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Do large capital inflows hinder competitiveness? The Dutch disease in Ethiopia

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Do large capital inflows hinder competitiveness?

The Dutch disease in Ethiopia

Pedro M. G. Martins

Institute of Development Studies, University of Sussex, Brighton, BN1 9RE, UK

pedromgmartins@gmail.com

This paper investigates whether large inflows of foreign aid and remittances have had a damaging impact on the Ethiopian real exchange rate (RER). We improve the current empirical literature by: (i) compiling a unique quarterly dataset to provide a larger sample size and enable the modelling of important intra-year dynamics – which should lead to better model specifications; (ii) providing a new empirical approach (Unobserved Components) to test the ‘Dutch disease’ hypothesis; and (iii) using several cointegration approaches to further test the robustness of our conclusions. Our results suggest that there are two main long-run determinants of the RER in Ethiopia: trade openness is found to be correlated with RER depreciations, while a positive shock to the terms of trade tends to appreciate the RER. Foreign aid is not found to have a statistically significant impact, while there is only weak evidence that remittances are associated with RER appreciations. The lack of empirical support for the Dutch disease hypothesis suggests that Ethiopia has been able to effectively manage large capital inflows, thus avoiding major episodes of macroeconomic instability. We believe that most African countries will therefore be able to absorb large inflows of foreign capital without damaging their external competitiveness.

JEL Classification: C22, F35, O24, O55

Keywords: Real Exchange Rate, Foreign Aid, Time Series Models, Africa

I. Introduction

The term 'Dutch disease' is commonly used to describe the potential negative effects of large inflows of foreign currency on the recipient economy. This 'disease' usually manifests itself through the appreciation of the real exchange rate and the consequent loss of export competitiveness. The surge in foreign exchange can take the form of foreign aid inflows, workers' remittances, higher export receipts (e.g. following an increase in natural resource prices), or foreign direct investment. The main focus of this paper will be on the first two.

The real exchange rate is one important channel through which foreign aid inflows can affect the recipient economy. Concerns about 'Dutch disease' have been recently revived due to the commitment of the international development community to scale up aid flows to developing countries, and in particular to double the resources to Africa. Evidence that foreign aid has had a detrimental effect on the growth of the export sector could offer an explanation for the lack of robust evidence that aid fosters economic growth. For example, [Rajan and Subramanian \(2005\)](#) argue that aid flows are responsible for the decline in the share of labour-intensive and tradable industries in the manufacturing sector – through its contribution to real exchange rate overvaluation.¹ However, the empirical evidence is mixed, with several studies even suggesting that foreign aid leads to the depreciation of the local currency, potentially through supply side effects or aid tied to imports ([Li and Rowe, 2007](#)). Moreover, the impact of foreign aid on the composition of (public) expenditure seems to be crucial to the overall effect on the exchange rate. If aid inflows are used to purchase capital goods from abroad (e.g. import support), then they are not likely to have a significant impact on the local currency. However, if the inflows are significantly biased towards the purchase of (non-tradable) local goods, and if there are significant supply-side constraints, then rising domestic inflation will erode the real exchange

¹ The authors do not find similar effects from remittance flows.

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3 rate, affecting the competitiveness of the country's exports.² These are some of the effects that
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5 this empirical exercise will try to uncover in order to improve our understanding of how large
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7 aid inflows impact economic performance.
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11 The paper is organised in six sections. After this short introduction, we review and summarises
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13 the empirical evidence from the 'Dutch disease' literature. Section III introduces the
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15 methodologies to be used in this study, while section IV draws some considerations about the
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17 data. Section V presents the empirical results from the econometric models and the structural
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19 time series model. Section VI concludes the paper.
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26 **II. Literature Review**

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28 [Corden and Neary \(1982\)](#) developed a theoretical model that illustrates the Dutch disease
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30 hypothesis for a small open economy with a booming export sector. However, the core model
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32 can easily be adapted to demonstrate the potential impact of a surge in aid inflows, rather than
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34 an energy boom (see [Nkusu, 2004](#)). Foreign aid can be seen as a real income transfer that will
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36 raise the demand for both tradable and non-tradable goods produced in the economy. Under
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38 certain assumptions, this higher demand will lead to an appreciation of the real exchange rate.
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44 Notwithstanding the theoretical arguments put forward by [Corden and Neary \(1982\)](#), [Corden](#)
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46 [\(1984\)](#), [van Wijnbergen \(1984, 1986\)](#) and [Edwards \(1989\)](#), it is has been difficult to establish a
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48 robust association between increased aid inflows and the appreciation of the real exchange rate.
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51 Table 1 provides an overview of the empirical evidence. Most time series studies use
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53 cointegration analysis to avoid inference based on spurious relations, with the added advantage
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55 of separating the long-run (steady-state) information from the short-run dynamics. The results
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57 from [Bourdet and Falck \(2006\)](#) for Cape Verde, [Opoku-Afari et al \(2004\)](#) for Ghana, and [White](#)
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² Since remittance inflows predominantly finance the (private) purchase of (non-tradable) local goods, we may expect remittances to have a stronger impact on the RER than foreign aid inflows.

and Wignaraja (1992) for Sri Lanka seem to suggest that foreign aid inflows are associated with appreciations of the real exchange rate. However, the findings from Issa and Ouattara (2008) for Syria, Li and Rowe (2007) for Tanzania, Sackey (2001) for Ghana, and Nyoni (1998) for Tanzania suggest that foreign aid flows are associated with RER depreciation, rather than appreciation.

Table 1: Long-Run Impact of Aid on the RER

Main Studies	Sample	Data	Methodology	RER
<i>Time Series</i>				
Issa & Ouattara (2008)	Syria (1965-1997)	DAC	UECM (OLS)	-
Li & Rowe (2007)	Tanzania (1970-05)	DAC	EG (FM-OLS)	-
Bourdet & Falck (2006)	Cape Verde (1980-00)	WB	EG (OLS)	+
Opoku-Afari et al (2004)	Ghana (1966-00)	DAC	VECM (MLE)	+
Sackey (2001)	Ghana (1962-96)	DAC	UECM (OLS)	-
Nyoni (1998)	Tanzania (1967-93)	DAC	UECM (OLS)	-
White & Wignaraja (1992)	Sri Lanka (1974-88)	Local †	Levels (OLS)	+
<i>Cross-Section</i>				
Mongardini & Rayner (2009)	36 SSA (1980-06)	DAC	Panel (PMG)	-
Lartey (2007)	16 SSA (1980-00)	WB	Panel (DPD/GMM)	+
Ouattara & Strobl (2004)	12 CFA Franc Zone (1980-00)	DAC	Panel (DPD/GMM)	-
Elbadawi (1999)	62 developing (1990 & 95)	DAC	Panel (RE, FE, IV)	+
Yano & Nugent (1999)	44 aid-dependent (1970-90)	DAC	Mixed (TS, CS)	+
Adenauer & Vagassky (1998)	4 CFA Franc Zone (1980-92)	WB	Panel (GLS)	+

Obs.: '+' appreciation, '-' depreciation, EG Engle-Granger Two-Step Approach, OLS Ordinary Least Squares, MLE Maximum Likelihood Estimator, UECM Unrestricted Error Correction Model, VECM Vector Error Correction Model, FM-OLS Fully-Modified OLS, CS Cross-Section, DPD Dynamic Panel Data, GLS Generalised Least Squares, GMM Generalised Method of Moments, IV Instrumental Variables, PMG Pooled Mean Group, RE Random Effects, TS Time Series. † Includes Remittances. Younger (1992) does not undertake an econometric exercise (Ghana).

