.012	0.008	-0.045	0.114	0.027	0.115	0.092	0.008	0.090	0.023
aid (*t*-1)	-0.073	-0.005	-0.081	-0.032	0.043	0.080	-0.014	-0.024	-0.096	0.124	-0.050	-0.056	0.067
aid (*t*-2)	0.031	0.034	0.063	0.082	-0.003	0.006	-0.031	-0.021	0.062	0.033	0.058	0.023	-0.036

Table A6: Fixed Country Characteristics

(i) country-specific observations

country	fixed capital - GDP ratio	trade volume - GDP ratio	log average GDP *per capita*	government effectiveness	regulatory quality	hard exchange rate peg	maritime coastline
Benin (BEN)	0.20	0.51	5.79	0.42	0.41	yes	yes
Botswana (BOT)	0.29	1.13	7.37	-0.55	-0.62	no	no
Burkina Faso (BFA)	0.18	0.45	5.47	0.68	0.26	yes	no
Cameroon (CAM)	0.18	0.33	6.51	0.81	0.81	yes	yes
Cent. Afr. Rep. (CAR)	0.13	0.55	5.77	1.47	1.12	yes	no
Comoros (COM)	0.21	0.55	5.88	1.55	1.40	yes	yes
Congo Rep. (COG)	0.28	1.31	6.74	1.26	1.20	yes	yes
Côte d'Ivoire (CDI)	0.14	0.77	6.60	0.96	0.72	yes	yes
Gabon (GAB)	0.25	0.83	8.44	0.67	0.29	yes	yes
Gambia (GAM)	0.29	0.42	6.38	0.60	0.46	no	yes
Ghana (GHA)	0.14	0.88	5.82	0.11	0.18	no	yes
Guinea (GUI)	0.20	0.72	5.86	1.03	0.97	no	yes
Kenya (KEN)	0.19	0.55	6.04	0.58	0.28	no	yes
Lesotho (LES)	0.39	1.49	5.69	0.32	0.54	yes	no
Madagascar (MGR)	0.17	0.75	5.59	0.57	0.43	no	yes
Mauritania (MIA)	0.26	1.03	6.15	-0.48	-0.40	no	yes
Mauritius (MTS)	0.22	1.24	7.54	-0.58	-0.52	no	yes
Niger (NER)	0.22	0.51	5.44	0.89	0.62	yes	no
Nigeria (NIG)	0.07	0.61	6.25	0.96	0.96	no	yes
São Tomé (STP)	0.31	0.94	6.65	0.65	0.76	yes	yes
Senegal (SEN)	0.19	0.69	6.29	0.21	0.23	yes	yes
Seychelles (SEY)	0.26	0.99	8.30	-0.12	0.56	no	yes
Swaziland (SWA)	0.19	1.40	6.99	0.80	0.49	yes	no
Togo (TOG)	0.18	0.81	5.69	1.36	0.74	yes	yes
Tanzania (TAN)	0.25	0.27	5.64	0.45	0.42	no	yes
Zambia (ZAM)	0.14	0.24	6.16	0.84	0.49	no	no
mean	*0.21*	*0.77*	*6.35*	*0.59*	*0.49*		
standard deviation	*0.07*	*0.35*	*0.81*	*0.58*	*0.48*		

(ii) correlations

	trade volume - GDP ratio	log average GDP *per capita*	government effectiveness	regulatory quality	hard exchange rate peg	maritime coastline
investment-GDP ratio	0.49	0.25	-0.35	-0.21	0.08	-0.07
trade volume to GDP ratio		0.42	-0.36	-0.25	0.09	-0.10
log avgerage GDP *per capita*			-0.38	-0.28	-0.09	0.17
government effectiveness				0.90	0.51	-0.04
regulatory quality					0.44	0.10
hard exchange rate peg						-0.21

(iii) definitions and sources

variable	*definition*	*Source*
investment-GDP ratio	ratio of nominal annual gross fixed capital formation to gross domestic product, averaged over 1971-2009	National Accounts statistics in the World Bank *World Development Indicators*
trade volume to GDP ratio	ratio of nominal annual imports plus exports to gross domestic product, averaged over 1971-2009	National Accounts statistics in the World Bank *World Development Indicators*
log avg. GDP *per capita*	log of annual gross domestic product *per capita* in deflated international Dollars, averaged over 1971-2009	National Accounts statistics in the World Bank *World Development Indicators*
government effectiveness	government effectiveness index, averaged over 1996, 1998, 2000 and 2002-2007	Kaufmann and Kraay (2009)
regulatory quality	regulatory quality index, averaged over 1996, 1998, 2000 and 2002-2007	Kaufmann and Kraay (2009)
hard exchange rate peg	variable = 1 if the country had a hard exchange rate peg over 19710-2009; variable = 0 otherwise	hard peg group = the Franc Zone, S. African satellite states
maritime coastline	variable = 1 if the country has a maritime coastline; variable = 0 otherwise	CIA *World Factbook*

Table A7: Determinants of the Cross-Sectional Variation in the Response of the Real Exchange Rate to an Increase in Aid

