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Aid and exchange rates in sub-Saharan Africa: No more Dutch Disease?

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Aid and Exchange Rates in sub-Saharan Africa: No More Dutch Disease?

Oliver Morrissey, Lionel Roger and Lars Spreng

Abstract

Given the significant inflows of foreign aid to sub-Saharan Africa (SSA) the possibility of Dutch Disease has been a concern. Most macroeconomic models predict that aid inflows, especially if large and/or unanticipated (shocks), will lead to an appreciation of the real exchange rate and undermine the competitiveness of the economy. Empirical evidence is inconclusive, but a common presumption is that aid has been associated with Dutch Disease effects in SSA. Previous empirical studies rely on annual data and few include data since the mid-2000s. This paper focuses on the more recent period employing monthly time series data for ten countries over 2001 to 2017 to estimate a structural VAR. For the majority of countries aid has no or a minimal effect on the real exchange rate; there is evidence of a significant real appreciation in only two countries. Additional analysis shows that commodity export prices are a more important determinant of the real exchange rate, with an effect on average twice that of aid. The paper conjectures that the absence of a Dutch Disease effect since the 2000s is due to a declining level of aid inflows and improved macroeconomic management.

JEL Classification: F31, F35, O11, O55

Keywords: Foreign Aid, Exchange Rates, Dutch Disease, sub-Saharan Africa

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1 INTRODUCTION

The macroeconomic effects of foreign aid inflows is a subject of substantial interest to researchers and policy-makers concerned with aid recipient countries. Aid is beneficial to the recipient economy as it relaxes the government's budget constraint in a context where domestic revenue is low and finances public investment where domestic savings are insufficient. However, aid may have distortionary effects on the economy, for instance by crowding out private investment or by affecting the real exchange rate. This latter channel has received considerable attention in the theoretical literature in recent years, but the empirical evidence remains inconclusive.

Theoretical models calibrated to a typical country in sub-Saharan Africa (SSA) generally predict substantial real exchange rate (RER) appreciations following an increase in aid inflows, giving rise to concern with Dutch Disease (DD) effects (e.g. Arellano, Bulíř, Lane and Lipschitz, 2005; Buffie, Adam, O'Connell and Pattillo, 2008; Berg, Gottschalk, Portillo and Zanna, 2010). These models and variations, outlined in Section 2, focus on a context where aid accounts for a relatively large share of foreign currency inflows. Thus, aid surges induce an appreciation of the real exchange rate, reducing export competitiveness so that the tradeable sector shrinks while the non-tradable sector expands. There are scenarios where aid does not generate appreciation. Adam and Bevan (2006) show that if aid-financed investments improve productivity this can offset Dutch Disease effects. The basic scenario is that public infrastructure generates productivity spillovers that combine with learning-by-doing externalities to increase total factor productivity in the tradable sector. Alternatively, economies with unemployed resources or idle capacity would be able to adjust to an increase in aggregate demand without a real appreciation (Nkusu, 2004). The empirical evidence suggests that appreciation is less likely the more flexible the exchange rate and if aid finances investment that increases (non-tradables) productivity.

The limited empirical literature on the Dutch Disease effects of aid in SSA, mostly based on regressing the RER on aid and other variables, provides mixed evidence. Fielding and Gibson (2013, pp 3-4) review eight papers: those on Francophone Africa (under a fixed exchange rate regime) tend to find significant appreciation effects, whereas other studies rarely found evidence of appreciation (see also Adam, 2013, pp 5-6). These studies typically use relatively short time series observations of annual aid as reported by donors. Fielding and Gibson (2013) estimate the macroeconomic effects of aid in a three variable VAR (real GDP, RER and real growth) for 26 SSA countries over 40 years (1970-2009). Aid was associated with a significant appreciation in eight of the 13 countries (almost all Francophone) classified as fixed exchange rate regimes, but in only one (Mauritius, a relatively minor aid recipient) of the 13 countries with a flexible exchange rate (there was a significant depreciation for the Gambia). Almost all countries with flexible regimes and about half with fixed regimes exhibited no evidence of Dutch Disease. Using more recent data, Juselius, Reshid and Tarp (2017) find appreciation following aid shocks (in the long-run with CVAR analysis) in Ghana and Tanzania, but only significant in Ghana.

Other studies take an indirect approach, inferring Dutch Disease (DD) from the effect of aid on competitiveness or relative sector growth. Selaya and Thiele, 2010), for 65 developing countries over 1962-2001, find no empirical support for a DD effect as aid appears to have a similar positive effect on growth in value added for tradable and non-tradable sectors (DD implies faster growth of the latter). In contrast, Rajan & Subramanian (2011), for 32 countries in the 1980s and 15 countries in the 1990s, find that aid is associated with lower growth of manufacturing exports (similar to Arellano *et al*. 2009). They infer, but do not demonstrate, that the low growth of exports is due to real exchange rate appreciation attributable to aid.

A major challenge with empirical econometric studies of the DD effect of aid is that data on aid disbursements from conventional sources (e.g., DAC) is only available at an annual frequency. Consequently, available time series are usually quite short and are unable to allow for responses to

aid inflows, and effects on the exchange rate, that occur within a year. Li, Adam, Berg, Montiel and O'Connell (2019) show that structural vector-autoregressive (SVAR) estimates for SSA countries may fail to capture macroeconomic effects accurately, in particular monetary transmission (the relationship between the interest rate, output gap, inflation and RER). Their specific concern is that the short-run restrictions required to identify the SVAR will not support valid inference given the data limitations typical in SSA countries, notably measurement error in relatively short data series when policy regimes are changing and there are high frequency supply shocks. Using a DSGE model as a data generating process, they show that SVAR will reveal transmission if it is present and strong and estimation is based on a relatively long series of quality data (the SVAR power is much lower if transmission is actually weak). They show that the combination of short data series with measurement error and output shocks bias SVAR estimates downwards so the method is less likely to find the effect even if it is present. The imprecision of SVAR impulse response estimates may be greatest using GDP (or output gap) where, for almost all SSA countries, one is restricted to annual data. Similar concerns could apply to estimating the effects of aid on the exchange rate (noting that many of the theoretical models are DSGE). To address this we use higher frequency monthly data, as recommended by the authors although they note 'that measurement error is likely to be greater in monthly data, especially for measures of real activity' (Li *et al.*, 2019, p22).

Macroeconomic management of aid in sub-Saharan Africa (SSA) and low-income countries (LICs) is particularly challenging given that levels of aid and vulnerability to external shocks are typically high. In SSA, aid inflows have often exceeded 10% of GDP and more than half of the government's budget but are highly volatile (Herzer and Morrissey, 2013; Bulíř and Lane, 2002). Macroeconomic management difficulties are exacerbated by highly undiversified exports in volatile world markets; shocks to prices of export commodities have an immediate impact on the current account and potentially on the exchange rate.

Theoretical models, when calibrated to reflect properties of typical SSA countries, generally predict substantial RER appreciations following an increase in aid inflows, and consequently attribute a lot of importance to Dutch Disease effects (see Section 2). From conventional sources (e.g., DAC), data on aid disbursements is only available at an annual frequency, and generally reported as recorded by the donor; most of the literature on macroeconomic effects of aid (on growth, fiscal variables or exchange rates) has used such data. This may be appropriate when studying the overall impact of aid on growth, but if the concern is with specific policy responses to aid, it is arguably preferable to use aid as reported by the recipient country. For example, to investigate how fiscal variables such as spending and tax respond to receipt of aid it is appropriate to use the measure of aid available to the fiscal authorities, i.e. aid as recorded in the budget (Bwire *et al.,* 2017; Mascagni & Timmis, 2017). Similarly, as the effect on the exchange rate is determined by how monetary authorities respond, it is appropriate to use a measure of aid reported as received by the Central Bank. An innovation in this paper is to use data from local sources.

A number of Central Banks or other government institutions provide data on aid at a monthly frequency. We compile this information for ten SSA countries (Botswana, Burkina Faso, Burundi, Ghana, Kenya, Lesotho, Malawi, Mauritius, Tanzania, Uganda) where such data exist, covering the period from 2001 to 2017 (although for many of the countries data begin from 2008/9), and complement it with key macroeconomic variables also available monthly (usually from the same sources). This allows us to move the analysis from an annual to a monthly frequency, thereby dramatically increasing the amount of temporal variation to exploit. Not only does this allow us to better capture the short-run dynamics related to inflows of foreign aid, but we can also focus our attention on more recent and shorter periods, where it is much more likely that we are observing a

single regime. A particular problem with studies of Dutch Disease effects of aid in SSA using annual data over 1970-2000 is the frequent changes in exchange rate regimes. A possible limitation is that the reported aid data are only for net cash grants; while this may understate the inflow of foreign exchange associated with aid, it is the measure known to Central Banks (on a monthly basis) and captures aid that goes direct to government (and hence potentially for non-tradeables). Appendix A1 illustrates the differences comparing our data to other aid measures, but on average and for half of the countries our data are close to donor data on grants disbursed.

