Foreign aid, debt interest repayments and Dutch Disease effects in a real exchange rate model for the African countries

Abstract

The international competitiveness of developing countries is integral to their economic development, hence understanding the main determinants of the real exchange rate is important. The empirical literature supports the Dutch disease hypothesis that foreign aid inflows significantly contribute to a real appreciation of African currencies, but these studies do not account for the downward pressure on the exchange rate from foreign currency payments. Using a panel of sub-Saharan African countries from 1980 to 2017, we test the hypothesis that the real exchange rate appreciation from aid inflows is moderated by interest repayments on external debt. Our findings suggest that one-third of the Dutch disease effect of aid inflows on the real exchange rate is offset by external debt interest repayments. These findings are important in showing that countries with external debt servicing obligations can mitigate the Dutch disease effect of aid inflows on competitiveness.

JEL Classification: F31; F32; F35; F41

Keywords: Real exchange rate; Foreign aid; Debt interest repayments; Panel cointegration; African economies.

1. Introduction

The international competitiveness of developing countries is an important factor of their economic development. A unilateral rise in foreign exchange from higher amounts of foreign aid can directly or indirectly lead to an appreciation of the real exchange rate (RER), implying a loss of international competitiveness for recipient countries. The direct effect of foreign currency inflows – especially relevant for countries with a flexible exchange rate policy – will increase the demand for the home currency and thereby, raise the value of the nominal exchange rate. Independent of any changes in the nominal exchange rate, the indirect effect of more foreign currency entering a country when converted into the local currency will add to consumption spending on goods that are not easily traded across borders. This is known as the spending effect: greater domestic demand will induce higher prices for non-traded goods (relative to the price of internationally traded goods), leading to a RER appreciation that lowers a country's export competitiveness on international markets.[1]

In all, three channels of Dutch disease effects from foreign exchange income have been identified: (1) the spending effect (as above); (2) the resource movement effect, whereby a movement of labour out of the non-tradeable sector into the resource sector creates excess demand for the former over and above the spending effect, implying a further appreciation; and (3) the liquidity effect where a rise in income will increase the demand for money, with the mechanisms for real appreciation depending on the type of exchange rate regime (Neary 1985). Although the

[1] Extending the work of Corden and Neary (1982) on natural resource discoveries, van Wijnbergen (1986) use the Salter–Swan model to show that foreign exchange in the form of international aid can bring about windfall gains that increase domestic income, raise the price of non-traded goods and appreciate the value of the real exchange rate.

last channel is not likely to be important here, the implications of these Dutch disease effects suggest that foreign aid receipts can have a detrimental effect on a country's competitiveness.[2]

Previous findings on the linkages between aid and the real exchange rate for the sub-Saharan African countries are mixed. Among the time-series studies, an analysis of five countries that experienced substantial increases in foreign aid (Ethiopia, Ghana, Mozambique, Tanzania and Uganda) do not support an aid-related RER appreciation, although the fear of Dutch disease can play an important role in the policy reaction to aid receipts (Hussain *et al*., 2009). The findings of Nyoni (1998) and Sackey (2001) suggest that, in the long-run, higher foreign aid inflows for Tanzania and Ghana are associated with a RER depreciation. In contrast, a study of 15 sub-Saharan African countries conclude in favour of significant Dutch disease effects (Khan Jaffur *et al*. 2020). Similar results were obtained by Fielding and Gibson (2013) based on 26 sub-Saharan African countries, but in view of the large degree of heterogeneity of country characteristics and exchange rate policies, their findings also suggest that countries with hard fixed exchange rate regimes incur a larger exchange rate appreciation.

Panel studies tend to support the Dutch disease hypothesis that foreign aid inflows lead to a RER appreciation. For example, Adenauer and Vagassky (1998) using data for four west African francophone countries (Burkina Faso, Côte d'Ivoire, Senegal and Togo) over the 1980-1992 period and Ouattara and Strobl (2008) for a broader sample of Communauté Financière Africaine (CFA) franc zone countries between 1980 and 2000.

The Dutch disease hypothesis has also been tested for larger groups of developing countries. Consistent with Dutch disease effects, Elbadawi (1999) confirm a negative relation

[2] The term 'Dutch disease' was originally coined in relation to the Dutch economy, which had discovered large gas reserves that led to a surge in exports, an influx of foreign currency and a higher valued Dutch currency (the guilder) with a concomitant loss of competitiveness.

between aid inflows and the RER for a panel of 62 developing countries, including 28 African countries. In finding strong evidence that aid undermines the competitiveness of the export sector, Rajan and Subramanian (2011) suggest that a higher valued RER stemming from aid inflows acts as a channel through which the size of the tradeable (manufacturing) sector shrinks. Kang *et al*. (2010) also conclude that aid inflows adversely affect a country's competitiveness based on a panel of 30 aid-receiving countries over the period 1960 to 2002.[3, 4]

While demand-side Dutch disease effects can dominate in the short-run, Adam and Bevan (2006) show that positive supply-side effects accruing from aid-financed public expenditure is more likely to prevail in the medium-term. Specifically, using aid to finance productive investments in public goods and infrastructure can generate learning-by-doing externalities and productivity spillovers that favour non-tradeable production (although a lower income distribution can leave the rural poor worse-off). In other words, long-run productivity gains arising from technology transfers or learning-by-doing effects can counteract short-run Dutch disease effects on the exchange rate.

[Insert Table 1 here]

In the context of sub-Saharan Africa, many countries are net debtor nations. This means they accumulate net foreign debt payments that can weaken their currencies and improve their competitiveness (Elbadawi, 1999). Although studies have examined key issues in relation to aid and debt in poorer countries (Takagi, 1981; Cassimon and van Campenhout, 2007), evidence on the effects of external debt or debt-servicing obligations on exchange rates is limited (see, for

[3] See Table 1 for a summary of selected studies testing the Dutch disease hypothesis that higher foreign aid inflows lead to a RER appreciation.

[4] While aid has added one percentage point to the annual growth of the bottom billion, it is unlikely (on its own) to address the development issues faced by the poorest countries (Collier, 2007). Doucouliagos and Paldam (2009) conclude that the Dutch disease effects on exchange rates provide a plausible explanation for the ineffectiveness of development aid.

example, Lin 1994). Nevertheless, in assessing the growth effects of foreign aid, Bjerg *et al*. (2011) draw attention to an additional mechanism through which the effects of foreign aid can be felt. In poorer countries with high levels of external debt, foreign aid provides much needed foreign currency to meet debt-related payments. The proportion of aid inflows that is dedicated to repaying debt does not enter the economy for exchange purposes and therefore is free from potential Dutch disease effects. Put another way, as the real exchange rate moves to equilibrate the current account, Dutch disease effects can be mitigated if some of the foreign aid received is used to finance external debt repayments.

In summary, (1) foreign aid can lead to Dutch disease effects; (2) it can be used to finance public infrastructure investment; and (3) it can be used to finance debt-related payments. On the assumption that debt-servicing limits a government's ability to invest in productive public capital, this study simultaneously evaluates the RER effects of foreign aid inflows and debt interest outflows within the same model. The possibility of Dutch disease mitigation can also be illustrated by the data for foreign aid receipts and debt interest payments.