(Weighted Least Squares estimates using responses from the unadjusted time series model; $N = 26$)

response in first year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.588	-2.59	0.02	-0.445	-1.95	0.07	-0.617	-2.40	0.03	-0.507	-1.99	0.06
log average GDP per capita	-0.015	-0.76	0.46	-0.010	-0.47	0.64	-0.029	-1.40	0.18	-0.026	-1.21	0.24
hard exchange rate peg	0.127	3.78	<0.01	0.107	3.17	0.01	0.137	3.85	<0.01	0.120	3.57	<0.01
trade openness	0.061	1.96	0.07	0.056	1.61	0.12	0.041	0.79	0.44	0.051	0.97	0.34
governance	-0.072	-2.28	0.03	-0.051	-1.46	0.16	-0.075	-2.15	0.05	-0.062	-1.77	0.09
aid-GDP ratio	0.301	2.06	0.05	0.257	1.65	0.12	0.245	1.58	0.13	0.203	1.27	0.22
R^2		0.67			0.62			0.62			0.59	
joint significance p value		<0.01			<0.01			<0.01			0.01	

response in second year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-1.013	-2.57	0.02	-0.717	-1.81	0.09	-0.860	-1.98	0.06	-0.597	-1.35	0.19
log average GDP per capita	-0.023	-0.68	0.50	-0.014	-0.37	0.71	-0.032	-0.88	0.39	-0.023	-0.61	0.55
hard exchange rate peg	0.258	4.30	<0.01	0.221	3.62	<0.01	0.290	4.72	<0.01	0.248	4.15	<0.01
trade openness	0.085	1.49	0.15	0.074	1.15	0.27	-0.057	-0.65	0.53	-0.033	-0.35	0.73
governance	-0.153	-2.68	0.02	-0.117	-1.85	0.08	-0.176	-2.92	0.01	-0.143	-2.29	0.03
aid-GDP ratio	0.528	2.06	0.05	0.434	1.57	0.13	0.468	1.77	0.09	0.370	1.32	0.20
R^2		0.65			0.59			0.61			0.56	
joint significance p value		<0.01			0.01			<0.01			0.01	

Table A7 (continued)

response in third year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.726	-1.25	0.23	-0.404	-0.71	0.49	-0.528	-0.86	0.40	-0.232	-0.37	0.71
log average GDP per capita	-0.052	-1.02	0.32	-0.037	-0.69	0.50	-0.056	-1.10	0.28	-0.045	-0.84	0.41
hard exchange rate peg	0.245	2.69	0.01	0.193	2.13	0.05	0.282	3.13	0.01	0.225	2.59	0.02
trade openness	0.077	0.89	0.38	0.078	0.82	0.42	-0.088	-0.69	0.50	-0.054	-0.41	0.69
governance	-0.148	-1.72	0.10	-0.081	-0.87	0.39	-0.178	-2.02	0.06	-0.113	-1.25	0.23
aid-GDP ratio	0.161	0.43	0.67	0.082	0.21	0.84	0.111	0.30	0.77	0.012	0.03	0.98
R^2		0.39			0.32			0.38			0.30	
joint significance p value		0.12			0.24			0.13			0.28	

Table A8: Determinants of the Cross-Sectional Variation in the Response of the Real Exchange Rate to an Increase in Aid

(OLS estimates using responses from the adjusted time series model; $N = 26$)

response in first year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.608	-2.55	0.02	-0.469	-2.03	0.06	-0.621	-2.32	0.03	-0.517	-2.00	0.06
log average GDP per capita	-0.015	-0.75	0.46	-0.012	-0.59	0.57	-0.028	-1.28	0.22	-0.027	-1.20	0.25
hard exchange rate peg	0.134	3.83	<0.01	0.120	3.44	<0.01	0.145	3.91	<0.01	0.133	3.82	<0.01
trade openness	0.059	1.81	0.09	0.051	1.45	0.16	0.031	0.57	0.57	0.040	0.74	0.47
governance	-0.071	-2.12	0.05	-0.058	-1.58	0.13	-0.072	-1.95	0.07	-0.068	-1.81	0.09
aid-GDP ratio	0.293	1.97	0.06	0.242	1.56	0.13	0.235	1.50	0.15	0.189	1.20	0.24
R^2		0.63			0.60			0.58			0.57	
joint significance p value		<0.01			<0.01			0.01			0.01	

response in second year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.981	-2.27	0.04	-0.686	-1.62	0.12	-0.800	-1.71	0.10	-0.538	-1.16	0.26
log average GDP per capita	-0.029	-0.78	0.45	-0.024	-0.61	0.55	-0.032	-0.82	0.42	-0.027	-0.68	0.51
hard exchange rate peg	0.283	4.46	<0.01	0.257	4.02	<0.01	0.319	4.91	<0.01	0.285	4.59	<0.01
trade openness	0.088	1.48	0.16	0.068	1.06	0.30	-0.086	-0.91	0.38	-0.062	-0.64	0.53
governance	-0.156	-2.55	0.02	-0.136	-2.01	0.06	-0.180	-2.77	0.01	-0.162	-2.41	0.03
aid-GDP ratio	0.486	1.80	0.09	0.371	1.32	0.20	0.432	1.57	0.13	0.318	1.13	0.27
R^2		0.65			0.61			0.62			0.59	
joint significance p value		<0.01			<0.01			<0.01			0.01	