In terms of the evidence from cross-country studies, we note that only Mongardini and Rayner (2009) have explicitly addressed the issue of non-stationarity. Their results suggest that aid grants are associated with RER depreciation, while remittances do not have a statistically significant effect. Ouattara and Strobl (2004) corroborate the conclusion for foreign aid flows. Nonetheless, the remaining four studies argue that foreign aid is associated with RER appreciation.

The mixed evidence on the impact of aid inflows may be explained by a number of factors, including: (i) the different structure of recipient economies and country-specific aid dynamics;³

³ This has been suggested by several computable general equilibrium (CGE) studies.

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3 (ii) omitted RER 'fundamentals'; and (iii) the use of different empirical methodologies. In order
4 to overcome these difficulties, we undertake a rigorous empirical assessment for Ethiopia, one
5 of the largest aid recipients in the world.⁴ Ethiopia has many of the structural bottlenecks
6 present in most African economies (e.g. poor infrastructure and lack of skilled labour and
7 technology), but it is often praised for its macroeconomic policies. This makes Ethiopia an
8 interesting case study for countries that have been (or will be) receiving large inflows of capital
9 from abroad. Moreover, our main empirical approach (Unobserved Components) allows us to
10 isolate the effect of aid and remittances on the RER without requiring an exhaustive set of
11 explanatory variables – hence avoiding any potential omitted variable bias. Finally, we use
12 traditional econometric frameworks to complement our empirical analysis.
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28 However, there are a few other issues that may affect model estimates, especially in time series
29 studies: (i) the scarce number of observations; (ii) potential structural breaks; (iii) the
30 composition and timing for the aid variable; and (iv) endogeneity. We take these in turn.
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34 Amongst the studies surveyed here, the largest sample contains 35 yearly observations, which
35 can be a problem if the model includes several regressors and a long lag structure. Moreover,
36 most samples are likely to contain structural breaks, since they include periods where exchange
37 rate markets were highly regulated and the macroeconomic policies pursued were rather
38 different (mainly 1970s and 1980s). In this regard, the use of quarterly data to analyse the RER
39 behaviour over a shorter time span (1995-2008) will enable us to avoid major structural breaks
40 and capture richer dynamic patterns. In terms of the aid variable, data is usually taken from
41 OECD-DAC. The problem, however, is that data reported from donors is likely to include items
42 that do not have an impact on the exchange rate. For example, aid in kind (food aid) is not likely
43 to affect the real exchange rate, while a substantial share of technical assistance payments do
44 not even leave the donor country. Another issue relates to the timing of transactions, since
45 donors often record disbursements in a different period from the recipient country. Ideally, we
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⁴ According to the OECD-DAC 2011 Development Co-operation Report, Ethiopia has received \$3.8 billion of Official Development Assistance in 2009, second only to Afghanistan.

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3 should recover data on grants and concessional loans from the central bank's balance of
4 payments statistics. Finally, the single-equation approach may impose strong exogeneity
5 conditions on the regressors. The estimates can be significantly biased if there are unmodelled
6 feedback effects from the RER to other variables. The only study analysed here that uses a
7 system approach is [Opoku-Afari et al \(2004\)](#). However, potential misspecification errors in one
8 equation of the system would be propagated to the entire model, while its finite-sample
9 properties may be undesirable ([Greene, 2003](#)). Our decision to use single-equation frameworks
10 is based on two main premises: (i) the argument for endogeneity of most explanatory variables
11 used in this paper is not particularly strong (e.g. remittances or aid flows are not likely to be
12 responsive to the RER level); and (ii) some of the cointegration methods used in this paper
13 provide corrections for endogeneity.
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30 **III. Methodology**

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33 While the core Dutch disease model developed by [Corden and Neary \(1982\)](#) is an important
34 reference point for analytical assessments of the impact of capital inflows on the RER, empirical
35 investigations have traditionally used the equilibrium real exchange rate (ERER) approach
36 proposed by [Edwards \(1989\)](#). The ERER is defined as the domestic relative price of tradable
37 goods to non-tradable goods that simultaneously attains internal and external equilibrium:
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$$46 \text{ RER} = \frac{P_T}{P_{NT}}$$

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52 where P_T is the price of tradables (expressed in local currency) and P_{NT} the price of non-
53 tradables. Internal equilibrium is defined as the clearing of the non-tradable goods market,
54 hence with employment at the 'natural' level. External equilibrium is achieved when current
55 account balances are compatible with long-run sustainable capital flows. This definition implies
56 that the ERER is not a constant number, as it depends on a number of real and nominal
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determinants. It is also important to distinguish between the short-run and the long-run, since some determinants may only have a temporary impact on the ERER. Misalignment is defined as 'sustained departures of the actual real exchange rate from its [long-run] equilibrium level' (Edwards, 1989:15). For example, during the 1980s several developing countries had overvalued real exchange rates. Edwards (1989) suggests that the dynamic behaviour of the RER can be captured by:

$$\Delta \ln e_t = \theta (\ln e_t^* - \ln e_{t-1}) - \lambda (Z_t - Z_t^*) + \phi (\ln E_t - \ln E_{t-1})$$

where e_t is the actual RER, e_t^* is the ERER, Z_t is an index of macroeconomic policies, Z_t^* is the sustainable level of macroeconomic policies, E_t is the nominal exchange rate, θ is the adjustment coefficient of the self-correcting term, λ reflects pressures associated with unsustainable macroeconomic policies (e.g. excess credit), and ϕ provides information about the impact of nominal devaluations. The long-run determinants (i.e. 'fundamentals') of the ERER are described by:

$$\ln e_t^* = \beta_0 + \beta_1 \ln \text{TOT}_t + \beta_2 \ln \text{GCN}_t + \beta_3 \ln \text{CAP}_t + \beta_4 \ln \text{EXC}_t + \beta_5 \ln \text{TEC}_t + \beta_6 \ln \text{INV}_t + \varepsilon_t$$

where TOT is the external terms of trade, GCN government consumption of nontradables, CAP controls on capital flows, EXC index of severity of trade restrictions and exchange controls (proxied by the spread), TEC measure of technological progress, and INV ratio of investment to GDP. Finally, the index of macroeconomic policies is defined by excess supply of domestic credit (CRE) and the ratio of fiscal deficit to lagged high-powered money (DEH). Thus the typical equation to be estimated is:

$$\ln e_t^* = \gamma_0 + \gamma_1 \ln \text{TOT}_t + \gamma_2 \ln \text{GCN}_t + \gamma_3 \ln \text{CAP}_t + \gamma_4 \ln \text{EXC}_t + \gamma_5 \ln \text{TEC}_t + \gamma_6 \ln \text{INV}_t + (1 - \theta) \ln e_{t-1} - \lambda_1 \text{CRE}_t - \lambda_2 \text{DEH}_t + \phi \text{DEV}_t + \varepsilon_t$$