The second innovation is that we consider two structural vector auto-regressive systems (SVARs) in order to distinguish the policy response (mechanisms) from the macroeconomic dynamics (outcomes) that follow a shock in aid inflows. In order to identify exogenous aid shocks, we exploit the high frequency of our data. The fact that aid inflows are difficult to predict in the short run by recipient countries (Hamann and Bulíř, 2001), and do not adjust quickly to contemporaneous macroeconomic conditions given the lack of information within any given month, means that we can credibly place aid inflows at the beginning of the sequence in an SVAR identified with a classical Cholesky decomposition (the remainder of the sorting being irrelevant; see Christiano *et al*., 1999). Our estimation framework then consists of country-specific structural VARs for each of the ten countries, taking full account of any parameter heterogeneity. First, we estimate a *policy* system for each country, which describes the reactions of domestic debt held by the central bank, money supply,[1] and foreign reserves following an aid shock in each country. Second, we estimate an *outcomes* system, describing the trajectory of the real exchange rate, interest rates and the balance of trade following an aid surge. We complete this system with a set of exogenous variables, namely country-specific commodity price indices and foreign interest rates (proxied by the yield of US treasury bills), and, where this is warranted, dummy variables to flexibly account for extraordinary occurrences (e.g., violent conflict, debt write-offs). We complement our analysis with a forecast error variance decomposition, with the aim of quantifying the relative importance of foreign aid inflows compared to other shocks to the economy (commodity prices in particular) in determining the RER.

The remainder of this article proceeds as follows. Section 2 provides an overview of the existing theoretical and empirical literature, and motivates the empirical framework. Section 3 describes the data, discusses some conceptual issues related to the variables, and provides details on the data collection process and sources. Section 4 discusses the methodology and derives the empirical framework. Section 5 presents the key results for each countries individually, and section 6 discusses the differences we observe across countries and puts them into the context of the theoretical literature. Section 7 concludes.

2 LITERATURE REVIEW

Over the past 20 years or so, studies have been using open macroeconomy general equilibrium (GE) or Dynamic Stochastic General Equilibrium (DSGE) models to investigate the macroeconomic effects of aid in SSA. An advantage of these models is that a variety of policy scenarios can be considered (but analysis is based on simulation rather than econometric estimation). Theoretical models typically imply real exchange rate appreciation and adverse Dutch Disease (DD) effects of aid, but this is not always the case. Adam & Bevan (2006) elaborate how aid-financed investments may improve productivity and offset Dutch Disease effects. Their model goes beyond the focus on short-run Dutch

[1] Money is included in the policy system because in many of the countries included in our study, monetary policy is still primarily conducted using a monetary target. By contrast, in the theoretical literature, the interest rate is typically considered an outcome rather than a policy tool used actively in the management of aid inflows. The separation is not clear cut, which should be borne in mind when interpreting the results.

Disease effects, to allow for a possible supply-side impact of aid-financed public expenditure, where public infrastructure generates an intertemporal productivity spillover, which may exhibit a sector-specific bias, and allows for a learning-by-doing externality, through which total factor productivity in the tradable sector is an increasing function of past export volumes. Under a fixed exchange rate, with no sterilisation and spending in full, aid leads to a moderate appreciation. The novel model framework permits a focus on distributional effects of appreciation, suggesting that income gains accrue predominantly to skilled and unskilled urban households, leaving the rural poor relatively worse off.

Prati & Tressel (2006) use a GE framework (with a closed capital account) to examine the effect of aid on productivity growth, allowing for a positive externality through public expenditure (investment, similar to Adam & Bevan, 2006) and a negative exchange rate externality (capturing DD). Foreign aid tends to be associated with lower exports (hence DD) during normal years (although sterilisation mitigates the effect), but not in years of adverse shocks (presumably because the aid offsets the adverse effects of the shock). Recent papers extend this type of model in various ways. Although the papers share a similar model structure, the policy scenarios considered vary and we only provide a brief overview (Appendix A2 in Morrissey et al, 2019, outlines the core features of these papers).

Buffie, Adam, O'Connell & Pattillo (2008) develop a small open economy model with two sectors (non-traded and traded) and two currencies (foreign and domestic), as well as government bonds. The model is calibrated to Ghana to simulate the impact of highly persistent aid shocks in a number of policy scenarios, assuming no sterilisation: pure float and crawling peg as polar cases with managed float as an intermediate regime. Given the assumption of no sterilisation, the lower the assumed elasticity of currency substitution (representing the ease at which agents switch between domestic and foreign currency) the smaller the RER appreciation; medium or high elasticity of currency substitution is associated with medium RER appreciation (greatest under sticky prices with a crawling peg). An earlier version of this model (O'Connell, Adam, Buffie & Pattillo, 2006) is simulated for Tanzania, Uganda and Mozambique. Many scenarios are considered and simulations suggest a moderate appreciation under a dirty float with sticky prices, a larger appreciation for either a clean float or flexible prices, and the largest appreciation when there is a clean float with partial spending and sticky prices. In broad terms, given the values of other parameters, a cleaner float is associated with greater appreciation.

Adam, Buffie, O'Connell & Pattillo (2009) considers a stochastic model in which private sector currency substitution determines the effect of alternative monetary and fiscal policy strategies in the face of volatile aid flows. Simple monetary rules, specifically an (unsterilized) exchange rate crawl and a 'reserve buffer plus float' (under which the authorities set a time-varying reserve target corresponding to the unspent portion of aid financing and allow the exchange rate to float freely once this reserve target is satisfied), are associated with less appreciation under an aid surge. The greatest appreciation occurs under a pure float with partial spending. When the exchange rate regime is more restrictive than a pure float (in this case a crawling peg), there is no sterilisation and spending in full, aid induces a small appreciation, and even a depreciation in post-stabilisation countries when aid expenditure is smoothed. In a similar vein, Buffie, O'Connell & Adam (2010) extend Buffie et al. (2008) to scenarios where donors cannot pre-commit to support scaled-up public spending programs, and governments cannot credibly commit to reduce expenditure rapidly if aid revenues decline. In this case, an aid boom induces a credibility problem; the absorb-and-spend strategy recommended by the IMF leads to capital flight, higher inflation, and large current account surpluses inclusive of aid. Given a flexible exchange rate and full absorption, an aid increase generates a small or moderate appreciation.

Berg, Gottschalk, Portillo & Zanna (2010) employ a (DS)GE model to analyse the macroeconomic effects of scaling-up aid allowing for public investment efficiency, a learning-by-doing (LBD) externality

that captures DD effects, and distinguishing between spending the aid (fiscal policy) and absorbing the aid (financing a higher current account deficit) determined by the central bank's reserve policy. The general results of simulations under alternative scenarios with full spending are that aid is associated with a larger appreciation if there is no sterilisation with flexible exchange rates, and the smallest appreciation under full sterilisation and fixed exchange rates. Calibrating the model to Uganda indicates that a policy mix with full spending and absorption can generate temporary demand and real exchange rate appreciation, but has a positive effect on real GDP in the medium term through higher public capital. Full spending with partial absorption, on the other hand, mitigates appreciation pressures but also reduces real GDP effects (due to private sector crowding out). Aid has the most harmful DD effects under very low public investment efficiency and strong LBD externalities (partial absorption can mitigate the effect).

Zanna, Berg, Mirzoev, & Portillo (2010) employ a similar open-economy, two sector, new-Keynesian model to analyse the short-term effects of aid-financed fiscal expansions, and as in Portillo et al. (2010) distinguishes between spending and absorbing the aid. A policy mix that results in spending but not absorbing the aid can lead to a temporary real depreciation if demand pressures threaten external balance. This is consistent with experience in Uganda when a surge in aid in the early 2000s increased government spending but real interest rates rose and there was a real depreciation. Berg, Portillo & Zanna (2015) use a simplified version of the Portillo et al. (2010) model to consider the effect of aid surges assuming full spending, under fixed or flexible exchange rates, and reserve accumulation or full bond sterilization. Bond sterilization is associated with moderate DD effects under either exchange rate regime, whereas appreciation is greater under no sterilization. Under no sterilization, a fixed regime allows for almost full aid absorption (through an increase in the current account deficit net of aid), with the same DD effects as a flexible regime but higher inflation. Regardless of the regime, policies that limit absorption and permit accumulation of reserves reduce the real appreciation, but also constrain medium-term growth.

Arellano, Bulíř, Lane & Lipschitz (2009) examine the effects of aid (and volatility) on consumption, investment, and the structure of production with an inter-temporal two-sector general equilibrium model calibrated to Cote d'Ivoire. Aid mainly finances consumption rather than investment and large aid flows are associated with real exchange rate appreciation and a smaller tradable sector (because aid is a substitute for tradable consumption). Aid volatility results in substantial welfare losses.