Figure 1 shows foreign aid receipts for the top-20 recipient countries in sub-Saharan Africa summed over the full sample period, 1980-2017. Several features of the data are noteworthy. Over the four decades, high volumes of foreign aid have been received, ranging from $20 billion for Madagascar to $63 billion for Ethiopia. The top-20 rankings include several poorer countries (DR Congo, Ethiopia, Madagascar, Malawi and Uganda) and some larger countries (Ethiopia, Kenya, Nigeria and Sudan). Geographically, the top recipients of foreign aid are dominated by countries located on the eastern flank of the continent (Ethiopia, Kenya, Mozambique, Sudan, Tanzania, Uganda and Zambia).

[Insert Figure 1 here]

The corresponding top-20 contributors of interest payments on external debt summed over the full sample period is shown in Figure 2. Accordingly, the largest contributors of debt interest repayments by far (Nigeria and South Africa) are also sub-Saharan Africa's two largest countries by income. While debt interest repayments are substantial, they tend to be smaller in value compared with foreign aid. Taken together, the data in tandem with the literature suggest that sizeable foreign aid inflows (Figure 1) can increase the value of African currencies in real terms, but it is possible that the full effect of aid inflows on exchange rates can be moderated by currency outflows in the form of debt interest repayments (Figure 2).

[Insert Figure 2 here]

This paper proposes a current account model of the equilibrium real exchange rate. Using a panel cointegration approach and vector autoregression (VAR) modelling, the main determinants of the real exchange rate are investigated for a panel of sub-Saharan African countries over the 1980-2017 period. The principal novelty of the model takes account of debt interest repayments as an explanatory variable for competitiveness. Specifically, to measure the extent to which interest payments on external debt can offset the potential Dutch disease effects from international aid inflows, the coefficient for the ratio of debt interest repayments to foreign aid is compared with that for foreign aid.

The findings of a negatively signed coefficient for foreign aid suggests that greater aid inflows appreciate the RER, consistent with Dutch disease effects. Expressing debt interest repayments as a ratio of foreign aid, the positive and significant coefficient indicates that the higher the debt interest repayments, the greater the depreciation of the RER and the more the aid-induced RER appreciation effect is dampened. The magnitudes for the respective coefficients suggest that

one-third of the Dutch disease effect of aid inflows on the RER is offset by debt interest repayments.

The remainder of the paper is structured as follows. Section 2 specifies the current account model of the real exchange rate where there are no new private international capital flows. Section 3 discusses the data and outlines the panel data estimation strategy. Section 4 discusses the empirical results. Section 5 concludes.

2. The theoretical model

As the balance of payments must always balance – due to the underlying accounting identity – it follows that the current account surplus (B), which is the sum of the trade balance (T) and what was formerly known as the invisibles balance (I), must be equal to the financial account deficit (ΔF):

$$B = T + I = -\Delta F \tag{1}$$

Assuming new net capital inflows for the sub-Saharan African countries are approximately zero, the balance of payments equilibrium amounts to a zero current account balance, that is, $T = -I$. The trade balance is hypothesised to depend upon the real exchange rate, defined as the ratio of the world price of traded goods to home traded goods, EP_T^* / P_T, where E is the domestic price of foreign currency, and relative output, Y / Y^*, as follows:

$$T = T(EP_T^* / P_T, Y / Y^*) \tag{2}$$

where the partial derivatives are $T_1 > 0$ and $T_2 > 0$. The positive sign on T_2 reflects the Absorption Approach (Alexander, 1952) and the Monetary Approach (Johnson, 1976) to the balance of trade, whereby a rise in home output improves the home country's balance of trade. To the extent that

expenditure on domestic output by domestic households and firms (absorption, *Z*) differs from the full employment level of output, the relative output term can be written as:

$$\frac{Y / Z(Y,G)}{Y^* / Z^*(Y^*,G^*)} \tag{3}$$

where $1 > Z_1, Z_1^* > 0$ and $Z_2, Z_2^* > 0$, reflecting the fact that the marginal propensity to absorb is assumed to be less than unity and that government spending (G) will directly raise home absorption. According to equation (3), if absorption increases relative to output then the excess demand will lead to a real exchange rate depreciation with some of the higher demand met through imports.

Defining the price of domestic output as $P = P_T^{1-\alpha} P_N^{\alpha}$, where P_N is the price of non-traded goods and α is the share of non-traded goods in GDP gives $P_T = P(P_T/P_N)^{\alpha}$. Assuming all world output is traded so that $P_T^* = P^*$, the trade balance equation can be written as:

$$T = T[(EP^*/P)(P_T/P_N)^{\alpha}, Y/Z(Y,G), Y^*/Z^*(Y^*,G^*)] \tag{4}$$

The invisibles balance – the net income balance plus unilateral transfers – is postulated to depend on debt payments (rD) relative to the amount of foreign aid received (A). Therefore, this part of the current balance can be expressed as:

$$I = -rD / A \tag{5}$$

where D is the stock of debt outstanding, r is the interest rate on the outstanding stock of debt and A is the amount of international aid received. The minus sign indicates these terms are net payments made abroad, corresponding with an invisibles balance deficit that is characteristic of many developing economies.

Combining equations (4) and (5) and $\Delta F = 0$, taking the natural logarithm gives:

$$\tau_1(e + p^* - p) + \alpha\tau_1(p_N - p_T) + \tau_2[(1 - z_y)(y - y^*) - z_G(g - g^*)] = \ln(rD / A) \qquad (6)$$

where lower case e, p, g and y are the natural logarithm of E, P, G and Y and τ_i and z_i correspond with T_i and Z_i, respectively. Defining the natural logarithm of the real exchange rate as $q = (e + p^* - p)$ and rearranging gives:

$$q = \beta_1(p_T - p_N) + \beta_2(y - y^*) + \beta_3(g - g^*) + \beta_4 \ln(rD / A) \qquad (7)$$

where $\beta_1 = \alpha > 0$, $\beta_2 = -(\tau_2 / \tau_1)(1 - z_1) < 0$, $\beta_3 = z_2\tau_2 / \tau_1 > 0$ and $\beta_4 = (1 / \tau_1) > 0$

This model postulates that a fall in the price of traded goods relative to non-traded goods prices gives rise to an appreciation of the RER. In other words, the relative rise in non-traded goods prices attracts resources away from the traded goods sector. A rise in home output relative to foreign output leads to a RER appreciation as more goods are available for export at given world prices. A rise in government spending raises domestic demand, increases import demand and depreciates the RER. Finally, and in relation to the novelty of this paper, foreign aid inflows that appreciate the RER can give rise to potential Dutch disease effects and the tendency to crowd-out exports. These effects, however, can be moderated by higher net debt repayments that depreciate the RER as currency is surrendered to service foreign currency denominated debts. In short, the net effect on competitiveness will depend on the relative size of foreign aid inflows and debt repayment outflows.