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5 where DEV is the nominal devaluation defined before ($\ln E_t - \ln E_t^*$), and the γ 's are combinations
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7 of the β and θ . The specific variables to be included in this study, along with their expected signs,
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9 will be presented in the following section.
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14 In terms of the estimation methodologies used in this paper, we follow three different
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16 approaches to cointegration: the unrestricted error correction model (Banerjee et al, 1998), the
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18 dynamic OLS estimator (Saikkonen, 1991), and the fully-modified OLS method (Phillips and
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20 Hansen, 1990).
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26 However, our main methodology is based on a new approach to estimating the impact of capital
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28 inflows on the RER. We use a structural time series model (Unobserved Components), whose
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30 main strength lies in its capacity to summarise the relevant properties of the data. In contrast to
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32 econometric models, a pure time series model ignores the role of explanatory variables and
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34 does not attempt to uncover economic behavioural relationships. Instead, the focus is on
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36 modelling the time series behaviour in terms of sophisticated extrapolation mechanisms to
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38 produce efficient forecasts (Kennedy, 2003). In recent times, the methodological gap between
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40 econometrics and time series analysis has been curbed by a number of factors. The finding that
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42 time series models tend to outperform forecasts produced by classic econometric models was
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44 taken as a strong indication that the latter were misspecified – they usually lacked a dynamic
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46 structure. Moreover, the increasing evidence of 'spurious regressions' in the context of non-
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48 stationary data also forced a rethink of econometric models. In practice, this led to the rise of
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50 vector autoregressive and error correction models.
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56 Meanwhile, time series researchers were confronted with the lack of economic interpretation of
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58 their models. This led to some modelling developments, namely the combination of univariate
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60 time series analysis and econometric regressions. Two main strategies have successfully

emerged: (i) mixed models, where a time series model is extended to incorporate current and/or lagged values of explanatory variables; and (ii) multivariate time series models, where a set of variables is jointly analysed.

The rationale behind mixed models is that explanatory variables will only partly account for the behaviour of the dependent variable, with some degree of non-stationarity likely to remain in the system. Hence, while dynamic regression models are assumed to provide a full behavioural explanation of the process (disturbance term assumed to be stationary), a mixed model will allow a time series component to capture any left-over non-stationarity (Harvey, 1993).⁵ This is particularly useful for the analysis of the long-run, where it is often difficult to find cointegration between a set of variables proposed by economic theory. In this case, we can specify a dynamic model with both explanatory variables and a stochastic trend to fully account for the movements in the dependent variable (see Appendix A for technical details).

IV. Data

There are several ways to compute a real exchange rate index. Edwards (1989) suggests that the weighting scheme, the choice of trading partners, and the choice of price indices does not have a significant impact on the construction of the RER. The crucial decision is between bilateral and multilateral rates, which show considerable differences in behaviour, sometimes moving in opposite directions. A multilateral rate (i.e. basket of foreign currencies) is usually preferred to a bilateral rate since it tends to be a better representation of overall competitiveness. Hence, the RER index used in this study is computed as the geometric trade-weighted average of a basket of bilateral real exchange rates,

$$RER_t = \prod_{i=1}^n \left(NER_{it} \times \frac{p_t^d}{p_t^f} \right)^{w_{it}} \quad \text{where } t = 1, \dots, T \quad \text{and } i = 1, \dots, n$$

⁵ Moreover, we avoid problems of size and power usually found in unit root and cointegration tests.

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5 where NER is the bilateral nominal exchange rate index expressed in foreign currency per birr,
6 while P^d and P^f are domestic and foreign price indices, respectively – proxied by the CPI and
7 PPI/WPI.⁶ In this case, an increase [fall] in the RER index represents an appreciation
8 [depreciation]. The subscript i identifies the trading partner, and t the time period. A total of 23
9 trading partners (n) were included in the construction of the REER index.⁷ Finally, w_i
10 corresponds to the weight of each trading partner, which is allowed to vary with time (as an
11 eight-quarter moving average) to capture changes in trade patterns (e.g. the rising importance
12 of China and India in the later part of the sample). The weights are computed as the share of
13 each partner's trade (exports plus imports) in the total volume of Ethiopia's trade with the
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$$30 \quad w_{it} = \frac{X_{it} + Z_{it}}{\sum_{j=1}^n (X_{jt} + Z_{jt})} \quad \text{with} \quad \sum_{i=1}^n w_{it} = 1 \quad 0 < w_{it} < 1$$

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36 Alternative methods to compute the RER index were also used (e.g. fixed-weights and fewer
37 trade partners), but the main measure was not sensitive to these changes.
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43 While most studies use net ODA flows from the OECD-DAC to proxy for foreign aid inflows, we
44 have argued that this is not an adequate measure. Therefore we use data from the balance of
45 payments.⁸ Due to data scarcity, remittances are proxied by 'private transfers'. Data on foreign
46 direct investment is very limited, and therefore it will not be used in this study. We construct a
47 terms of trade index using the international price of coffee as a proxy for export prices, and the
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59 ⁶ While (domestic) non-tradable prices were proxied by Ethiopia's consumer price index (CPI), (foreign) tradable
60 prices were proxied by the (trade partner's) producer price index (PPI) or wholesale price index (WPI).

⁷ They accounted for 73 percent of total trade flows during the period 1981-2008.

⁸ Our dataset was compiled from the IMF's Balance of Payments Statistics (BoPS), which reports data from the Central Bank of Ethiopia, and the International Financial Statistics (IFS).