Some common themes emerge from these studies. Aid has lower appreciation effects under full sterilisation, even under a fixed exchange rate regime. If there is no sterilisation, effects are more complex: appreciation tends to be greatest under pure floating regimes (mitigated if there is a lower elasticity of currency substitution, full spending or flexible prices), moderate under a fixed exchange, and lowest under dirty float or crawling peg regimes (especially if prices are sticky). Depreciation rarely occurs, but is more likely when aid is spent (a lower fiscal deficit) but not absorbed (not all used to finance imports), especially if aid financed investment increases productivity (of non-tradables in particular).

3 DATA AND SPECIFICATION

An informed empirical investigation of the macroeconomic effects of aid inflows has in the past been hampered by data limitations. The real exchange rate, a key outcome affected by foreign aid as predicted by economic theory (e.g., Arellano *et al*., 2009; Portillo *et al*., 2010) is not easy to capture empirically. Government agencies do not typically report their own measures, and common macroeconomic databases have very limited coverage; this often results in the use of inadequate

measures.[2] For other, more clearly defined and commonly reported variables, frequency can be a problem. This is particularly true for foreign aid, where relatively comprehensive data is reported on the donor side, but only at an annual frequency – a limitation for analysis of dynamics incorporating policy responses. First, many of the transmission mechanisms associated with foreign aid are likely to take place in a timeframe much shorter than a year. Second, identification becomes more difficult: while it can credibly be argued that aid disbursements are unlikely to be affected by domestic macroeconomic developments within a month, the same can hardly be said about a year (see section 4). Third, most African countries only gained independence in the 1960s and started receiving significant amounts of aid in the 1970s; sample sizes at an annual frequency therefore rarely exceed 40 observations, undermining the power of time series methods that typically have high requirements in terms of data. This problem is exacerbated by the fact that virtually every African country has undergone fundamental macroeconomic policy regime changes over the course of their independence, especially regarding exchange rate liberalisation. From an econometric perspective, this almost certainly leads to at least some degree of parameter instability, making it preferable to focus on shorter but more homogenous segments of time.

3.1 Variable definition and sources

To address these issues, we focus on a set of 10 sub-Saharan countries for which we were able to obtain high-frequency (monthly) data on our key variables of interest. Where possible, we use data as reported by the recipient country, typically by the Central Bank or the Ministry of Finance, as these are most likely to reflect the figures that actually underlie policy decisions, and, in the case of aid, a more precise account of the flows that actually reached the recipient country: donor data includes items such as technical assistance where the money is spent in the donor country. As monthly data tends to be patchy in many countries (e.g., the information is sometimes contained in individual documents for every month or quarter, but missing for several months in a row), we use international databases (IMF International Financial Statistics (IFS) and Datastream) when required.

We estimate two separate systems (elaborated below). We refer to the first as the *policy* system, intended to capture the mechanisms by approximating the policy reaction in each recipient country; it includes aid inflows, claims of the central bank on the government, broad money and foreign exchange reserves. The second is referred to as the *outcomes* system, capturing the relationship between aid inflows and core macroeconomic outcomes, namely the interest rate, the real exchange rate, and the balance of trade. Although it is a relevant policy variable, the Central Bank rate does not change at a monthly frequency and the time series is not smooth,[3] so we use the yield of Treasury bills with a maturity of 3 months for the interest rate. The interest rate that 3-month Treasury bills effectively trades at reflects market sentiment so is appropriately included in the outcome system, with money supply as the policy indicator in the policy system.

Our key variable, foreign aid inflows, is difficult to obtain in the form of a high frequency measure of the amount recipients receive. In line with the bulk of the theoretical literature, our focus is on net cash grants.[4] While virtually all fiscal budget reports include this item, most countries only publish such reports at an annual or quarterly frequency. The exceptions where (to the best of our knowledge)

[2] The IMF's International Financial Statistics only report the REER before 2007 for three out of ten countries included in our study (Ghana, Lesotho and Uganda), and has no such data at all for five of the countries.

[3] Furthermore, although the Central Bank intervenes to influence short-term rates, we are not aware of any models where aid is included in the bank's reaction function for interest rates.

[4] The implication is that we omit aid loans. Donor data typically includes the concessionary element of loans in their aid figures, but the computation of this share is controversial and is not typically declared in reports by recipient governments. We also omit aid projects where the aid is not recorded in recipient systems.

reports are available at a monthly frequency constitute the countries included in this study. For Botswana, Burundi, Kenya and Uganda, we were able to obtain series disseminated directly by the respective governments, either from their online portals or kindly provided by members of staff. For the remaining countries, we sourced data from the IFS or Datastream either entirely (Burkina Faso, Ghana, Lesotho, Mauritius, Tanzania) or for parts of the series (Malawi before 2016). Datastream, in turn, cites the respective government as their source in all cases.

As alluded to above, measuring the RER comes with a host of conceptual difficulties and choices, and this is reflected in its poor availability in government statistics and international databases. The first issue is that exchange rates are a bilateral concept; there is no unique exchange rate for any given country, but only for pairs of countries. For analytical purposes, it is therefore common to compute *effective* exchange rates, that is, indices that aggregate bilateral exchange rates weighted by trade partners. The choice of weights can be particularly contentious, and the data needed for computation is not always readily available. The second issue concerns the price indices employed to convert nominal exchange rates into real ones, as there is no clear consensus as to which prices are the relevant ones, and arguably this depends on the context. Where this is made explicit, two different definitions of the RER are used in the theoretical literature on aid inflows: one is determined by the ratio of the prices of traded to non-traded goods (e.g., Buffie *et al*., 2008), the other on the ratio of domestic consumer prices to foreign consumer prices (e.g., Berg *et al*., 2015). Taken together, these conceptual complications mean that data on the real effective exchange rate (REER) is not straightforward to obtain from conventional sources. We source monthly REER from the database maintained by Bruegel and based on the methodology outlined in Darvas (2012), which includes all countries included in this study. [5] This reports a CPI based REER; where interest is on the relative price of tradables and non-tradables, as in Dutch disease, this can be considered a proxy variable rather than the outcome itself.

The Balance of Trade is obtained by subtracting total imports from total exports as reported in the IMF Direction of Trade Statistics (DOTS). The effect will be negative if 'the aid inflow leads to an increase in the demand for both imports and domestic goods and services … [h]ence the aid is fully absorbed so that net imports still rise dollar-for-dollar with the aid, but absorption is represented by some increase in imports and a fall in exports' (Adam, 2013: 3). The measure of the interest rate is the yield of treasury bills with a maturity of 3 months, as this measure has the most consistent coverage across countries. International reserves (foreign currency or other) held by the central bank are obtained from Datastream or the IMF's International Financial Statistics (IFS). Net claims by the central bank on the central government are all obtained from the IFS. Broad money (M2) is obtained from Datastream, which in turn sources it from domestic central banks, but reports according to a harmonised definition. The *outcomes* system also includes two exogenous variables, namely a country-specific export commodity price index and the US Treasury bill rate. We use monthly export commodity price indices computed by Eberhardt and Presbitero (2018), which are based on fixed trade shares as advocated by Ciccone (2018) and the IMF Primary Commodity Prices (PCP) database. The 3-months US Treasury bill rate is obtained from the Federal Reserve Bank of St. Louis.

3.2 Data transformations

The units in which the variables are reported vary; whereas domestic fiscal variables are usually reported in local currency units (at current prices), open economy variables such as grants or trade volumes are frequently reported in US Dollars (USD). We harmonise across all variables. In the

[5] The database is regularly updated and can be downloaded at http://bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/ (last accessed August 2018). The exception is Tanzania, is not covered at a monthly frequency in Darvas (2012), so we construct the REER based on trade shares and nominal exchange rates with the five largest trading partners.

outcomes system, our main specification will be based on the series in USD, as the only variables that are expressed in monetary terms here are grants and the balance of trade, where USD are the natural unit. In the policy system however, we focus on the specification in local currency to approximate fiscal rules by the government, as domestic policy decisions can reasonably be expected to be made in reference to local currency units. Table 1 reports key summary statistics about the variables of interest; for comparability, all values are in USD at current prices;[6] unless specified otherwise.

Beyond currency units, a choice needs to be made regarding any non-linear transformations of the variables. In the *outcomes* system, our interest lies with elasticities: we seek to discern the percentage change that occurs to key macroeconomic outcomes that ensues from, say, a 10% increase in foreign aid inflows. The usual way of obtaining such measures is to apply a logarithmic transformation to the series, but this is not defined for negative and zero values, which naturally occur in some of our variables (namely the balance of trade, and occasionally claims and grants). One remedy is to add a constant before taking logarithms, or alternatively take logarithms of the absolute values and multiply with negative one where the original value was negative. However, these transformations can have substantial drawbacks. If the constant required to shift values to the positive domain is large compared to the rest of the series, relative changes will be severely distorted by the first method. If many values are very small and of changing signs (oscillating around zero), the discontinuity introduced around zero by the second method can prove overly influential.