Table A8 (continued)

response in third year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.626	-0.91	0.38	-0.290	-0.44	0.67	-0.352	-0.48	0.64	-0.046	-0.06	0.95
log average GDP per capita	-0.064	-1.08	0.29	-0.054	-0.88	0.39	-0.066	-1.08	0.29	-0.059	-0.94	0.36
hard exchange rate peg	0.291	2.88	0.01	0.250	2.49	0.02	0.343	3.35	<0.01	0.296	3.02	0.01
trade openness	0.122	1.29	0.21	0.110	1.08	0.29	-0.136	-0.90	0.38	-0.104	-0.68	0.51
governance	-0.161	-1.64	0.12	-0.110	-1.04	0.31	-0.196	-1.91	0.07	-0.153	-1.44	0.17
aid-GDP ratio	0.102	0.24	0.82	-0.009	-0.02	0.98	0.031	0.07	0.94	-0.094	-0.21	0.83
R^2		0.43			0.39			0.41			0.36	
joint significance p value		0.07			0.12			0.09			0.15	

Table A9: Determinants of the Cross-Sectional Variation in the Response of the Real Exchange Rate to an Increase in Aid

(Weighted Least Squares estimates using responses from the adjusted time series model; $N = 26$)

response in first year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.547	-2.26	0.04	-0.427	-1.80	0.09	-0.557	-2.04	0.06	-0.465	-1.75	0.10
log average GDP per capita	-0.012	-0.61	0.55	-0.009	-0.41	0.69	-0.026	-1.16	0.26	-0.023	-1.05	0.31
hard exchange rate peg	0.122	3.41	<0.01	0.106	3.04	0.01	0.135	3.54	<0.01	0.121	3.45	<0.01
trade openness	0.063	1.87	0.08	0.057	1.58	0.13	0.032	0.57	0.57	0.040	0.73	0.48
governance	-0.064	-1.89	0.08	-0.049	-1.34	0.20	-0.067	-1.81	0.09	-0.061	-1.66	0.11
aid-GDP ratio	0.293	1.89	0.08	0.254	1.57	0.13	0.239	1.44	0.17	0.201	1.20	0.24
R^2		0.63			0.60			0.57			0.56	
joint significance p value		<0.01			<0.01			0.01			0.01	

response in second year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.930	-2.27	0.04	-0.679	-1.69	0.11	-0.748	-1.67	0.11	-0.519	-1.16	0.26
log average GDP per capita	-0.016	-0.44	0.67	-0.008	-0.22	0.83	-0.022	-0.61	0.55	-0.016	-0.41	0.69
hard exchange rate peg	0.250	3.98	<0.01	0.221	3.55	<0.01	0.287	4.48	<0.01	0.252	4.15	<0.01
trade openness	0.090	1.51	0.15	0.078	1.20	0.25	-0.075	-0.81	0.43	-0.053	-0.56	0.58
governance	-0.135	-2.27	0.04	-0.109	-1.71	0.10	-0.161	-2.57	0.02	-0.139	-2.19	0.04
aid-GDP ratio	0.527	1.96	0.07	0.443	1.57	0.13	0.467	1.70	0.11	0.377	1.33	0.20
R^2		0.62			0.58			0.59			0.55	
joint significance p value		<0.01			0.01			0.01			0.01	

Table A9 (continued)

response in third year

trade openness variable:	*maritime coastline dummy*						*trade-GDP ratio (%)*					
governance variable:	*effectiveness*			*regulatory quality*			*effectiveness*			*regulatory quality*		
	coeff.	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*	*coeff.*	*t ratio*	*p value*
investment-GDP ratio (%)	-0.621	-1.06	0.30	-0.355	-0.63	0.54	-0.382	-0.62	0.55	-0.126	-0.20	0.84
log average GDP per capita	-0.039	-0.76	0.45	-0.027	-0.50	0.62	-0.043	-0.84	0.41	-0.034	-0.63	0.54
hard exchange rate peg	0.238	2.59	0.02	0.194	2.15	0.05	0.284	3.12	0.01	0.234	2.70	0.01
trade openness	0.090	1.03	0.32	0.091	0.96	0.35	-0.111	-0.86	0.40	-0.080	-0.60	0.55
governance	-0.124	-1.42	0.17	-0.067	-0.72	0.48	-0.160	-1.80	0.09	-0.106	-1.17	0.26
aid-GDP ratio	0.175	0.47	0.65	0.110	0.28	0.78	0.119	0.32	0.75	0.030	0.08	0.94
R^2		0.38			0.33			0.37			0.31	
joint significance p value		0.13			0.21			0.14			0.25	