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3 unit value of exports of trading partners to proxy for import prices.⁹ The degree of openness is
4 measured by the ratio of total trade (exports plus imports) to GDP, and is used to capture the
5 impact of trade policy (e.g. liberalisation) on the RER.
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11 Government consumption of non-tradable goods is proxied by total government consumption
12 as a share of GDP, since it is not possible to distinguish between expenditures on tradable and
13 non-tradable goods. The quality of this proxy will depend on the share of non-tradable goods in
14 total government consumption, which we think is likely to be high in the case of Ethiopia. Gross
15 Domestic Product (GDP) was interpolated from annual observations through the use of a local
16 quadratic polynomial with matched sums. Technological progress is proxied by a deterministic
17 time trend, as in Bourdet and Falck (2006) and Nyoni (1998), with the objective of capturing the
18 Balassa-Samuelson effect.
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32 With regard to short-run determinants, expansionary macroeconomic policies are proxied by
33 excess money growth in the economy – measured by the growth of broad money (M2) minus
34 real GDP growth. We also use the nominal exchange rate and international reserves in our
35 specification. As opposed to the ‘fundamentals’, these variables are assumed to only affect the
36 RER in the short-run, and are therefore not included in the long-run specification.
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45 Seasonal unit root tests were used to determine the order of integration of our quarterly
46 variables and to investigate stochastic seasonality. We use the test proposed by Hylleberg et al
47 (1990) for quarterly data. The results show that most variables have regular unit roots – see
48 Appendix B. The only exception is excess money growth (EXM2) and change in international
49 reserves (IRES), which reject the unit root hypothesis. The presence of annual or semi-annual
50 unit roots is rejected for all variables. These conclusions warrant the use of our cointegration
51 methodologies.
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⁹ Alternative measures were also calculated (e.g. combining prices for coffee and agricultural raw materials), but they performed poorly.

V. Empirical Results

Unobserved Components

We use a structural time series model (Unobserved Components), which provides an innovative approach to assess the impact of foreign aid and remittances on the RER. The starting point is Harvey's basic structural model (BSM):

$$y_t = \mu_t + \gamma_t + \varepsilon_t$$

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t$$

$$\beta_t = \beta_{t-1} + \zeta_t$$

where y_t is the observed variable, μ_t is the trend, γ_t the seasonal, and ε_t the irregular component.

Note that the components are initially assumed to be stochastic, whilst the cycle is excluded from the specification. Estimation is performed through the Kalman filter. The BSM seems to be a good starting point for the empirical analysis since the economic theory on RER determination does not provide a strong argument for the presence of cycles. Moreover, the validity of this assumption can be analysed through spectral analysis. The initial estimation results suggest that the seasonal component is deterministic, since the estimated variance of the component is not statistically significant. This corroborates the results from the HEGY test, and further validates the use of dummy variables to account for seasonality in the econometric (cointegration) models. Moreover, the variance of the irregular component is not statistically significant, indicating that the movements of the RER are totally explained by a stochastic trend and a deterministic seasonal component. The stochastic trend is then re-specified as a 'smooth trend' by setting the level variance to zero ($\sigma_\eta = 0$) whilst letting the slope variance unrestricted. Given the insights of the initial univariate model, we will now estimate and present the results of a

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3 mixed model, where we add potential explanatory variables to the structural model. The final
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5 specification is:
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$$10 \quad LNER_t = \mu_t + \gamma_t + \varepsilon_t + \sum_{i=0}^1 \alpha_{1i} LOPEN_{t-i} + \sum_{i=0}^1 \alpha_{2i} LTOT_{t-i} + \sum_{i=0}^1 \alpha_{3i} AID_{t-i} + \sum_{i=0}^1 \alpha_{4i} REM_{t-i}$$

$$14 \quad \mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t$$

$$16 \quad \beta_t = \beta_{t-1} + \zeta_t$$

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20 where $LNER$ is the logarithm of the real effective exchange rate index, $LOPEN$ is the logarithm of
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22 the ratio of total trade flows to GDP, $LTOT$ is the logarithm of our proxy for the terms of trade,
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24 AID is the ratio of foreign aid flows to GDP, and REM is the ratio of private transfers to GDP.¹⁰
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27 Both contemporaneous effects and one period lags are included for all explanatory variables. In
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29 terms of their expected effects, the impact of the terms of trade on the RER will depend on how
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31 income and substitution effects play out. A deterioration of the terms of trade where the income
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33 effect is predominant will tend to depreciate the RER. Moreover, openness is likely to contribute
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35 to the depreciation of the RER. The rationale is that trade liberalisation measures (e.g. reduction
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37 in import tariffs and abolition of non-tariff barriers) will stimulate the demand for imports,
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39 leading to the depreciation of the local currency.
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45 Since the results for the full sample do not suggest that any of the variables is statistically
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47 significant, we focus on the sub-sample 1995-2008. This is not particularly surprising, since we
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49 have strong evidence of structural breaks. The Ethiopian birr was pegged to the United States
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51 dollar (USD) until the early 1990s, which means that the behaviour of the RER was partly
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53 dependent on USD movements against other hard currencies. Since the early 1990s, the foreign
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55 exchange market has been gradually liberalised, which led to a significant reduction in the
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57 parallel exchange rate premium. Moreover, the Derg regime (1974-1991) promoted
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¹⁰ A similar approach is followed by Bourdet and Falck (2006) to proxy for workers' remittances.

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3 macroeconomic policies that were significantly different from those implemented in 1990s and
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5 2000s. Hence, we expect market forces to exert stronger influence on the RER in the latest part
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7 of the sample. The fall of the Derg regime in 1991 (leading to a period of high inflation) and the
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9 large devaluation in 1992 also present a significant modelling challenge. Given these clear
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11 structural breaks in the data, using the latter half of the sample will provide a significantly more
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13 stable relationship between the RER index and its 'fundamentals'.
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19 The sub-sample includes 53 observations and the order of trend smoothness value (p) is 3. The
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21 summary statistics in Table 2 suggest that the model passes the normality test, which is the
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23 Bowman-Shenton statistic based on the third and fourth moments of the residuals. The
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25 heteroscedasticity test (H) is the ratio of the squares of the last h residuals to the squares of the
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27 first h residuals (h is set at the closet integer of $T/3$) and it is centred around unity. Serial
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29 correlation is assessed through the Durbin-Watson test, serial correlation coefficients (r) at the
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31 first and last lags, and the (portmanteau) Box-Ljung statistic (Q) based on the first p
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33 autocorrelations. The results suggest only mild autocorrelation. Finally, the coefficient of
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35 determination based on the differences around seasonal means is 0.28, whilst the more
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37 common measure (R^2) is 0.89. In terms of the component's variances, we confirm that the level
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39 variance is set to zero (smooth trend), while the seasonal variance is estimated to be zero.
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45 Table 2: Summary Statistics and Disturbances (1995-2008)

Summary Statistics	5% critical value [p-value]		Disturbances	Variance	q-ratio
T	53		Level	0	0.000
p	3		Slope	4.87E-05	0.113
std. error	0.027		Seasonal	0	0.000
Normality	0.529	$\chi^2(2)=5.99$ [0.768]	Irregular	0.000431	1.000
H(13)	1.374	F(h,h)=2.48 [0.288]			
DW	1.681	N(2,4/T)=1.548 [0.123]			
r(1)	0.150	N(0,1/T)=-0.226 [0.863]			
q	8				
r(q)	-0.305	N(0,1/T)=-0.226 [0.013]			
Q(q,q-p)	11.578	$\chi^2(5)=11.07$ [0.041]			
Rs^2	0.280				

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Obs.: Allowing a stochastic level does not change results.