Note that in focusing on the current account of the balance of payments, the possibility of Dutch disease mitigation is premised on two key assumptions, namely (1) the sub-Saharan African countries have sufficiently high stocks of debt that require interest repayments (which limit a

government's ability to invest in productive public capital) and (2) net private capital inflows are relatively small. In terms of the first assumption, many African countries borrowed heavily on international capital markets in the 1980s, partly in response to the preceding oil price crises and partly reflecting greater liberalisation of trade and foreign exchange markets (Ahmad *et. al*., 2011). External borrowings, however, led to a debt crisis for many countries. At the height of the debt crisis in the 1990s, interest payments on external debt accounted for 40 per cent of African export earnings. Although debt interest repayments have since abated, these outflows nevertheless remain substantial (see Figure 2). The second assumption is plausible given the general lack of well-developed capital markets in sub-Saharan Africa (apart from South Africa), especially when compared with capital markets in other developing countries.[5]

3. Data and method

To examine the long-run effect of prices, output, government expenditure, foreign aid and debt interest repayments on the real exchange rate, a panel cointegration approach is employed. The approach seeks to overcome several econometric issues namely, cross-section dependence, data non-stationarity and potential endogeneity of the regressors arising from simultaneity by using the fully modified OLS (FMOLS) and dynamic OLS (DOLS) panel cointegration estimators.[6] Granger causality analysis is also undertaken to deal with an additional source of endogeneity stemming from reverse causality.

[5] Of the different types of capital inflows, foreign direct investment (FDI) is likely to be of greatest importance. The sub-Saharan African countries, however, underperform in terms of inward FDI, whether expressed in nominal dollar values or in terms of global shares. Other private inflows such as remittances also tend to be relatively small in value (Lartey *et al*., 2012).

[6] More details on the panel cointegration methodology are available in the Appendix.

The panel dataset comprises annual data for 43 sub-Saharan African countries over the 1980-2017 period.[7] All information is sourced from the *World Development Indicators* (WDI), World Bank except for the series on debt interest repayments, which is obtained from the *International Debt Statistics* (IDS), World Bank. The data definitions and hypothesised relations are as follows.

- The real exchange rate is measured as the log of national currency per US dollar, period averages, adjusted for relative prices in the home and foreign countries, $RER_{H/F}^{t} = lnEXC_{H/F}^{t} + lnCPI_{F}^{t} - lnCPI_{H}^{t}$, where prices refer to the log of the consumer price index (CPI, 2010 = 100). A decrease in the RER represents a real appreciation of the home country's currency, implying a loss of export competitiveness.
- Relative prices refer to the terms of trade (TOT) given by the ratio of the export value index to the import value index (2010 = 100). Many African countries export primary commodities, implying the RER will be affected by movements in the relative price of exports and imports. The effect of the terms of trade will depend on whether income or substitution effects dominate. If the income effect dominates, a worsening terms of trade will lead to a real depreciation; if the substitution effect dominates, a real appreciation will prevail.
- Relative output is the difference between the log of national output per person and world output per person, proxied by US GDP per capita (constant 2010 US dollars). Higher output relative

[7] Five countries (Eritrea, Mozambique, Somalia, South Sudan and Zimbabwe) have been dropped from the group of 48 sub-Saharan African countries due to poor data availability. The remaining 43 countries are Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, DR Congo, Congo Republic, Côte d'Ivoire, Equatorial Guinea, Eswatini, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Namibia, Niger, Nigeria, Rwanda, São Tomé and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda and Zambia.

to foreign output will tend to appreciate the real exchange rate as more goods are available for export at given world prices.

- General government final consumption expenditure (constant 2010 US dollars) is expressed in log values. The effect of consumption spending depends on its composition. A RER appreciation will ensue if consumption spending is mainly on non-tradeable goods whereas a RER depreciation is more likely if spending is predominantly on tradeables.
- Foreign aid refers to net official development assistance and official aid received (net of repayments, current US dollars), deflated using US CPI (2010 = 100) and expressed in log values. The Dutch disease hypothesis predicts that higher foreign aid inflows will lead to a RER appreciation.
- Interest payments on external debt (current US dollars) is deflated using US CPI (2010 = 100) and expressed in log values. The debt interest repayments to foreign aid ratio is the log value of the ratio of debt interest repayments to foreign aid received, $Ratio^t = \ln (DebtInt^t/Aid^t)$.[8] An increase in debt interest repayments will dampen the RER appreciation effect of aid inflows.

The summary statistics for the data, shown in Table 2, highlight several interesting features. First, the diverging availability of observations across the sub-Saharan African countries precludes estimation of a strongly balanced panel.[9] Second, the measures of dispersion suggest considerable variability for the real exchange rate and relative prices. Third, the range of values (minimum and maximum) for relative output are negatively signed reflecting the larger size and richer status of the foreign country (the United States). Fourth, government consumption expenditure is, on average, higher than receipts of foreign aid or payments made to cover interest on external debt.

[8] Equivalently but opposite in sign, net foreign aid is the difference between the log value of foreign aid received and the log value of interest payments on external debt, $netAid^t = lnAid^t - lnDebtInt^t$.
[9] A balanced panel for 43 countries over the 1980-2017 period would amount to 1,634 observations.

Fifth, the mean values suggest foreign aid receipts are, on average, higher than debt interest repayments, implying a positive mean value in net terms which becomes negative when the latter is expressed as a ratio of the former.

[Insert Table 2 here]

4. Empirical results

To examine the long-run effects of foreign aid and debt interest repayments on the real exchange rate (RER) for the group of 43 sub-Saharan African countries over the period 1980-2017, the results for cross-section dependence are presented in section 4.1; the properties of the data are reviewed in section 4.2; and cointegration tests and estimation are discussed in section 4.3. To check the sensitivity of the results, some robustness tests are undertaken in section 4.4. Panel Granger causality results and impulse response functions are presented in section 4.5.

4.1 Cross-section dependence

Table 3 presents the results for three test statistics of cross-section dependence. The null hypothesis of cross-sectional independence is rejected by two tests (the Pesaran CD test and the Frees statistic). In the case of mixed results, De Hoyos and Sarafidis (2006) note that the test statistic by Frees (2004) should supersede Pesaran's (2004) CD test, because the latter carries the limitation that adding up positive and negative correlations may lead to a failure to reject the null hypothesis. Taken together, these results suggest the presence of cross-section dependence.

[Insert Table 3 here]

4.2 Properties of the data

Following the recent literature on panel unit root tests and panel cointegration tests, Table 4 presents the IPS and CIPS panel unit root test results (Im *et al.* 2003; Pesaran 2007), the latter

additionally allowing for cross-sectional dependence. The CIPS test results suggest all variables are $I(1)$ except for relative output and relative prices for which the order of integration depends on whether a deterministic trend is included in the equation. The IPS results are mixed when the model includes a constant only, but when both a constant and trend is included, the failure to reject the null hypothesis of non-stationarity in levels (apart from relative prices) in contrast to its rejection in first differences suggests the model variables are integrated of order one, $I(1)$.