A third method, the inverse hyperbolic sine transformation, is our preferred transformation. Defined as $\ln\left(x + \sqrt{\{x^2 + 1\}}\right)$, it has become increasingly popular in the wealth literature, where zeros and negative values are a pervasive issue (Pence, 2006). Except for very small values, the function effectively runs parallel to the natural logarithm, and unit changes in the transformed series are close approximations of percentage changes in the original series; it is naturally defined for zero as well as negative values, and exhibits no discontinuity around zero (Burbidge *et al*., 1988). We apply this transformation to our *outcome* series, that is, the interest rate, the REER and the balance of trade. Elasticities obtained from applying this transformation to aid are somewhat problematic as the underlying shock would correspond to a given percentage change relative to the level of aid *at any given point in time*. Given the large variance of the aid series, and the presence of zeros, this can confound interpretation: a 10% increase in aid when the current level is 1 USD corresponds to 10 cents, but if the current level is one billion USD, a 10% increase would correspond to 100 million USD. These two shocks are unlikely to trigger the same macroeconomic reaction, which is why we leave the aid series in levels and report semi-elasticities, with shocks scaled to 10% of the mean level of aid.[7] Note that in the *policy* system, no non-linear transformation is employed, as we seek to determine changes in absolute terms, rather than relative changes in the values of fiscal variables (that is, to approximate the rule as to how a unit increase in aid is being put to use).

[6] For several reasons, we do not deflate local currency prices. First, when estimating fiscal rules, the contemporaneous (nominal) figures are arguably the ones underlying of decision-making. Furthermore, price indices can be approximated with a linear trend, which translates into a constant as we take first differences. As there is no cross-section dimension to our estimators, there is also no need to force the comparability of figures across countries. In the *outcomes* system, where we convert to USD, the exchange rate itself works as a deflator, and applying a CPI deflator on top of it would create distortions (and induce collinearity with the REER, which is based on the CPI).

[7] In a robustness check, we estimate our results in a system where aid, too, is IHS transformed. The results are qualitatively similar, the main difference being the scale of the coefficients.

Table 1: Summary statistics

	Mean	SD	Min	Max	Mean	SD	Min	Max
	Botswana (2004:11-2017:06)				Burkina Faso (2008:01-2017:02)			
Grants	5.38	10.85	-2.17	54.60	38.14	36.50	1.46	168.10
Interest	7.25	4.30	1.00	13.13	4.43	0.53	3.52	6.15
REER	108.92	4.56	99.88	117.75	98.96	5.30	85.18	110.10
BoT	9.03	206.07	-777.24	426.11	-99.34	70.81	-246.61	188.29
Reserves	8086.58	1020.66	5634.73	10345.48	2.47	1.25	0.00	5.13
Claims	-3371.86	733.68	-5056.15	-1955.52	-87.46	80.71	-247.73	91.46
M2	5535.45	1181.40	2507.93	6901.90	3152.03	887.93	1567.67	4651.38
	Burundi (2007:01-2017:04)				Ghana (2008:01-2017:04)			
Grants	9.59	10.66	0.00	68.95	47.68	47.08	0.00	244.43
Interest	8.22	2.16	3.74	12.59	19.68	5.61	9.25	25.90
REER	129.05	19.29	97.04	169.32	83.66	11.23	51.67	103.42
BoT	-40.12	14.20	-92.57	-13.55	20.09	275.82	-894.50	790.30
Reserves	240.54	84.02	84.60	359.84	4427.79	1369.82	1508.08	7875.13
Claims	150.90	68.20	54.70	318.47	1649.04	786.23	385.72	3503.03
M2	467.55	121.16	265.18	689.63	7458.70	1834.49	4242.63	10722.84
	Kenya (2001:12-2017:06)				Lesotho (2005:01-2017:05)			
Grants	23.59	55.60	-138.46	689.60	7.35	7.06	1.26	51.92
Interest	7.72	3.45	0.83	21.65	6.73	1.30	4.94	10.15
REER	104.39	25.36	65.45	150.79	86.94	10.47	61.78	105.37
BoT	521.58	345.16	-163.10	1351.10	-18.70	43.08	-104.01	79.34
Reserves	5354.10	2955.94	1442.00	11233.00	908.63	187.49	367.58	1250.08
Claims	-233.67	512.27	-2017.58	656.56	-439.38	131.94	-694.69	-169.85
M2	12568.90	6498.28	4027.68	23968.70	688.29	169.87	344.36	961.72
	Malawi (2009:01-2016:06)				Mauritius (2008:07-2017:06)			
Grants	27.87	27.86	2.54	141.58	6.01	15.29	0.00	76.40
Interest	16.71	9.26	5.66	42.19	3.33	1.70	0.93	9.12
REER	94.32	16.55	63.46	126.91	110.98	5.55	98.20	121.87
BoT	-97.84	42.17	-185.32	-12.61	-215.64	48.52	-345.70	-104.90
Reserves	361.06	198.90	81.10	776.95	3250.56	981.36	1686.10	5261.40
Claims	521.60	221.32	169.92	946.00	-525.23	257.05	-1135.89	-116.73
M2	1336.46	236.58	981.18	1917.35	8705.29	1043.74	6580.64	10791.78
	Tanzania (2003:12-2016:05)				Uganda (2001:12-2017:06)			
Grants	73.96	70.57	1.60	412.64	143.28	54.99	41.99	263.21
Interest	10.19	3.82	1.77	18.55	10.10	3.99	2.97	20.35
REER	82.03	8.26	68.67	98.69	96.82	7.47	76.73	118.73
BoT	-398.85	228.04	-1001.00	-63.00	-203.89	95.98	-405.57	-33.73
Reserves	3224.91	884.92	1800.68	4673.73	2202.96	799.35	809.54	3391.01
Claims	-378.47	563.59	-1475.99	845.87	-712.46	410.82	-1491.34	118.01
M2	4476.80	2240.30	1400.00	8306.35	2393.91	1069.34	758.83	4039.82

Notes: Grants = Net cash grants (USD Millions), Interest = 3 month treasury bill interest rate (% p.a.), REER = Real effective exchange rate (index), BoT = Balance of Trade (USD Millions), Reserves = Foreign currency reserves (USD Millions), Claims = Claims of monetary authority on central government (USD millions), M2 = Broad Money (USD Millions)

All estimations are carried out after taking first differences of all series to ensure stationarity (see augmented Dickey-Fuller tests in Appendix 03), as many series appear to be non-stationary when expressed in levels (see plots in Appendix A4). Removing unit roots precludes investigation of long-run equilibria through co-integration analysis; however, there can be no co-integrating relations for our variable of interest as aid is found to be stationary in all countries (with the exception of Malawi, where the ADF test just about fails to reject the null of there being a unit root at the 5% level; this contrasts with Juselius *et al*. (2014, 2017), although they consider aid series at an annual frequency). We therefore confine our attention to the short-run dynamics and include the series in first differences. With the non-linear transformations, we can interpret the values in the *outcomes* system as percentage changes (with some reservations, as discussed above). Those in the *policy* system are changes in absolute terms, that is, local currency units (or USD in a robustness check).

3.3 Method and Specification

In order to empirically capture the macroeconomic dynamics associated with aid inflows, including the full dynamics of the system and explicitly modelling potential endogeneity among the variables, country-specific vector autoregressions (VAR) are estimated with the monthly data. These are of the general form:

$$y_t = \alpha_t + \sum_{i=1}^{k} \Gamma_i y_{t-i} \; + \sum_{i=1}^{k} \Gamma_i^* x_{t-i} \; + D_t + \; \varepsilon_t \qquad (1)$$

where y_t is a vector of p variables, α_t is a vector of intercepts, Γ_i are $p \times p$ matrices of coefficients that quantify the interaction among variables at lag i, up until the maximum lag k.[8] To account for the effect of arguably important, yet credibly exogenous forces (namely, commodity prices and foreign interest rates in the *outcomes* system), we include an exogenous vector x_t that affects the system with coefficients collected in Γ_i^*, for which we impose the same lag-structure as for the endogenous part of the system. Further, we limit the impact of some major outliers by including dummy variables captured in D_t (see Appendix A1). ε_t is the error term, and we refrain from making strong assumptions about its structure (such as being i.i.d.), as will be discussed below.

To be more specific, we will estimate the general system outlined above for two sets of endogenous variables y_t. The main focus lies on the specification where $y_t = [aid_t, interest_t, REER_t, Trade_t]'$, which we refer to as the *outcome* system as it aims to quantify the impact of aid inflows on key macroeconomic variables in the short to medium run. The variables correspond to cash grants, the interest rate on 3-months Treasury bills, the REER, and the balance of trade respectively. In this specification, the vector of exogenous variables takes the form $x_t = [commodities_t, fed_t]'$. This includes country-specific price indices of export commodities, and the interest rate on 3-months treasury bills in the US as a proxy for world interest rates; both of these measures are recognised to be strong drivers of the REER (Chen and Rogoff, 2003; Cashin *et al*., 2004).