Table 3 shows the values of the state vector and regression effects. The coefficients of the explanatory values are interpreted as in classic econometric models. The results suggest that trade openness has a negative impact on the RER (i.e. depreciation), while a positive shock to the terms of trade tends to appreciate the RER – suggesting that the income effect dominates the substitution effect. The fact that the one period lags are statistically significant and not the contemporaneous values may suggest that the transmission mechanisms take a certain time to affect the RER. Neither foreign aid nor remittance flows are statistically significant, although the coefficient for workers' remittances is not far from significant. This might be due to depreciation and appreciation pressures cancelling each other out – e.g. capital inflows being used to ease supply bottlenecks, thus alleviating inflationary pressures.

Table 3: State Vector Analysis and Regression Effects at period 2008(1)

State Vector	Value	Prob.	Regressors	Coefficient	RMSE	<i>t</i> -value	Prob.
Level	4.846	0.000	LOPEN	-0.048	0.038	-1.255	0.217
Slope	0.006	0.587	LOPEN(-1)	-0.078*	0.040	-1.973	0.055
Seasonal (χ^2 test)	8.930	0.030	LTOT	-0.002	0.037	-0.061	0.952
S1	-0.011	0.073	LTOT(-1)	0.074**	0.036	2.084	0.044
S2	0.000	0.995	AID	-0.001	0.001	-0.413	0.682
S3	0.018	0.006	AID(-1)	-0.001	0.001	-0.655	0.516
S4	-0.007	0.233	REM	0.007	0.004	1.682	0.100
			REM(-1)	0.000	0.004	-0.108	0.914

Obs.: Disaggregating aid inflows into grants and loans does not change the conclusions. The asterisks represent significance at the 10 percent (*), 5 percent (**), and 1 percent (***) confidence levels.

We now undertake a graphical analysis of the residuals, in order to assess the robustness and reliability of the results. Figure 1 presents the standardised residuals, which do not suggest the presence of a significant outlier. Moreover, the histogram supports the normal distribution, while the CUSUM *t*-test confirms the stability of the model. The correlogram (Figure 2) does not show significant autocorrelations, except perhaps for lag 8.

Figure 1: Standardised Residuals and Histogram

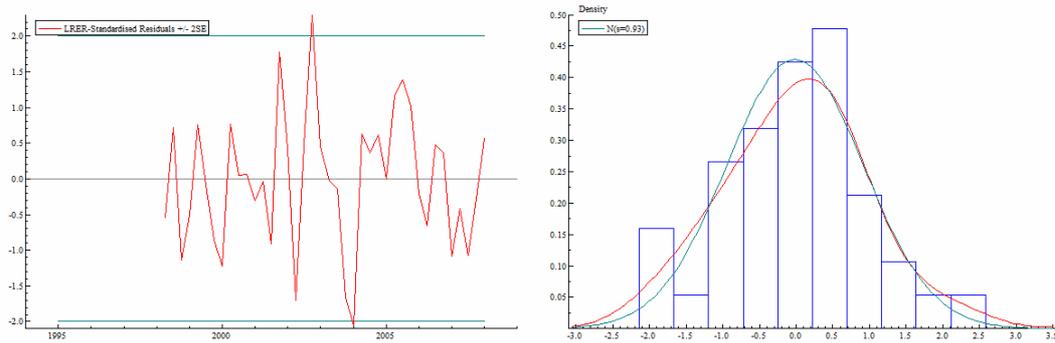
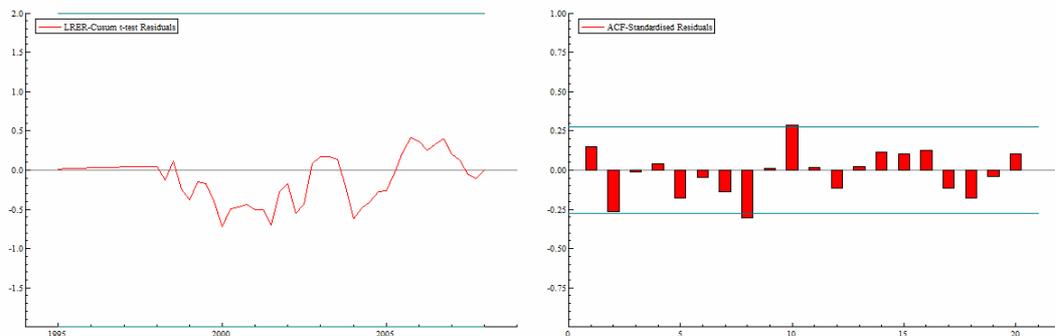
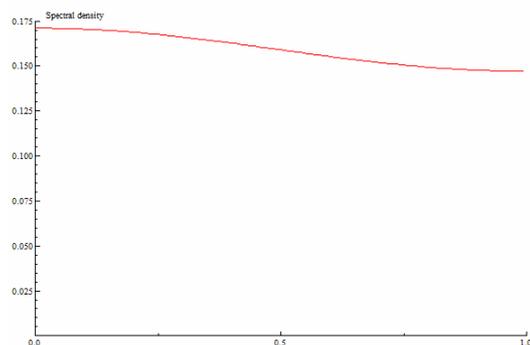


Figure 2: CUSUM t-Test and Correlogram



Finally, the spectral density is clearly flat, therefore supporting the decision to exclude of the cycle component from the model (Figure 3). A marked peak in the graph would have suggested the presence of a cycle.

Figure 3: Spectral Density



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6 In summary, the results from the unobserved components model suggest that the
7 liberalisation of trade flows in Ethiopia (openness) have contributed to the
8 depreciation of the RER, while positive terms of trade shocks contribute to appreciation
9 pressures. Foreign aid inflows are not found to have a significant impact on the RER,
10 while remittances may induce small appreciations.
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21 *Econometric Models*

22 This sub-section deals with the specification and estimation of our econometric
23 regression models. Taking into consideration previous theoretical and empirical
24 studies, the initial long-run relation to be explored is:
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$$32 \quad LRER = \alpha_0 + \alpha_1 LOPEN + \alpha_2 LTOT + \alpha_3 AID + \alpha_4 REM + \alpha_5 TREND + \varepsilon_t$$

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36 where the deterministic time trend is included to capture the Balassa-Samuelson effect.
37 Moreover, seasonal dummy variables are also included in the specification to account
38 for deterministic seasonal patterns. A number of other variables were also tested in the
39 main specification: the black market premium (BMP), i.e. the differential between the
40 parallel exchange rate and the official exchange rate; the change in international
41 reserves as percentage of GDP (IRES); the ratio of government consumption spending
42 to GDP (GEX); and excess money growth (EXM2). However, these variables were not
43 found to be statistically significant.
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56 Table 4 provides a summary of the long-run estimates for the period 1995-2008. Once
57 again, the results for the full sample (1981-2008) fail to provide statistically significant
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coefficients, while the model shows signs of misspecification and poor explanatory power.