[Insert Table 4 here]

4.3 Testing for cointegration and estimating the cointegrating equation

In finding the model variables are non-stationary, tests for cointegration are used to check for the existence of a long-run linear relation. According to Pedroni (1999), the null hypothesis of no cointegration can be rejected if the first test statistic (panel v) has a large positive value and the other six statistics have large negative values. While Pedroni's (1999) cointegration test statistics, shown in Table 5, are not unanimous in rejecting the null hypothesis of no cointegration, taken in combination with Kao's (1999) *t*-statistic, we conclude in favour of the presence of a long-run equilibrium relation among the model variables.[10]

[Insert Table 5 here]

Table 6 presents the long-run estimates for the exchange rate model using the FMOLS and DOLS panel cointegration estimators, which take account of potential endogeneity arising from simultaneity. Columns (1) and (3) are close in nature to the traditional model specification on the Dutch disease effects of aid inflows, which quantifies the effect of foreign aid on the real exchange

[10] Some panel unit root and cointegration tests require balanced panels or no gaps within the data. Economic series for many African countries come with a short time dimension and some have gaps, implying it is not possible to run the Westerlund (2007) cointegration test, which performs well in the presence of cross-section dependence.

rate. Columns (2) and (4) additionally take account of the effect of debt interest repayments. On balance, the group mean DOLS estimator forms the preferred estimator: group mean because of greater flexibility of the alternative hypothesis and lower small sample bias (Pedroni 2001a, 2001b); DOLS because of its better performance over OLS and FMOLS (Kao and Chiang, 2001; and Mark and Sul, 2003).[11]

[Insert Table 6 here]

The results for both estimators accord with theoretical priors. Specifically, the positive and generally significant coefficient estimates for relative prices and government consumption expenditure exert downward pressure on the RER while, in the opposite direction, the relative output values exert a substantial upward effect on the RER. In columns (1) and (3), the negatively signed coefficient for foreign aid suggests that greater aid inflows appreciate the RER, consistent with Dutch disease effects obtained in the literature (Adenauer and Vagassky, 1998; Elbadawi, 1999; Ouattara and Strobl, 2008). In columns (2) and (4), the positive and significant coefficients for the ratio of debt interest repayments to foreign aid indicate that the higher the debt interest repayments, the greater the depreciation of the RER and the more the aid-induced RER appreciation effect is dampened.

By how much can debt interest repayments moderate the Dutch disease-type crowding out effect of aid inflows on competitiveness? A comparison of the DOLS coefficients (the preferred estimator) for the parameters of interest (the coefficients for foreign aid and the ratio variable are –0.18 and 0.11 respectively), suggests about one-third of the Dutch disease effect of aid inflows on the RER is offset by debt interest repayments.

[11] Note that data availability issues (especially in relation to government consumption expenditure) reduce the number of cross-sections (43 countries) that can be estimated, implying a lower number of groups for the FMOLS estimator that is further reduced for the DOLS estimator by the inclusion of leads and lags.

4.4 Robustness checks on the cointegrating equation results

Some checks are undertaken to confirm the robustness of the cointegrating regression results. First, the model is re-estimated for a sub-sample of countries that excludes Nigeria and South Africa; these two countries are the largest economies in sub-Saharan Africa and the largest contributors of debt interest repayments (see Figure 2).

Second, while a diversity of exchange rate regimes characterises the sub-Saharan African countries,[12] many have traditionally favoured fixed-type regimes that can accentuate the effects of foreign exchange flows on competitiveness. The link between the choice of exchange rate regime and external competitiveness has previously been noted (see, for example, Aman *et al*., 2022). Therefore, the second sub-sample refers to the group of countries with fixed exchange rate regimes.

Third, as an alternative to the FMOLS and DOLS estimators, the cointegrating vector is estimated using the mean group (MG) estimator (Pesaran and Smith, 1995). The MG estimator allows for parameter heterogeneity, a potentially important feature in controlling for varying economic structures across the group of sub-Saharan African countries. In essence, the heterogeneous coefficient model involves separately estimating the parameters for each group and averaging the coefficients across the groups.

Re-estimating the cointegration equation using the preferred DOLS estimator, the results for the reduced samples of countries shown in columns (1) and (2) of Table 7 suggest the model coefficients are largely unaffected. The higher coefficients for the debt interest-to-foreign aid ratio, however, indicate a magnified effect of foreign exchange flows on competitiveness, which is even more apparent for the second sub-sample of countries. This result is consistent with the findings that Dutch disease effects are stronger in countries with a fixed exchange rate regime (Fielding

[12] No single currency regime is optimal for all countries at all times (Frankel, 1999; Holtemöller and Mallick, 2013).

and Gibson 2013). In column (3) of Table 7, the results for the MG estimator are broadly consistent with the estimates reported in Table 6, including the coefficient for the debt interest-to-foreign aid ratio, which is correctly signed, statistically significant, albeit somewhat smaller in magnitude.

[Insert Table 7 here]

4.5 Panel Granger causality and impulse response functions

In addition to the panel cointegration results, a panel VAR framework is used to model the dynamic relationships among the variables. In treating each model variable as a function of its own lagged values and the lagged values of all other model variables, VAR estimation controls for endogeneity due to reverse causality. Estimating a series of VAR equations with each equation using an (endogenous) model variable as the dependent variable, Table 8 reports the associated pairwise Granger causality results. The results are broadly consistent with the predictions of the theoretical model and the cointegration results. Focusing on the variables of interest, the findings suggest there is a significant uni-directional causation between aid and the RER and similarly between debt interest repayments and the RER across all samples of countries. The ratio of debt interest repayments to aid, however, does not show a significant uni-directional relation.

[Insert Table 8 here]

The impulse response functions (IRFs), computed from the estimated VAR model, illustrate the dynamic responses of exchange rates to a foreign aid shock versus a shock to the ratio of debt interest repayments relative to foreign aid. Figures 3a, 3b and 3c show the dynamic exchange rate responses to a foreign aid shock for the full sample of countries and two sub-samples comprising fixed and flexible exchange rate regimes. The corresponding exchange rate responses

to a shock to the ratio of debt interest repayments relative to foreign aid are shown in Figures 4a, 4b and 4c.[13]

[Insert Figures 3a, 3b, 3c here]

[Insert Figures 4a, 4b, 4c here]

On the whole, the IRFs suggest that exchange rates appreciate in response to higher foreign aid receipts (Figures 3a to 3c). For the full sample of countries, the exchange rate response to the foreign aid shock is initially insignificant but subsequently becomes significant, implying a time lag for the appreciation to take effect (Figure 3a). The IRFs also suggest that the relationship between exchange rates and foreign aid depends, to an extent, on the exchange rate regime. In tandem with the broader pattern for the full sample, currencies appreciate with a time lag for the countries with fixed regimes (Figure 3b) compared with an insignificant exchange rate response to the foreign aid shock for countries with flexible regimes (Figure 3c), consistent with the findings of Fielding and Gibson (2013). In contrast, exchange rates initially depreciate in response to a shock to the ratio of debt interest relative to foreign aid (Figures 4a and 4b), implying that the Dutch disease effects associated with inflows of foreign aid are dampened by outflows in the form of debt interest repayments.[14]

5. Conclusions

This paper proposes a current account model of the equilibrium real exchange rate. Using a panel cointegration approach and VAR modelling, the main determinants of the real exchange rate are

[13] The responses are based on a generalised one standard innovation, which is not sensitive to the order of the variables in the VAR. As a robustness check, similar results are obtained using the Cholesky decomposition with the order of the variables alternated.