We estimate a second system, which we refer to as the *policy* system, as the goal here is to approximate the policy response that any given country tends to have with respect to a unit increase (or decrease) in aid inflows. The endogenous variables included in this system are $y_t = [aid_t, reserves_t, claims_t, money_t]$. These are some of the key variables at policy-makers disposal in their reactions to aid inflows: $reserves_t$ is the amount of international reserves held by the central bank, $claims_t$ are the claims of the central bank on the central government (a measure that can fluctuate both with government debt as well as with open market operations by the central bank, e.g.

[8] For internal consistency, we choose k=6 as our preferred lag-length, taking into account the data of 2 quarters prior to any given observation (specification tests can be found at https://tinyurl.com/yddm8ffb).

as a means of sterilisation), and $money_t$ is broad money (M2). This set of variables captures a broad range of the policy options described in the theoretical literature, and the results from this system will be used to put any heterogeneity across countries in terms of *outcomes* following an aid shock into context.

Our main focus in either of these systems will be on the impulse response functions associated with aid shocks, quantifying the reaction of each of the variables to a change in aid over time. In order to identify exogenous aid shocks and compute impulse response functions accordingly, we impose some assumptions about the contemporaneous interaction of our variables, and therefore the error terms collected in ε_t , using a conventional Cholesky decomposition (e.g., Sims 1980). While this identification strategy has attracted a lot of criticism in the past for forcing researchers to make unrealistic assumptions about the causal chain between the variables included in the system, we argue that this criticism does not apply because we are only interested in the reactions to a single shock to foreign aid. At a monthly frequency, it is plausible to assume that aid does not react to the other variables in the system, so it can comfortably be put at the beginning of the ordering of the variables (where presumably slow variables come first, and fast reacting ones come last). This is because the precise timing of aid disbursements is decided by donors, and notoriously difficult to predict from a recipients perspective (Hamann and Bulíř, 2001). Crucially, donors typically have no information about macroeconomic or fiscal developments *within the month* that would allow them to react contemporaneously. The high frequency of our data therefore not only provides us with more information than earlier studies, but also substantially adds to the credibility of the identification strategy. Moreover, the ordering of the subsequent variables is irrelevant to the IRFs to an aid shock, and the fact that this ordering does not necessarily reflect an economically credible relationship between the variables is without consequences (i.e., any ordering will yield the same results regarding our variable of interest; Christiano *et al*., 1999). We therefore refrain from more elaborate identification schemes, such as sign-restrictions (Uhlig, 2005; Arias *et al*., 2014; Baumeister and Hamilton, 2015), simply because the problem these are designed to solve is not pertinent in the study at hand.

For all its benefits, the high frequency of our data also creates some new difficulties. In particular, this concerns the commonly made assumption that the errors ε_t are independent and identically distributed, let alone normally distributed. As noted by Kilian and Lütkepohl (2017), this assumption generally becomes hard to defend at a higher frequency. Indeed, we will see that throughout our models, normality of the residuals is frequently rejected. The problem concerns mainly the estimation of standard errors and confidence intervals. Asymptotically derived standard errors rely on normally distributed residuals, and conventional bootstrapping methods require them to be i.i.d. to yield valid inference. We therefore obtain the confidence intervals for our IRFs from a residual based wild bootstrap as discussed in Goncalves and Kilian (2004, 2007), which has been shown to perform well under weaker conditions and in the presence of conditional heteroscedasticity of unknown form. We note that, compared to more conventional methods, this has a tendency of widening the confidence intervals in our application and sometimes leads to a loss of significance at conventional levels.

4 RESULTS AND DISCUSSION

Estimating the two systems for each country produces a description of how it (typically) handles increases in foreign aid, as well as how this strategy translates into outcomes. This will allow us to place our results in the context of the various policy scenarios in the theoretical literature discussed in Section 2. The *policy* system tracks three variables that are available at a high frequency for the countries in our sample and play a key role in the characterisation of the policy scenarios discussed in

the theoretical literature. *Claims* of the Central Bank (CB) on the Central Government deserve some discussion because the variable is somewhat ambiguous but plays a central role in the policy reaction (see Prati and Tressel, 2006). The ambiguity stems from the fact that changes can come from two sources that are quite different regarding their nature and implications. Claims fluctuate with open market operations, as the CB buys or sells treasury bonds on the open market. In the aftermath of a foreign aid inflow, a decrease in claims held by the CB is likely to reflect a strategy of bond sterilisation, that is, the sale of assets in order to absorb surplus liquidity that accrues from aid-financed spending. Claims also fluctuate with domestic debt, at least to the extent this debt is taken up vis-à-vis the CB (which is frequently the case, see Christensen, 2004). A decrease may therefore equally reflect the fact that the government employs foreign aid inflows towards reducing the fiscal imbalance. Strictly speaking, it would therefore be preferable to include domestic debt separately, but this variable (like fiscal variables in general) is not typically available at a monthly frequency. We therefore consider the reactions of M2 as an auxiliary tool in order to discriminate between sterilisation and domestic debt. By construction, sterilisation should moderate the increase in money supply; M2 would hence be expected to increase by substantially less than the amount of aid flowing in.

4.1 Policy reactions

Table 2 reports the point estimates of the IRFs resulting from the *policy* system after 0, 6, 12 and 36 months, Figure 1 gives a graphical representation that also includes the 95% (light grey) and 90% (darker grey) confidence bands. There is a substantial degree of heterogeneity across the countries in our sample in terms of how aid is put to use, but there are common patterns. In most countries, aid inflows appear to be followed by a reduction in the Central Bank's claims against the Central Government (Botswana, Lesotho, Mauritius and Uganda are the exceptions, but hardly reach statistical significance). As mentioned above, this measure can vary for two reasons. For one thing, governments have a tendency to borrow from the Central Bank, and changes in claims can reflect changes in domestic borrowing. The result could therefore indicate that aid serves to reduce the deficit, which is a central premise in the simulations of Buffie *et al*. (2008) for example. Alternatively, a reduction in claims held by the Central Bank can simply mean that the government debt has been passed on to other institutions or individuals. This would typically be the case if the Central Bank engages in contractionary open market operations, reflecting a strategy of bond sterilisation.

Table 2: Policy reactions to a 1 unit increase in aid

1 Local Currency Unit shock to aid															
	Botswana			Burkina Faso			Burundi			Ghana			Kenya		
Month	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.
0	*4.00*	-0.30	-4.94	**-0.81**	-0.26	0.00	**-0.55**	0.13	**0.90**	**1.54**	-0.19	-0.07	-0.10	**0.19**	*0.17*
6	*5.22*	1.54	-3.93	**-0.53**	0.11	0.00	**-0.88**	0.02	**0.95**	1.03	*2.58*	0.36	**-0.61**	**0.82**	**0.95**
12	*6.94*	1.10	-6.80	**-0.60**	0.19	0.00	**-0.99**	0.16	**1.24**	0.43	1.50	1.30	**-0.62**	**1.05**	**0.70**
36	*6.92*	0.87	-6.74	**-0.47**	0.25	0.00	**-1.04**	0.21	**1.31**	0.32	1.36	1.07	**-0.56**	**1.47**	**0.88**
	Lesotho			Malawi			Mauritius			Tanzania			Uganda		
Month	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.	Claims	Money	Reser.
0	**-1.19**	-0.12	**1.58**	**-0.59**	0.52	**0.79**	-0.27	1.04	0.74	**-0.78**	-0.03	0.78	-0.01	*-0.72*	*-1.16*
6	0.62	-0.79	-0.10	*-0.98*	0.15	0.84	0.69	0.34	0.44	**-0.97**	**-0.71**	0.37	0.74	-0.27	*-2.06*
12	1.13	-0.72	-1.10	*-1.06*	0.10	0.56	0.59	-0.16	0.17	**-0.81**	*-0.41*	0.50	0.69	-0.46	*-2.11*
36	1.53	-0.74	-1.77	*-1.36*	-0.09	0.42	0.70	-0.15	0.11	**-0.81**	*-0.43*	0.49	0.54	-0.59	*-2.04*

Notes: Values are point estimates of the IRF to an aid shock after 0, 6, 12 and 36 months. They result from our *policy* specification, with variables expressed in local currency units without further transformations. Results in italics are significantly different from zero at the 10% level, bold ones at the 5% level.

In most cases, reserves increase following an aid inflow. In Malawi, Mauritius and Tanzania, aid is partially used towards reserve accumulation, while in Burundi and Kenya, reserves increase almost one to one with aid inflows (at least after 6 months). To a certain degree, this can be problematic, as by construction it limits absorption: if foreign currency is retained by the Central Bank, it cannot serve to finance a trade deficit, and aid financed expenditure becomes similar to printing money with all its macroeconomic repercussions (e.g., Berg *et al*., 2010). In Botswana and Uganda reserves decline, but the size seems implausible (see below). Burkina Faso has almost no reserves (Table 1) and the lack of any aid effect is consistent with the fixed exchange rate.