Table 4: Long-Run Coefficients (1995-2008)

	UECM		DOLS		FMOLS
	LRER	LRER	LRER	LRER	LRER
C	4.174***	4.097***	4.398***	4.340***	4.693***
LOPEN	-0.282***	-0.288***	-0.296*	-0.289**	-0.305***
LTOT	0.176***	0.191***	0.163**	0.169***	0.117***
AID	-0.002		-0.001		-0.006***
REM	0.000		-0.003		0.008*
TREND	0.007***	0.008***	0.007**	0.008***	0.006***
<i>Error Correction</i>	<i>-0.393</i>	<i>-0.393</i>			
Observations	53	53	51	51	53
R-Squared	0.573	0.570	0.923	0.923	
Serial Correlation	[0.621]	[0.622]	[0.000]	[0.001]	
Functional Form	[0.468]	[0.347]	[0.217]	[0.290]	
Normality	[0.778]	[0.704]	[0.646]	[0.666]	
Heteroscedasticity	[0.383]	[0.273]	[0.403]	[0.278]	
ECM test	-3.771	-4.236**			
F-test (deletion)	3.920*	6.759***			
ADF test			-5.36***	-5.45***	-5.22***

Obs.: Wald tests are used to evaluate statistical significance. The asterisks represent significance at the 10 percent (*), 5 percent (**), and 1 percent (***) confidence levels. P-values in square brackets. The critical values for the ECM-test and F-test are taken from Pesaran et al (2001). ADF tests use MacKinnon (1996) one-sided p-values.

Cointegration in the unrestricted ECM model is tested through the ECM-test proposed by Banerjee et al (1998) and the bounds test approach (F-test) proposed by Pesaran et al (2001).¹¹ Both tests suggest that there is a meaningful (long-run) economic relation between the RER, trade openness and the terms of trade. However, neither foreign aid nor remittances flows appear to have a significant effect on the RER.

The dynamic OLS (DOLS) model uses two leads and four lags of each first-differenced regressor. Moreover, we use adjusted variance matrices to correct for potential heteroscedasticity and serial correlation. Cointegration is evaluated through an ADF test on the residuals of each regression. The lag length of the ADF regression is selected

¹¹ The ECM-test is a *t*-test on the lagged dependent variable, which in practice assesses the statistical significance of the adjustment coefficient of the error-correction term. The bounds test approach uses the conditional unrestricted ECM and performs an *F*-test (or Wald-test) on the long-run coefficients. The distribution of both tests is non-standard, and therefore we use the tabulated values from Pesaran et al (2001).

by the Schwarz Information Criterion. The DOLS results corroborate the findings of the UECM. Although the regressions appear to suffer from serial correlation, the *F*-version of the test does not reject the null hypothesis of serially uncorrelated errors. The CUSUM tests do not suggest any structural breaks in the sub-sample.

Finally, the Phillips-Hansen approach to cointegration (FMOLS) methodology uses a semi-parametric correction to solve potential endogeneity and serial correlation, therefore providing standard errors that are more reliable than those from traditional OLS. This procedure requires all regressors to be $I(1)$ and not cointegrated amongst themselves. Robustness checks included different weighting schemes, truncation and variables. The FMOLS results provide further evidence that trade openness depresses the RER, while the terms of trade are associated with a RER appreciation. The impact of the remaining variables is rather small or even statistically insignificant. The coefficient on foreign aid is significant, but not with the expected theoretical sign. Moreover, remittances appear to appreciate the RER, but the impact is small and only weakly significant. The plot of the residuals does not suggest misspecification problems.

Table 5: Summary of Long-Run Impacts

	ECM	DOLS	FMOLS
LOPEN	-0.29***	-0.29***	-0.30***
LTOT	0.19***	0.17***	0.12***
AID	0.00	0.00	-0.01***
REM	0.00	0.00	0.01*
TREND	0.08***	0.08***	0.06***

Overall, the three approaches to cointegration used in this paper provide strong evidence that trade openness and the external terms of trade have a significant impact on the long-run path of the RER. The former always entails a depreciation of the RER, as predicted by economic theory, whilst the latter tends to appreciate the RER, suggesting that the income effect is stronger than the substitution effect. With regard to capital inflows, there is little evidence of a significant impact of foreign aid or remittance

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3 inflows on the RER. Hence, the Dutch disease hypothesis does not seem to hold for
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5 Ethiopia. Other variables were also included in the specification, but little was gained in
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7 terms of explanatory power. Finally, the time trend is statistically significant, possibly
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9 capturing the Balassa-Samuelson effect. Disaggregating aid inflows into grants and
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11 loans does not affect the conclusions.
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17 **VI. Conclusions**

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20 This paper investigated whether large capital inflows – foreign aid and remittances –
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22 tend to cause the RER to appreciate as suggested by the theoretical literature. Despite
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24 the unequivocal theoretical prediction that large capital inflows will force the RER to
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26 appreciate, empirical studies have seldom found robust evidence of Dutch disease
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28 effects, especially with regard to foreign aid inflows. Hence, this paper conducted a
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30 thorough empirical investigation of the RER dynamics in Ethiopia, one of the largest aid
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32 recipients in the world.
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38 The unobserved components (UC) model (Harvey, 1992) provided a new empirical
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40 framework to test the ‘Dutch disease’ hypothesis. Its main strength lies in its explicit
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42 modelling of the stochastic trend, and by extending the UC model to include
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44 explanatory variables we are able to evaluate whether capital inflows (as well as other
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46 ‘fundamentals’) have had a significant impact on RER determination. Since this
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48 approach does not require an exhaustive specification of potential determinants, we
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50 are able to focus our attention on the most pertinent variables. Moreover, three
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52 cointegration frameworks were used to complement our analysis: (i) the unrestricted
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54 error correction model proposed by Banerjee et al (1998); (ii) the dynamic OLS
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56 approach suggested by Saikkonen (1991) and Stock and Watson (1993); and (iii) the
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58 fully-modified OLS estimator of Phillips and Hansen (1990).
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3 The results emerging from both the structural time series and econometric models
4 suggest the following conclusions. The openness measure has a negative impact on the
5 long-run value of the RER, which means that reforms undertaken in the 1990s to
6 liberalise trade flows and exchange markets have contributed to downward pressures
7 on the RER (depreciation). Moreover, external terms of trade shocks have a positive
8 impact on the RER (appreciation). The implication of this finding is that the income
9 effect outweighs any potential substitution effects. With regard to capital inflows,
10 neither foreign aid nor workers' remittances were found to be statistically significant,
11 although the latter might be weakly associated with appreciation pressures. This may
12 be due to the fact that a large share of private transfers tends to be spent on domestic
13 products. The lack of robust evidence that capital inflows appreciate the RER questions
14 the Dutch disease hypothesis.
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32 Hence, this paper argues that the main fluctuations of the Ethiopian RER can be
33 accounted by three main factors: (i) external commodity price shocks (measured by the
34 terms of trade), mainly affecting coffee exports and oil imports; (ii) political events,
35 such as the instability towards the end of the Derg regime that caused unusually high
36 inflation; and (iii) economic policy, especially the liberalisation of trade flows and the
37 exchange rate market. These effects are not likely to act through the capital account,
38 since there are still several capital restrictions in Ethiopia. Moreover, the lack of
39 significance of variables such as excess money supply and government consumption
40 may suggest that Ethiopia has pursued sound macroeconomic policies since the fall of
41 the Derg regime. To conclude, the results suggest that Ethiopia has been able to
42 effectively manage large capital inflows, thus avoiding major episodes of
43 macroeconomic instability. A prudent approach from the central bank and aid flows
44 targeted at alleviating supply-side constraints (mostly through public investment) may
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have played an important role. This demonstrates that African countries can manage large inflows of foreign capital, without damaging their external competitiveness.