[14] While the direction of the exchange rate responses is in line with the theoretical model, the magnitude and significance of the responses are generally weak. Future research might entail testing the hypothesis for a larger group of net debtor countries.

investigated for a panel of sub-Saharan African countries over the 1980-2017 period. The results suggest that relative prices and government consumption expenditure exert downward pressure on the RER while, in the opposite direction, relative output exerts a substantial upward effect on the RER. Of most interest, the findings confirm that an aid-induced RER appreciation consistent with Dutch disease effects can be partly offset by higher debt interest repayments. The magnitudes for the foreign aid and the ratio coefficients suggest that one-third of the Dutch disease effect of aid inflows on the RER is offset by debt interest repayments. The empirical results are important in showing that outflows associated with debt interest repayments can enhance a country's international competitiveness and can, at least partially, offset the negative Dutch disease effect of aid inflows.

As debt reduction programmes and debt interest forgiveness schemes begin to take effect, it is likely that debt interest repayments will decline relative to aid flows, implying a loss of competitiveness for the sub-Saharan African economies. From a policy perspective, protecting the competitiveness of these economies could involve reducing foreign aid inflows in direct proportion to the fall in debt interest repayments. Alternatively, the effect of foreign aid on the real exchange rate can be mitigated if the aid money is spent on imported capital goods that build future output capacity, thereby generating a matching demand for foreign currency so as to prevent any real appreciation. In other words, competitiveness can be restored in the longer run if the effects of aid inflows are offset by roughly equal purchases of foreign currency to meet current outstanding foreign liabilities.

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Table 1
Selective literature on the linkages between foreign aid inflows and the real exchange rate[a]

Authors	Data	Method	RER effect
Adenauer and Vagassky (1998)	Four west African CFA member countries (1980-1992)	Panel GLS	RER appreciation
Nyoni (1998)	Tanzania (1967-1993)	Time-series	RER depreciation
Elbadawi (1999)	62 developing countries (1984-1995; 5-year intervals)	Panel RE	RER appreciation
Sackey (2001)	Ghana (1962-1996)	Time-series	RER depreciation
Ouattara and Strobl (2008)	CFA franc zone countries (1980-2000)	First-difference gmm	RER appreciation
Hussain *et al*. (2009)	Five African countries (1998-2000; 2000-2004)	Country study	RER depreciation (4 countries); No effect (Ghana)
Kang *et al*. (2010)	Major recipients of aid (1960-2002)	Panel MG	RER appreciation
Rajan and Subramanian (2011)	Major recipients of aid (1980-1990, 1990-2000)	Panel FE	RER appreciation
Fielding and Gibson (2013)	26 sub-Saharan African countries (1970-2009)	Time-series	RER appreciation
Addison and Baliamoune-Lutz (2017)	Morocco, Tunisia (1980-2009)	Time-series	RER appreciation (Morocco); No effect (Tunisia)
Khan Jaffur *et al*. (2020)	15 sub-Saharan African countries (1980-2015	Time-series	RER appreciation

[a] CFA is the abbreviated term for Communauté Financière Africaine (African Financial Community); GLS stands for generalised least squares; RE and FE refer to random effects and fixed effects estimation respectively; gmm is the generalised method of moments estimator; and MG is the mean group estimator.

Table 2
Summary statistics

Regressors	Mean	Standard deviation	Minimum	Maximum	No. of obs
Real exchange rate	4.84	2.07	–0.30	9.48	1375
Relative prices	1.33	1.82	0.07	33.59	1603
Relative output	–3.60	1.00	–5.52	–0.84	1576
Govt consumption exp	20.69	1.42	16.00	25.18	1130
Foreign aid	19.53	1.25	9.99	23.24	1615
Debt interest repayments	17.49	1.77	11.43	22.43	1496
Debt interest repayments-foreign aid ratio	–2.18	1.59	–7.06	4.09	1494

Table 3

Cross-section dependence test results[a]

	Pesaran (CD)	Frees (statistic)	Friedman (statistic)
Panel	26.18***	6.20***	26.37
	(0.00)	(1.10)	(0.92)

[a] Test statistics for the null hypothesis of cross-section independence against the alternative of cross-section dependence; *p*-values for the Pesaran CD test and Friedman's statistic are shown in parentheses; the 0.01 critical value from the Q distribution is shown for the Frees statistic.

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4
Panel unit root test results[a]

Variable	IPS[b]		CIPS[c]	
	Constant	Constant & Trend	Constant	Constant & Trend
Levels				
Real exchange rate	–3.40*** (0.00)	–0.38 (0.35)	–1.21 (0.11)	2.40 (0.99)
Relative prices	–2.42*** (0.01)	–2.47*** (0.01)	–2.47*** (0.01)	–0.86 (0.20)
Relative output	–3.23*** (0.00)	1.05 (0.85)	–1.68** (0.05)	–2.92*** (0.00)
Govt consumption exp	4.57 (1.00)	1.63 (0.95)	5.94 (1.00)	5.88 (1.00)
Foreign aid	–2.28*** (0.01)	0.35 (0.64)	0.59 (0.72)	0.62 (0.73)
Debt interest repayments	–0.28 (0.39)	0.04 (0.52)	0.85 (0.80)	1.65 (0.95)
Debt interest repayments-aid ratio	–0.02 (0.49)	0.91 (0.82)	1.61 (0.95)	2.33 (0.99)
First differences				
Real exchange rate	–8.86*** (0.00)	–8.36*** (0.00)	–4.09*** (0.00)	–3.18*** (0.00)
Relative prices	–16.00*** (0.00)	–12.22*** (0.00)	–12.04*** (0.00)	–8.78*** (0.00)
Relative output	–8.08*** (0.00)	–6.83*** (0.00)	–6.64*** (0.00)	–3.60*** (0.00)
Govt consumption exp	–6.41*** (0.00)	–11.14*** (0.00)	–9.06*** (0.00)	–5.70*** (0.00)
Foreign aid	–11.57*** (0.00)	–8.40*** (0.00)	–11.06*** (0.00)	–8.34*** (0.00)
Debt interest repayments	–12.27*** (0.00)	–9.28*** (0.00)	–9.14*** (0.00)	–4.40*** (0.00)
Debt interest repayments-foreign aid ratio	–12.31*** (0.00)	–9.86*** (0.00)	–10.65*** (0.00)	–8.26*** (0.00)

[a] A maximum lag structure of 2 is specified for the augmented Dickey–Fuller (ADF, 1979) regressions.
[b] The W(t-bar) statistics are computed for an unbalanced panel to test the null hypothesis that all series are non-stationary against the alternative that some series are stationary (Im et al. 2003); *p*-values are shown in parentheses.
[c] The Z(t-bar) statistics extend the IPS test to additionally allow for cross-section dependence (Pesaran 2007).
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 5
Panel cointegration test results[a, b]

Test Statistic	Constant	Constant & Trend
Pedroni		
Panel v	1.79**	0.24
	(0.04)	(0.40)
Panel ρ	0.60	2.57
	(0.72)	(0.99)
Panel PP	–4.28***	–4.13***
	(0.00)	(0.00)
Panel ADF	–4.90***	–7.45***
	(0.00)	(0.00)
Group ρ	3.51	5.13
	(0.99)	(1.00)
Group PP	–7.79***	–7.39***
	(0.00)	(0.00)
Group ADF	–6.44***	–6.49***
	(0.00)	(0.00)
Kao		
t-statistic	–5.57***	–
	(0.00)	