It may be more insightful to consider the movement of M2 following an aid shock. Where reserves are accumulated but money supply does not increase (or even decrease), this indicates an aid regime where the additional resources are either employed towards consolidating the fiscal balance and replenishing foreign reserves, or the CB actively steers against increases in money supply using bond sterilisation (Malawi and Tanzania). If on the other hand money supply increases as reserves are accumulated (Burundi, Ghana and Kenya to varying degrees), this corresponds more to the 'printing money' scenario described above, and increases in money supply without absorption may exert inflationary pressure.[9] In Botswana, Lesotho and Uganda, our results actually indicate a *reduction* of foreign reserves following aid inflows (although only significantly at the 10% level in Uganda; in Malawi, the initial reaction is positive and significant). Although the empirical results are relatively weak for this case, it could be consistent with a scenario where an increase in the flow of foreign exchange encourages policymakers to reduce the stock of reserves. Table 3 gives a brief summary of the policy reactions observed in our sample (abstracting from the monetary dimension, which we mainly consider as auxiliary information in order to discriminate between bond sterilisation and deficit reduction).

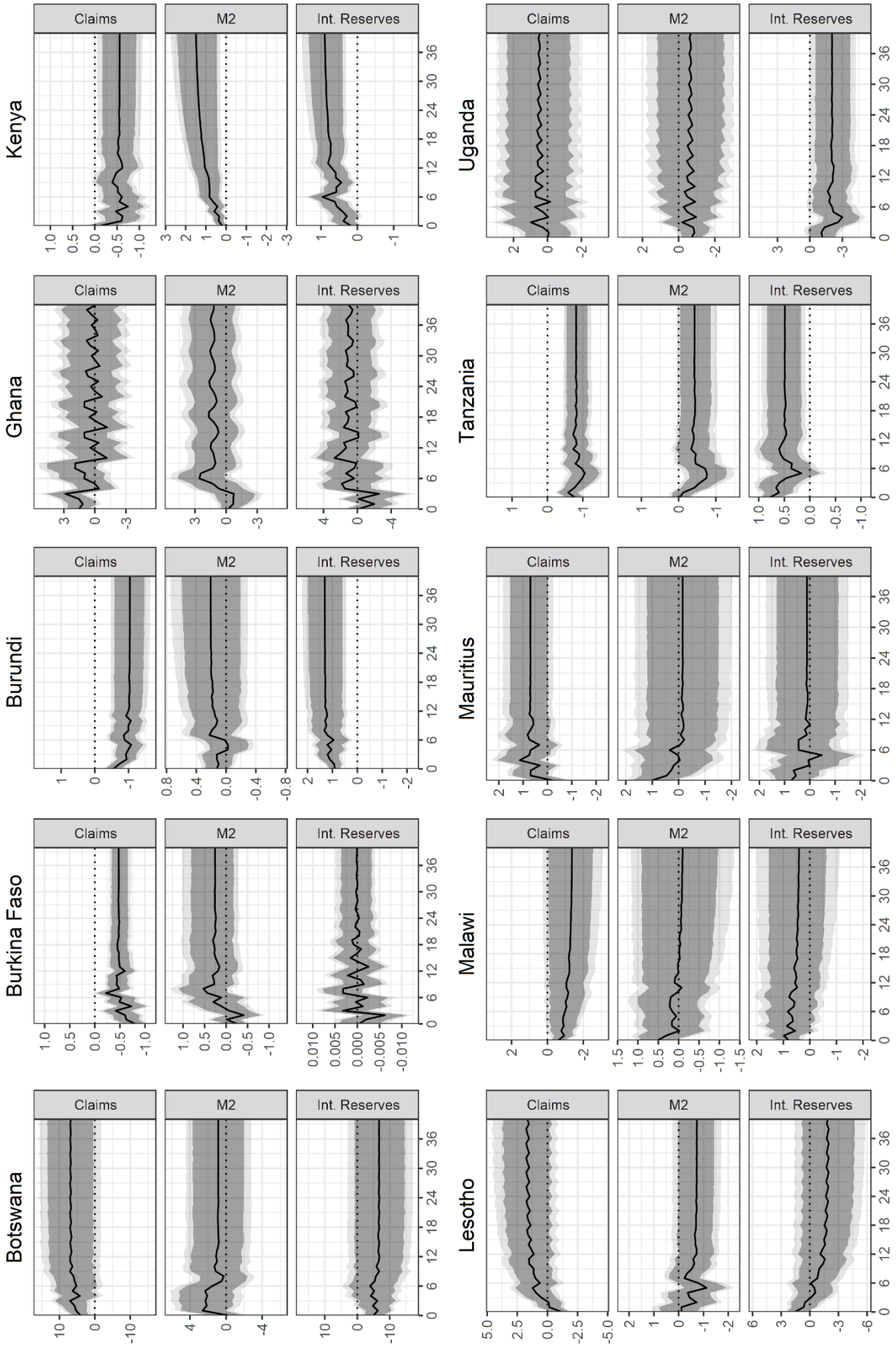
It should also be highlighted that some point estimates for individual countries appear somewhat implausible. In particular, in Botswana a 1 Pula increase in aid is estimated to increase (decrease) claims (reserves) by almost 7 Pula, and in Uganda reserves are estimated to drop by 2 shillings for every additional shilling of aid. In each of these cases, however, the confidence intervals (Figure 1) are very large and also incorporate perfectly credible results. We hence attribute the puzzling point estimates to either conventional sample variance or problems with the scaling in the data rather than taking them at face value, and confine our attention to the sign of the estimate.

[9] The repercussions this has on the exchange rate are ambiguous: the additional supply of domestic currency should trigger a nominal depreciation, while inflationary pressures work towards a real appreciation.

Table 3: Summary of policy reactions to a positive aid shock

Reserves \ Claims	+	+/-	-
+		Reserve accumulation, incomplete absorption, possible increases in spending paired with bond sterilisation. (Ghana)	Fiscal deficit reduction or bond sterilisation, incomplete absorption. (Burundi, Kenya, Malawi, Tanzania)
+/-	Increase of fiscal deficit, full absorption. (Mauritius)		Debt reduction or bond sterilisation, full absorption. (Burkina Faso)
-	Increase of fiscal deficit, reduction of foreign reserves. (Lesotho, Botswana)	Possibly increases in spending paired with bond sterilisation, reduction of foreign reserves. (Uganda)	

Figure 1: Policy reactions to a 1 unit increase in aid



4.2 Outcomes

Table 4 reports the IRFs from the main specification of our *outcomes* system, that is, with monetary variables expressed in USD and all outcome variables transformed using the IHS transformation to approximate percentage changes. The results refer to a positive shock that corresponds to 10% of the average monthly inflow of aid. describes the IRFs to a 10% shock graphically, including the 95% and the 90% confidence intervals shaded in grey.

The main observation is that the effects of the aid shock on our macroeconomic variables tends to be moderate, and in many cases are not statistically different from zero at conventional levels. Given the prominence of the Dutch Disease argument in the debate, our main interest lies with the response of the REER to an aid inflow; point estimates suggest an REER appreciation in 7 out of the 10 countries in our sample. While the estimates suggest a relatively sizeable appreciation of 3.7% after 36 months on average, they reach statistical significance only in one case (Burkina Faso), and in individual periods after the shock in another three cases – month 0 for Ghana and Mauritius (the only one significant at 5%), and month 6 for Tanzania. In Botswana, Malawi and Uganda, the point estimates even suggest a depreciation following an aid surge, on average by 9.3% after 36 months. However, this average is heavily influenced by Uganda (the only significant case, at 5%, and only in month 0), and these results take unlikely magnitudes (so may be due to sample variance and scaling issues in the data). Overall, the impact of aid shocks on the exchange rate appears to be rather moderate, and only rarely reaches statistical significance.

According to the point estimates, the Treasury bill rate decreases following an aid surge in 7 of the countries, on average by 0.81% of its nominal value. This result is statistically significant at the 10% or 5% level in at least some of the periods following the shock in Burkina Faso, Burundi, Kenya and Lesotho. In Ghana, Tanzania and Uganda, our estimates suggest an increase in the interest rate, and this is statistically significant in Tanzania. With the exceptions of Burkina Faso (negative) and Tanzania (positive) there is little evidence that aid shocks have a significant effect on the interest rate.

In the vast majority (8) of the countries, the point estimates suggest that the impact of aid on the Balance of Trade is mostly negative (aid supports an increase in the trade deficit). The result reaches statistical significance only in four countries (Ghana, Malawi and Mauritius in month 0, Uganda throughout). Note that the numeric values of these IRFs tend to be relatively large, which is due to the nature of the variable: variations that are relatively minor compared to the overall volume of trade may represent a large share of the *Balance* of Trade (net exports). While this renders the specific values of the coefficients difficult to interpret, it is largely a matter of scaling and does not affect their sign or significance. A more ad hoc observation is that within the first year after an aid shock, there appears to be an increase in the variability of the trade balance in most of the countries in our sample (see Figure 4).