For Peer Review

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Appendix A: Structural Time Series Model

State Space Form

The state space form is often a useful way to specify a wide range of time series models.

The application of the Kalman filter can then provide algorithms for smoothing and

prediction, as well as a means to constructing the likelihood function (Harvey,

1993:82&181). The main concepts are now briefly explained for the univariate case,

but these can be easily extended to a multivariate context. The observed variable y_t is

related to the *state vector* α_t via the following *measurement equation* (Lutkepohl,

2005:611):

$$y_t = Z_t \alpha_t + \varepsilon_t$$

where Z_t is a matrix of coefficients that may depend on time, and ε_t is the observation

error (usually taken as a white noise process). The elements of α_t are usually not

observable, but are known to follow a first-order Markov process (Harvey, 1993:83).

This can be expressed by the following *transition equation*:

$$\alpha_t = T_t \alpha_{t-1} + \eta_t$$

where T_t is a matrix of coefficients, which again can be time-dependent, and η_t is a

white noise error process (uncorrelated to ε_t). A state space model will necessarily

comprise both measurement and transition equations.

Unobserved Components (UC) Model

The exposition here follows Koopman et al (2007:171). The univariate structural time

series model can be represented by the following measurement equation:

$$y_t = \mu_t + \psi_t + \gamma_t + \varepsilon_t$$

where y_t is the observed variable, μ_t is the trend, ψ_t the cycle, γ_t the seasonal, and ε_t the irregular component. All the components are assumed to be stochastic, but reduce to deterministic components as a limiting case. The stochastic trend is specified by the following transition equations:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t$$

$$\beta_t = \beta_{t-1} + \zeta_t$$

where β_t is the slope of the trend, η_t (level disturbance) and ζ_t (slope disturbance) are independent white noise processes, therefore uncorrelated with the irregular component. Table 6 presents alternative specifications of the trend.

Table 6: Level and Trend Specifications

Level	σ_ε	σ_η	
Constant term	*	0	
Local level	*	*	
Random walk	0	*	
Trend	σ_ε	σ_η	σ_ζ
Deterministic	*	0	0
Local level with fixed slope	*	*	0
Random walk with fixed drift	0	*	0
Local linear	*	*	*
Smooth trend	*	0	*
Second differencing	0	0	*
Hodrick-Prescott	*	0	$0.025\sigma_\varepsilon$

Obs.: '*' indicates any positive number.

Source: Koopman et al (2007, Table 9.1)

The seasonal component is specified by the trigonometric seasonal form:

$$\gamma_t = \sum_{j=1}^{[s/2]} \gamma_{j,t}$$

where each $\gamma_{j,t}$ is generated by:

$$\begin{bmatrix} \gamma_{j,t} \\ \gamma_{j,t}^* \end{bmatrix} = \begin{bmatrix} \cos\lambda_j & \sin\lambda_j \\ -\sin\lambda_j & \cos\lambda_j \end{bmatrix} \begin{bmatrix} \gamma_{j,t-1} \\ \gamma_{j,t-1}^* \end{bmatrix} + \begin{bmatrix} \omega_{j,t} \\ \omega_{j,t}^* \end{bmatrix}, \quad j = 1, \dots, [s/2], \quad t = 1, \dots, T$$

where $\lambda_j = 2\pi j/s$ is the frequency in radians, and the seasonal disturbances (ω_t and ω_t^*) are mutually uncorrelated white noise processes with common variance. Finally, the cycle is specified as:

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \rho_\psi \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix}, \quad t = 1, \dots, T$$

Where ρ_ψ is a damping factor (with a range $0 < \rho_\psi \leq 1$), λ_c is the frequency in radians (with a range $0 \leq \lambda_c \leq \pi$), and the cycle disturbances (κ_t and κ_t^*) are mutually uncorrelated white noise processes with common variance.

Harvey's (1993:142) basic structural model (BSM) is often a good starting point for the analysis of time series data. The model is similar to the general univariate case specified above, except for the cycle component, which is excluded. The BSM can thus be written in the following compact form:

$$y_t = [1 \ 0 \ 1 \ 0 \ 0] \alpha_t + \varepsilon_t$$

$$\alpha_t = \begin{bmatrix} \mu_t \\ \beta_t \\ \gamma_t \\ \gamma_{t-1} \\ \gamma_{t-2} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -1 & -1 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mu_{t-1} \\ \beta_{t-1} \\ \gamma_{t-1} \\ \gamma_{t-2} \\ \gamma_{t-3} \end{bmatrix} + \begin{bmatrix} \eta_t \\ \zeta_t \\ \omega_t \\ 0 \\ 0 \end{bmatrix}$$

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10 *Explanatory Variables and Interventions*

11 The model presented above can be extended to include current and lagged values of
12 explanatory variable, lags of the endogenous variable, as well as intervention dummies.
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14 The model can then be written as:
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$$y_t = \mu_t + \psi_t + \gamma_t + \varepsilon_t + \sum_{\tau=1}^p \phi_\tau y_{t-\tau} + \sum_{i=1}^k \sum_{\tau=0}^q \alpha_{i\tau} x_{it-\tau} + \sum_{j=1}^h \lambda_j \varpi_{jt}$$