[a] The optimal lag length is determined by the Akaike information criterion (AIC).
[b] Based on the residuals from the cointegrating regression, the *t*-statistics test the null hypothesis of no cointegration against the alternative that all series are stationary; *p*-values are shown in parentheses (Kao 1999; Pedroni 1999).
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 6
Long-run cointegration estimates[a]

	FMOLS		DOLS	
Regressors	(1)	(2)	(3)	(4)
Relative prices	0.14***	0.14***	0.21**	0.11
	(5.12)	(4.51)	(2.38)	(0.81)
Relative output	–0.57***	–0.72***	–0.87***	–0.99***
	(–6.91)	(–8.29)	(–4.50)	(–3.12)
Govt consumption exp	0.12**	0.07**	0.10**	0.12
	(2.04)	(2.06)	(2.17)	(1.62)
Foreign aid	–0.09***	–	–0.18***	–
	(–4.46)		(–4.64)	
Debt interest repayments-foreign aid ratio	–	0.06***	–	0.11**
		(5.21)		(2.33)
No. of obs	958	929	725	724
No. of groups	39	37	24	24

[a] Using the group mean FMOLS and DOLS estimators; *t*-statistics are shown in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 7
Robustness checks on the cointegration results

Regressors	Sub-sample (1)[a,b]	Sub-sample (2)[a,b]	Mean Group (3)[c]
Relative prices	0.06	0.28	0.12***
	(0.49)	(1.26)	(3.08)
Relative output	–0.83**	–0.73	–0.78***
	(–2.56)	(–1.27)	(–5.34)
Govt consumption exp	0.10	0.03	0.08
	(1.62)	(0.36)	(1.01)
Debt interest repayments-foreign aid ratio	0.14***	0.23***	0.05***
	(3.79)	(3.60)	(3.49)
No. of obs	669	384	949
No. of groups	22	12	37

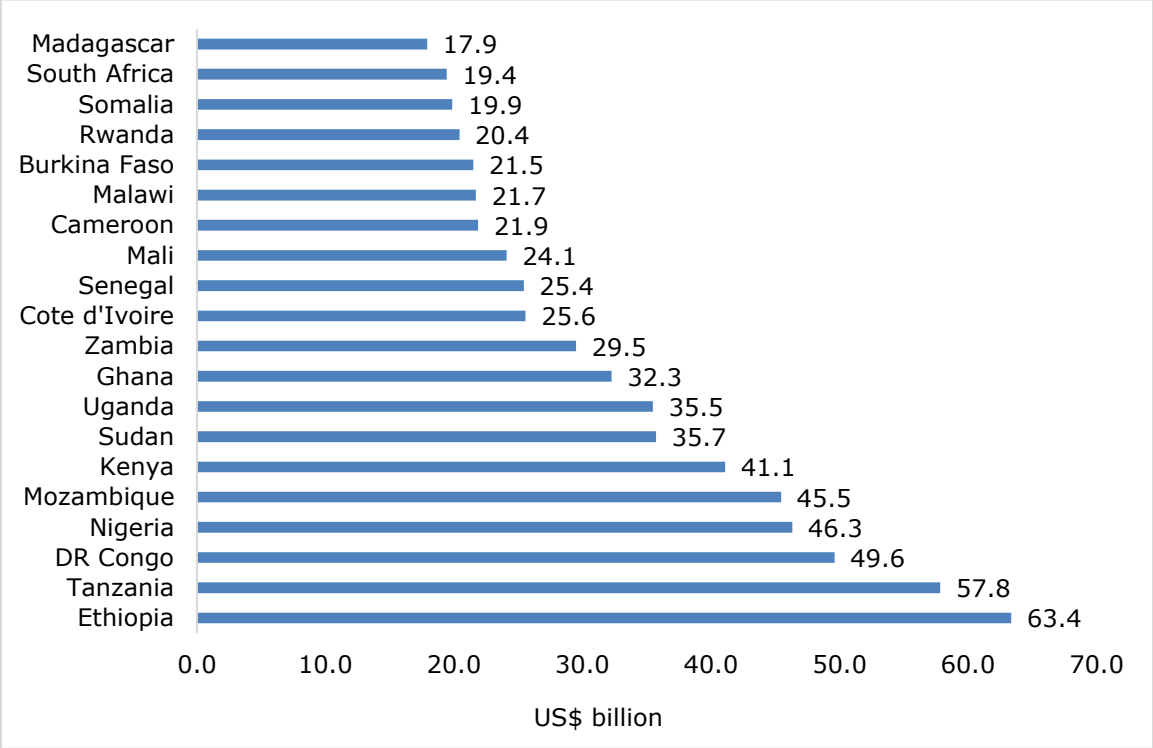
[a] The group mean DOLS estimator; *t*-statistics are shown in parentheses.
[b] Sub-sample (1) excludes South Africa and Nigeria; sub-sample (2) is for the group of countries with fixed exchange rate regimes only.
[c] The mean group (MG) estimator (Pesaran and Smith, 1995); *z*-statistics are shown in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 8
Panel Granger causality results[a]

	Aid → RER	Debt interest → RER	Debt interest-to-foreign aid ratio → RER
Full sample	4.84**	3.84*	1.79
Flexible exchange rate regimes	14.10**	7.53**	1.00
Fixed exchange rate regimes	3.95*	2.96*	2.02

[a] The optimal lag length of the VAR model is determined by the Schwartz Information Criterion (SIC).
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

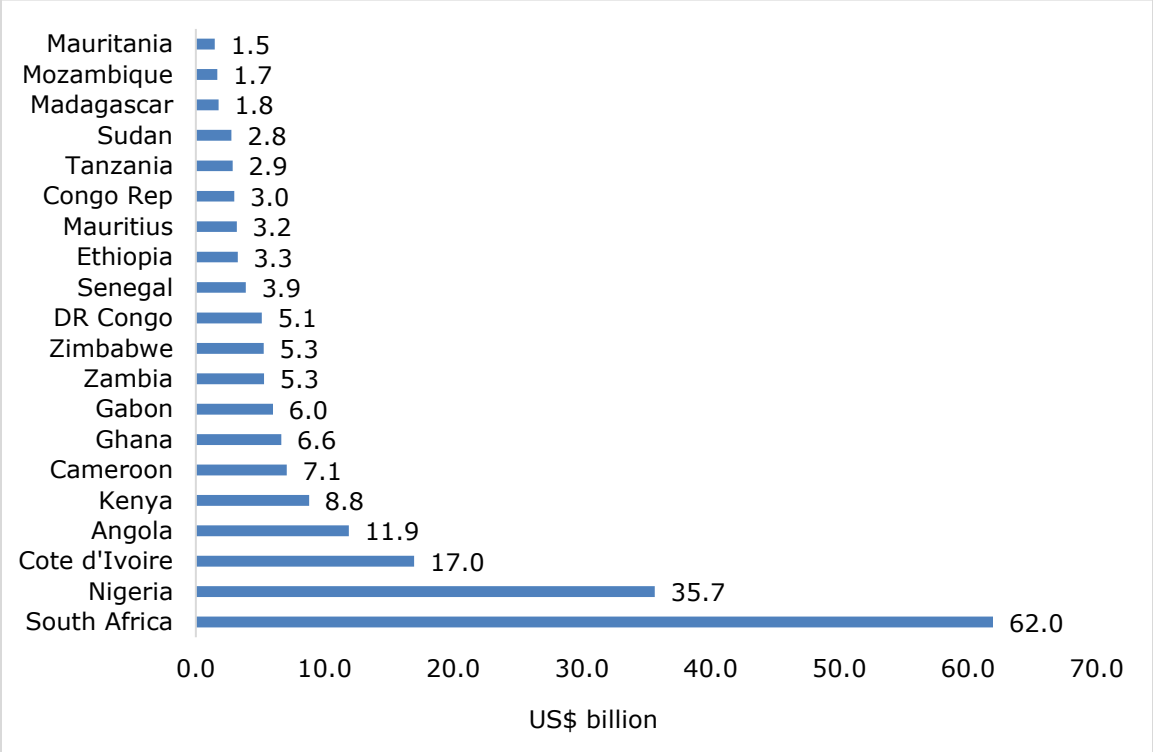
Figure 1
Foreign aid received, 1980-2017 (current US dollar billions)