Table 4: IRFs of outcomes to aid shocks

10% Shock to aid															
	Botswana			Burkina Faso			Burundi			Ghana			Kenya		
Month	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT
0	-0.002	0.000	0.782	0.002	-0.007	2.715	**-0.014**	-0.005	-0.135	-0.006	*0.015*	**-10.443**	**-0.011**	0.001	-0.047
6	-0.004	-0.005	1.276	*-0.007*	**0.050**	-4.424	-0.012	0.035	-0.217	0.022	0.074	0.307	-0.008	0.000	-0.078
12	-0.004	-0.004	0.051	**-0.009**	**0.055**	-0.615	-0.016	0.024	0.128	0.014	0.062	-3.164	-0.006	0.002	-0.031
36	-0.004	-0.004	0.440	**-0.010**	**0.058**	-0.813	-0.015	0.011	0.100	0.009	0.055	-3.564	-0.007	0.002	-0.022
	Lesotho			Malawi			Mauritius			Tanzania			Uganda		
Month	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT	Interest	REER	BoT
0	*-0.003*	0.012	-1.069	-0.023	0.044	**-0.983**	-0.002	**0.010**	**-0.300**	**0.020**	0.007	-0.151	0.033	**-0.298**	**-8.868**
6	-0.007	0.075	-1.172	-0.027	-0.087	0.115	-0.001	0.005	-0.052	**0.041**	*0.081*	-0.187	0.124	-0.202	**-6.410**
12	-0.007	0.077	-0.883	-0.007	-0.029	0.294	0.000	0.010	-0.049	**0.031**	0.028	-0.094	0.157	-0.238	**-6.516**
36	-0.007	0.076	-0.728	-0.013	-0.052	0.342	-0.001	0.009	-0.038	**0.037**	0.045	0.000	0.147	-0.224	**-6.225**

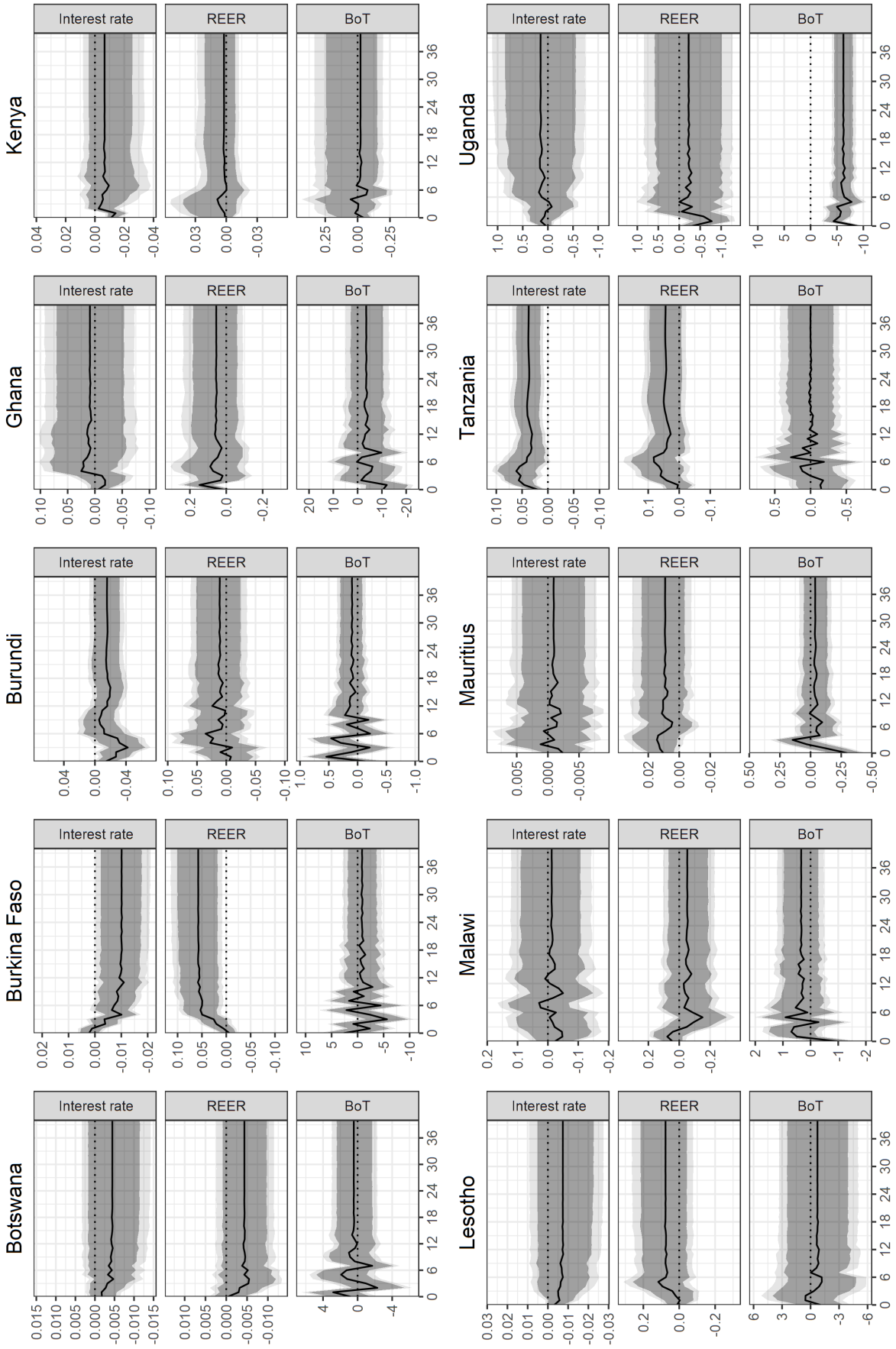
Notes : Values are point estimates of the IRF to an aid shock after 0, 6, 12 and 36 months; the shock is scaled to correspond to 10% of the average level of aid inflows of the respective country. The underlying specification is the *outcomes* specification, where the aid series is expressed in first differences, and Interestm REER and BoT in first differences of the inverse hyperbolic sine transformed series. Results in italics are significantly different from zero at the 10% level, bold ones at the 5% level.

Table 5: Key institutional features

	Transparency	CB Independence	ER Regime (de facto)
Botswana	0.35	0.52	Crawling band (USD/Rand)
Burkina Faso			Fixed (Euro)
Burundi	-	-	Crawling peg (USD)
Ghana	0.20	0.56	Crawling band/Managed float (USD)
Kenya	0.30	0.48	Crawling band (USD)
Lesotho			Fixed (Rand)
Malawi	-	-	Crawling band / Managed float (USD); Freely falling (2015-16)
Mauritius	0.20	-	Crawling band (USD)
Tanzania	0.25	0.53	Crawling band / Managed float (USD); Freely falling (2008-09)
Uganda	0.60	0.52	Crawling band / Managed float (USD)

Notes: Transparency and Central Bank independence are taken from Crowe and Maede (2008) and range from 0 (lowest) to 1 (highest). For scale, the average value of the transparency index is 0.32 in Africa and 0.47 for the rest of the World, CB Independence has an average of 0.49 in Africa and 0.63 in the rest of the World. De facto exchange rate regimes are those reported by Ilzetzki et al. (2017) for the countries during the sample period.

Figure 2: Response of outcome variables to a 10% aid shock



To set additional context before discussing the results, Table 5 provides some information on institutional features. Most countries had partially flexible exchange rate regimes, either crawling peg or managed ('free falling' in one year for two cases: Tanzania in the aftermath of the global financial crisis, and Malawi who drastically devalued the Kwacha to overcome major fuel shortages in 2015); only Burkina Faso and Lesotho had fixed peg regimes. The reported index, computed by Crow and Maede (2008), is based on four elements: appointment procedures for the head of the central bank, the resolution of conflict between the central bank and the executive branch of government, the use of an explicit policy target, and rules limiting lending to government. All countries in the sample had relatively low CB independence, on average 0.52 compared to an average value of 0.63 outside of Africa. Under these circumstances, government priorities are likely to restrict policy responses to some extent. As the values are very similar for all countries, this would not explain differences in responses. There is greater variability in the sample in terms of transparency, using the measure computed by Crowe and Mede (2008) to capture five dimensions of transparency (political, economic, procedural, policy, and operational). The level of this measure is, once more, generally low in our sample, with an average of 0.32 compared to a non-African average of 0.47. One implication is that it is difficult to observe policy decisions (e.g. limited information in quarterly reports). More generally, the combination of low independence and transparency suggests limited capability of the central bank to implement effective independent macroeconomic management.

4.3 *Interpretation of Results*

In six countries the coefficient on aid is positive (Table 4; Kenya is positive but effectively zero), consistent with the theoretical predictions that aid (surges) induce a real appreciation and may have Dutch Disease effects. In four of these countries the appreciation is significant (in at least one period): Burkina Faso, one of the two countries with a fixed exchange rate regime (see Table 5), Mauritius (in month 0 at 5% level), Ghana (month 0 at 10% level) and Tanzania (month 6 at 10% level). This suggests that in these countries the policy responses did not (fully) mitigate appreciation effects of aid, whereas in the other countries responses were more effective. This can be considered with reference to the theoretical literature (Section 2). Table 5 shows that the countries had relatively low CB independence (which may restrict policy responses) and transparency (so it is difficult to observe policy decisions), with varying degrees of ER management (mostly flexible, either pegged in a band or managed, with some cases of freely floating).