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28 where x_{it} are exogenous variables, ϖ_{jt} are intervention dummy variables (e.g. impulse,
29 level or slope), while ϕ_τ , $\alpha_{i\tau}$ and λ_j are unknown matrices.
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34 This 'mixed model' is a valuable complement to traditional econometric analysis. Since
35 explanatory variables are often not able to account for all the variation in y_t , we allow
36 the unobserved components to capture 'left over' stochastic behaviour – trend or
37 seasonal (Harvey, 1993:152).
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Appendix B: Seasonal Unit Root Tests

The HEGY test (Hylleberg et al, 1990) is based on the following model:

$$\Delta_4 y_t = \pi_1 z_{1,t} + \pi_2 z_{2,t} + \pi_3 z_{3,t} + \pi_4 z_{4,t} + \sum_{j=1}^p \alpha_j \Delta_4 y_{t-j} + u_t$$

where $z_{1,t} = (1 + L + L^2 + L^3)y_t$, $z_{2,t} = -(1 - L + L^2 - L^3)y_t$, $z_{3,t} = -(1 - L^2)y_t$ and L is the lag operator. The null hypotheses $H_0: \pi_1=0$, $H_0: \pi_2=0$ and $H_0: \pi_3=\pi_4=0$ correspond to tests for regular, semi-annual and annual unit roots, respectively. These hypotheses are tested by estimating the model above by OLS and using the relevant t -tests and F -tests. The critical values reported are from Franses and Hobijn (1997). It should be noted, however, that the asymptotic distributions of the test statistics under the respective null hypotheses depend on the deterministic terms in the model. This fact is taken into consideration since there is evidence that at least some of the series seem to be trended. The results of the unit root tests are reported in Table 7.

Table 7: Seasonal Unit Root Tests (Levels and First Differences)

Var.	Lag	H_0	Test	Stat	Var.	Lag	H_0	Test	Stat
LRER	0	$\pi_1=0$	t_{π_1}	-2.19	DLRER	0	$\pi_1=0$	t_{π_1}	-4.84***
		$\pi_2=0$	t_{π_2}	-6.09***			$\pi_2=0$	t_{π_2}	-5.15***
		$\pi_3=\pi_4=0$	F_{34}	49.61***			$\pi_3=\pi_4=0$	F_{34}	25.11***
LOPEN	0	$\pi_1=0$	t_{π_1}	-2.06	DLOPEN	0	$\pi_1=0$	t_{π_1}	-6.21***
		$\pi_2=0$	t_{π_2}	-5.80***			$\pi_2=0$	t_{π_2}	-4.87***
		$\pi_3=\pi_4=0$	F_{34}	23.44***			$\pi_3=\pi_4=0$	F_{34}	17.06***
LTOT	0	$\pi_1=0$	t_{π_1}	-2.76	DLTOT	0	$\pi_1=0$	t_{π_1}	-5.38***
		$\pi_2=0$	t_{π_2}	-7.61***			$\pi_2=0$	t_{π_2}	-6.44***
		$\pi_3=\pi_4=0$	F_{34}	32.83***			$\pi_3=\pi_4=0$	F_{34}	22.71***
AID	0	$\pi_1=0$	t_{π_1}	-2.93	DAID	0	$\pi_1=0$	t_{π_1}	-7.54***
		$\pi_2=0$	t_{π_2}	-4.76***			$\pi_2=0$	t_{π_2}	-4.72***
		$\pi_3=\pi_4=0$	F_{34}	25.73***			$\pi_3=\pi_4=0$	F_{34}	24.35***
REM	0	$\pi_1=0$	t_{π_1}	-2.77	DREM	0	$\pi_1=0$	t_{π_1}	-6.81***
		$\pi_2=0$	t_{π_2}	-4.89***			$\pi_2=0$	t_{π_2}	-4.74***
		$\pi_3=\pi_4=0$	F_{34}	36.37***			$\pi_3=\pi_4=0$	F_{34}	26.35***
EXM2	0	$\pi_1=0$	t_{π_1}	-4.58***	DEXM2	0	$\pi_1=0$	t_{π_1}	-7.25***
		$\pi_2=0$	t_{π_2}	-4.74***			$\pi_2=0$	t_{π_2}	-4.59***
		$\pi_3=\pi_4=0$	F_{34}	35.20***			$\pi_3=\pi_4=0$	F_{34}	29.13***
BMP	0	$\pi_1=0$	t_{π_1}	-1.95	DBMP	0	$\pi_1=0$	t_{π_1}	-4.04***
		$\pi_2=0$	t_{π_2}	-6.64***			$\pi_2=0$	t_{π_2}	-4.93***
		$\pi_3=\pi_4=0$	F_{34}	38.70***			$\pi_3=\pi_4=0$	F_{34}	31.68***
GEX	0	$\pi_1=0$	t_{π_1}	-1.56	DGEX	0	$\pi_1=0$	t_{π_1}	-5.60***
		$\pi_2=0$	t_{π_2}	-3.98***			$\pi_2=0$	t_{π_2}	-3.12**

		$\pi_3 = \pi_4 = 0$	F_{34}	24.45***			$\pi_3 = \pi_4 = 0$	F_{34}	17.48***
IRES	0	$\pi_1 = 0$	$t_{\pi 1}$	-4.17***	DIRES	0	$\pi_1 = 0$	$t_{\pi 1}$	8.58***
		$\pi_2 = 0$	$t_{\pi 2}$	6.52***			$\pi_2 = 0$	$t_{\pi 2}$	7.25***
		$\pi_3 = \pi_4 = 0$	F_{34}	29.16***			$\pi_3 = \pi_4 = 0$	F_{34}	30.12***

Obs.: The Schwarz Criterion was used (maximum set at 10 lags). The deterministic components included were: constant, trend, and seasonal dummies. For the differences, the trend was dropped. The results for the sub-sample 1995-2008 lead to similar conclusions, i.e. EXM2 and IRES potentially stationary. The asterisks represent significance at the 10 percent (*), 5 percent (**), and 1 percent (***) confidence levels.

The null hypothesis of the HEGY test is that there is a unit root. We include a constant, a deterministic trend, and seasonal dummies in the test regression. The number of lagged seasonal differences (i.e. lag length) was selected according to the Schwarz Criterion. As expected, the results show that most variables have regular (zero frequency) unit roots (i.e. cannot reject $\pi_1=0$). The only exception is excess money growth (EXM2) and change in international reserves (IRES), which reject the unit root hypothesis. However, and perhaps more importantly, the presence of a semi-annual unit root ($\pi_2=0$) or annual unit root ($\pi_3=\pi_4=0$) is rejected for all variables. Finally, the HEGY test on the (first) differenced variables seems to reject the null hypotheses of unit roots.

Hence, the HEGY tests do not provide evidence of seasonal unit roots. The seasonal components do not seem to be time-dependent, suggesting that the patterns of the selected variables within the year remained relatively stable throughout the sample. The tests also suggest that most variables are integrated of order one, whilst two variables (EXM2 and IRES) appear to be stationary.