Source: Author calculations (the summed values of foreign aid receipts over the sample period) using data from the *World Development Indicators*, World Bank.

Figure 2

Interest payments on external debt, 1980-2017 (current US dollar billions)



Source: Author calculations (the summed values of interest payments on external debt over the sample period) using data from the *International Debt Statistics*, World Bank.

Figure 3
Exchange rate response to a foreign aid shock[a]

Figure 3a: Full Sample

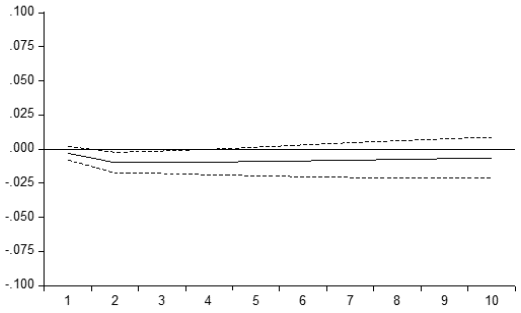


Figure 3b: Fixed Regimes

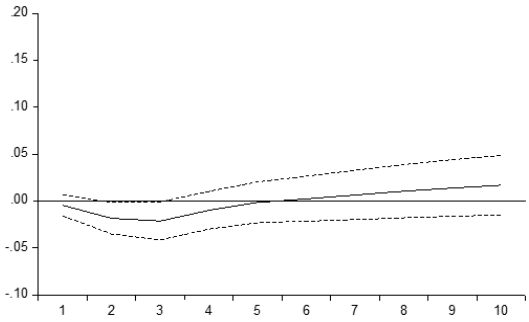


Figure 3c: Flexible Regimes

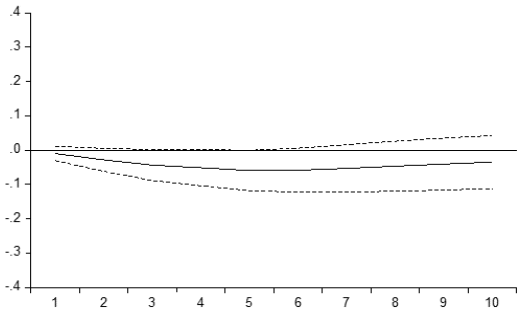


Figure 4
Exchange rate response to a shock to debt interest repayments-to-foreign aid[a]

Figure 4a: Full Sample

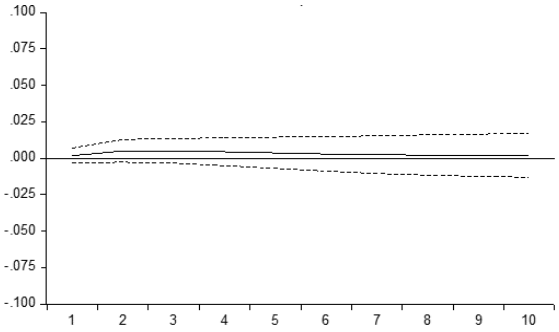


Figure 4b: Fixed Regimes

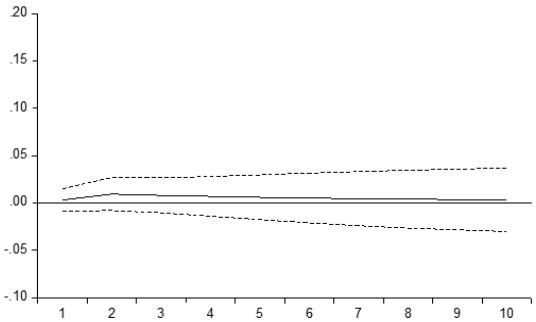
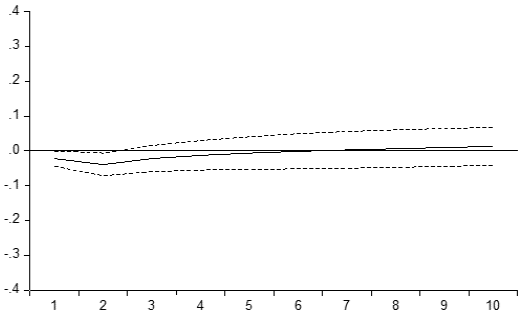


Figure 4c: Flexible Regimes



[a] The IRFs show the dynamic exchange rate responses to a foreign aid shock for the full sample of countries (Figure 3a) and two sub-samples comprising fixed exchange rate regimes (Figure 3b) and flexible exchange rate regimes (Figure 3c). The corresponding exchange rate responses to a shock to the ratio of debt interest repayments relative to foreign aid are shown in Figures 4a, 4b and 4c respectively. The y-axis shows the direction and magnitude of the responses to the shocks and the x-axis represents the number of time horizons. Note that a decrease in the RER represents a real appreciation of the home country's currency.

Appendix: Panel cointegration methodology

A.1 Cross-section dependence

The starting point for panel cointegration is to examine the order of integration of the series. Panel unit root tests, however, can lead to spurious results in the presence of cross-section dependence, which is likely given the regional economic and financial linkages between the sample of African countries, implying we need to allow for co-movements of the economic time-series.

Tests for cross-section dependence can be broadly split according to the dimensions of the panel. If the number of time periods is greater than the number of cross-sectional units $(T > N)$, the Lagrange multiplier (LM) test by Breusch and Pagan (1980) is appropriate. If the reverse is true $(N > T)$, the range of tests include Pesaran's (2004) cross-section dependence (CD) test, Friedman's (1937) statistic and the test statistic proposed by Frees (1995).

Consider the standard panel data model:

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it}, \quad \text{for } i = 1,..., N \quad \text{and } t = 1,..., T \tag{A1}$$

where i refers to the cross-sectional dimension, t refers to the time-series dimension, y_{it} is the dependent variable, x_{it} is a $K \times 1$ vector of time-varying regressors, β is a $K \times 1$ vector of parameters to be estimated and α_i are the time-invariant individual parameters. Much of the literature assumes cross-section independence, but the assumption that the

error term is independent and identically distributed across units, $u_{it} \sim iid(0, \sigma_{iu}^2)$, may not be valid for the group of African countries.[15]

A.2 Properties of the data

Examining the properties of the data is important to establish their order of integration and avoid the spurious regression problem generated from non-stationary data. The first generation of panel unit root tests differ in terms of the null hypothesis (of stationarity or non-stationarity), the matrix of observations (a balanced or unbalanced panel) and whether or not homogeneity is assumed (the requirement that all series in the panel have identical orders of integration).

In general, panel unit root tests can be specified as an autoregressive process of order 1, AR(1), as follows:

$$y_{it} = a_i + \delta_i \tau + \rho_i y_{it-1} + \varepsilon_{it} \qquad \text{(A2)}$$

where a_i is the individual fixed effect, τ is the individual time trend, ρ_i is the autoregressive coefficient and ε_{it} is the error term. The series y_{it} contains a unit root if $|\rho_i| = 1$. The IPS panel unit root test (Im *et al.* 2003) has the advantage of allowing for heterogeneity under the alternative hypothesis that some (but not necessarily all) series have a unit root. In other words, ρ_i is allowed to vary across countries. Therefore, the null of a unit root, $H_0 : \rho_i = 0$ for all i is tested against the alternative of stationarity, $H_1 : \rho_i < 0$ for $i = 1,..., N$ and $\rho_i = 0$ for $i = N_1 + 1,\ i = N_1 + 2,..., N$. Computing the IPS

[15] De Hoyos and Sarafidis (2006) provide a survey on cross-sectional dependence tests for panels with fixed T and $N \to \infty$.

test involves estimating the augmented Dickey–Fuller (ADF, 1979) regression for the i^{th} cross-section unit:

$$\Delta y_{it} = a_i + \delta_i \tau + \rho_i y_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta y_{it-j} + \varepsilon_{it} \tag{A3}$$

where Δ is the difference operator, $\Delta y_{it} = y_{it} - y_{it-1}$, and p_i is the lag length of the autoregressive process, using the standardised t-bar statistic:

$$\Gamma_{\bar{t}} = \frac{\sqrt{N}(\bar{t}_{NT} - \mu)}{\sqrt{v}} \tag{A4}$$

where $\bar{t}_{NT}$ is the average of the N cross-sectional ADF t-statistics and μ and v are the mean and variance respectively of the average of the individual t-statistics.

The second generation of panel unit root tests relaxes the assumption of cross-sectional independence inherent to the first-generation models. This is important as the first-generation models tend to over-reject the null hypothesis when cross-sectional dependence is high (Pesaran 2007). In allowing for cross-correlation of units, Pesaran (2007) extends the IPS test statistic (Im *et al.* 2003) by proposing the ADF regressions be augmented with the cross-section averages of lagged levels and first differences of the individual series, which gives the cross-sectional ADF (CADF) regression:

$$\Delta y_{it} = a_i + \delta_i \tau + \rho_i y_{it-1} + \phi_i \bar{y}_{t-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta y_{it-j} + \sum_{j=0}^{p_i} \theta_{ij} \Delta \bar{y}_{t-j} + \varepsilon_{it} \tag{A5}$$

where $\bar{y}_t$ is the cross-section mean of y_{it}, $\bar{y}_t = N^{-1} \sum_{i=1}^{N} y_{it}$. The cross-sectional augmented version of the IPS (CIPS) test statistic is given by:

$$CIPS(\bar{t}) = N^{-1} \sum_{i=1}^{N_i} t_i \tag{A6}$$

where t_i is the t ratio of the coefficient of y_{it-1} in the CADF regression.

A.3 Testing for cointegration and estimating the cointegrating equation

To test for cointegration, Pedroni (1999, 2004) developed seven statistics that extend the Engle–Granger (1987) residual-based approach to testing the properties of the error term. The residuals are integrated of order zero, $I(0)$, if the variables are cointegrated and are integrated of order one, $I(I)$, if the variables are not cointegrated. In effect, the test for cointegration is a test for the presence of a unit root in the residuals from equation (7):

$$u_{it} = \rho_i u_{it-1} + \eta_{it} \tag{A7}$$

where ρ_i is the autoregressive coefficient of the residual, u_{it}. The null hypothesis of no cointegration, $H_0 : \rho_i = 1$ for $i = 1,..., N$, is tested against two alternative hypotheses. First, four panel test statistics are specified against the homogenous alternative, $H_1^1 : (\rho_i = \rho) < 1$ for all i, which restricts the first order serial correlation coefficient ρ of the error processes, u_{it}, to be identical for $i = 1,..., N$. The panel test statistics consist of the variance ratio statistic (panel v); the panel versions of the Phillips and Perron (1988) ρ-statistic (panel ρ) and the t-statistic (panel PP); and the augmented Dickey–Fuller (ADF, 1979) t-statistic (panel ADF). Second, three group mean statistics (group ρ, group PP and group ADF) based on cross-section averages of ρ_i are specified against the heterogeneous alternative, $H_1^2 : \rho_i < 1$ for all i and $\rho_i = 1$ for $i = N_1 + 1,..., N$.

If all the variables are integrated of the same order, a linear combination of two or more non-stationary series may be stationary and hence cointegrated (Engle and Granger

1987). Known as the cointegrating equation, the stationary linear combination can be interpreted as a long-run equilibrium relationship among the variables.

Taking account of potential endogeneity in the regressors (arising from simultaneity) and serial correlation in the errors, the cointegrating equation can be estimated using fully modified OLS (FMOLS) and dynamic OLS (DOLS). In controlling for possible simultaneity in the cointegrating equation, the FMOLS estimator involves a non-parametric correction using the error term, u_{it}, and the differenced right-hand side variables, Δx_{it}, whereas the DOLS estimator involves a parametric correction by including past and future values of Δx_{it} as additional regressors in the cointegrating regression:

$$y_{it} = \alpha_i + \beta_i' x_{it} + \sum_{j=-p_i}^{p_i} \Phi_{ij} \Delta x_{it-j} + v_{it} \tag{A8}$$

In a panel setting, Pedroni (2001a, 2001b) has proposed two versions of FMOLS: a pooled (within group) version and a group mean (between group) version, the latter allowing the coefficients to differ across countries. Similarly, for the DOLS estimator: a pooled version (Kao and Chiang 2001; Mark and Sul 2003) and a group mean version (Pedroni 2001b). In general, the group mean estimators involve separately estimating the regression for each country and averaging the slope coefficients such that:

$$\hat{\beta} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_i \tag{A9}$$

The t-statistic is obtained by summing the individual t-statistics and dividing by the root of the number of cross-sectional units:

$$t_{\hat{\beta}} = \sum_{i=1}^{N} \frac{t_{\hat{\beta}_i}}{\sqrt{N}} \tag{A10}$$

The main advantages of the group mean based estimators are greater flexibility of the alternative hypothesis and lower small sample size distortions (Pedroni 2001a, 2001b). Both estimators can also handle fixed effects to control for heterogeneity, an additional source of endogeneity. Heterogeneity between the African countries in the sample may stem from different exchange rate regimes, for example, or varying levels of financial development and commodity market integration.