Burkina Faso was the only country with a significant positive coefficient which had a fixed exchange rate. The only significant policy reaction (Table 2) was a decline in claims; this does suggest sterilisation as there was no evident increase in M2 or reserves, while there is some indication of absorption (the trade deficit increased, albeit not significantly; Table 4). This is consistent with theories predicting a small appreciation under a fixed exchange rate and sterilisation plus (partial) absorption (e.g., Portillo *et al*., 2010). This may also apply to Lesotho, where the increase in REER is not significant: the only significant effects (in month 0 only) were a decrease in claims, increase in reserves and (at 10% level) decline in the interest rate; the absence of an increase in M2 and the deterioration in the trade balance (albeit insignificant) are consistent with (partial) sterilisation and absorption to mitigate any effect of an aid surge on the REER.

The other countries had flexible (albeit managed) exchange rates, so results from the *policy* and *outcomes* systems can be interpreted under such exchange rate scenarios. Sterilisation generally reduces the extent of appreciation. In the absence of full sterilisation, appreciation tends to be lower under a crawling peg (Adam *et al*., 2009), low elasticity of currency substitution (Buffie *et al*., 2008)

and sticky prices (O'Connell *et al*., 2009); the latter two, however, are not observed. As noted above, a reduction in CB claims against the government is an indicator of sterilisation, especially in the absence of a significant increase in money supply (M2). There are no obvious patterns in the data so it is appropriate to consider each country briefly.

The appreciation effect is significant in Mauritius (although only in the first period and the coefficient is small). Policy responses were not significant (and note that Mauritius had the lowest transparency score), but there was a tendency for claims, reserves and M2 to increase, suggesting at best limited stabilisation. The trade deficit deteriorated (significantly in the first period), suggesting absorption. This scenario of flexible regime, no sterilisation and reserve accumulation (with limited capital mobility) is consistent with predictions of medium appreciation effects in Berg *et al*. (2015). There is evidence of mild appreciation in Tanzania (significant at 10% level after six months) and of sterilisation as there was a significant decline in claims and in M2 (consistent with a significant increase in the interest rate). The effect of sterilisation may have been constrained by limited absorption as reserves increased and the trade deficit decreased, but neither were significant. Sterilisation may have been more effective in Burundi as claims decreased and M2 did not increase, although reserves increased significantly (which may be why the insignificant increase in the trade deficit was not sustained after month 6). In both cases, the combination of crawling peg and no (or at least partial) limited sterilisation is consistent with the prediction of small appreciation in Adam *et al*. (2009). The REER appreciation in Ghana is only significant in the first period (at 10%): claims increase (significantly in the first period), M2 (significant at 10% in month 6) and Reserves increase after a small (insignificant) initial decline. This suggests limited (if any) sterilisation; although Reserve accumulation suggests little absorption, the trade deficit increased (significantly in month). Ghana is the only country in the sample to have adopted inflation targeting, from May 2007 (Ilzetzki *et al*. 2017: Table 3), so perhaps other policy objectives took priority, but had the effect of mitigating appreciation effects (also, aid inflows in the form of grants were typically very low or zero after about 2012).

There was no evidence of appreciation in Botswana, Malawi and Uganda, where the coefficient was negative (only significant in Uganda), all of which had crawling peg or managed float. Uganda is the most interesting as the depreciation is significant. There may have been 'oversterilisation' as reserves decreased significantly (at 10% level) as did M2 (at 10% significance in month 0), although claims increased (but not significantly). There was a significant and apparently large deterioration in the trade deficit, suggesting (more than) full absorption, and interest rates increased (albeit not significant). This is similar to the scenario in Adam *et al*. (2009) where a combination of sterilisation and spending in full leads to depreciation under a managed exchange rate. Although spending is not included in our model, the results in Bwire *et al*. (2007) suggest that aid is mostly spent (using monthly data). Zanna *et al*. (2010) predict depreciation under a mix of spending but not absorbing with an increase in real interest rates; this is not fully supported by our results as there is absorption.

Malawi is consistent with Adam *et al*. (2009) and Zanna *et al*. (2010) if spending the aid is assumed (given the insignificant coefficient indicates the depreciation effect is at most weak): there is sterilisation as claims decline without any change in M2, but there is no evidence of absorption as reserves increase and the trade balance improves. Botswana is different: claims and money supply increase (suggesting an absence of sterilisation) but reserves decline and the trade balance improves (suggests absence of absorption). The only significant effect is on claims, so it would be inappropriate to try and over-interpret the results, beyond noting the lack of evidence for an appreciation effect.

5 THE RELATIVE IMPORTANCE OF AID SHOCKS

Our final exercise aims at assessing the relative importance of aid shocks on our main outcome of interest, the REER. In order to assess the relevance of foreign aid as a driver of the exchange rate and potential cause of Dutch disease, it is a natural question to ask what share of the variation in the REER is really down to aid shocks, compared to shocks originating from other drivers. Many aid recipients also rely heavily on only few export commodities, and global shocks to commodity prices are generally recognised to be a major factor in determining their exchange rate (O'Connell *et al*., 2006; Venables, 2016).

Table 6: The relative importance of shocks on the REER

	Botswana					Burkina Faso				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	15.5%	0.1%	0.0%	0.0%	84.5%	0.0%	0.5%	0.2%	0.0%	99.4%
6	25.8%	2.8%	5.2%	1.6%	64.7%	0.6%	7.4%	3.7%	7.9%	80.4%
12	27.5%	2.8%	5.6%	2.4%	61.8%	1.4%	7.4%	3.7%	8.7%	78.8%
∞	27.4%	2.8%	5.6%	2.5%	61.7%	1.4%	7.6%	3.8%	8.9%	78.3%
	Burundi					Mauritius				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	29.9%	0.0%	0.1%	0.0%	70.0%	0.0%	4.2%	5.8%	0.0%	89.9%
6	27.8%	3.4%	3.6%	6.7%	58.6%	12.7%	2.9%	6.8%	16.9%	60.7%
12	27.5%	5.7%	4.6%	8.1%	54.1%	14.7%	4.9%	11.5%	15.2%	53.7%
∞	27.0%	6.3%	4.8%	8.4%	53.5%	15.9%	5.3%	11.6%	14.8%	52.4%
	Ghana					Kenya				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	4.2%	0.1%	0.0%	0.0%	95.7%	0.6%	0.0%	0.3%	0.0%	99.1%
6	5.3%	12.9%	3.7%	2.8%	75.3%	2.4%	0.3%	4.8%	0.0%	92.5%
12	5.3%	12.8%	4.2%	3.6%	74.1%	3.6%	0.5%	5.4%	0.0%	90.5%
∞	5.3%	12.8%	4.2%	3.6%	74.1%	3.8%	0.5%	5.4%	0.0%	90.3%
	Lesotho					Malawi				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	1.6%	0.1%	0.1%	0.0%	98.2%	0.0%	0.2%	13.9%	0.0%	85.9%
6	3.0%	1.6%	5.4%	6.1%	83.9%	4.1%	5.3%	21.9%	3.9%	64.9%
12	8.7%	1.9%	6.3%	6.6%	76.4%	8.2%	5.5%	23.1%	5.4%	57.8%
∞	8.8%	1.9%	6.5%	6.7%	76.0%	9.4%	6.1%	22.7%	5.5%	56.2%
	Tanzania					Uganda				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	0.6%	0.1%	4.8%	0.0%	94.6%	0.4%	1.3%	0.2%	0.0%	98.1%
6	6.1%	2.3%	13.3%	2.2%	76.1%	2.3%	8.4%	3.6%	1.9%	83.9%
12	8.8%	2.9%	15.2%	3.8%	69.3%	6.2%	8.3%	4.9%	2.0%	78.6%
∞	9.1%	3.0%	15.8%	4.1%	68.0%	6.3%	8.4%	4.9%	2.1%	78.3%
	Median					**Mean**				
h	Comm.	Aid	Interest	BoT	Residual	Comm.	Aid	Interest	BoT	Residual
1	0.6%	0.1%	0.2%	0.0%	95.1%	5.3%	0.7%	2.5%	0.0%	91.5%
6	4.7%	3.2%	5.0%	3.3%	75.7%	9.0%	4.7%	7.2%	5.0%	74.1%
12	8.5%	5.2%	5.5%	4.6%	71.7%	11.2%	5.3%	8.4%	5.6%	69.5%
∞	9.0%	5.7%	5.5%	4.8%	71.1%	11.4%	5.5%	8.5%	5.7%	68.9%

In order to quantify the relative importance of commodity price shocks versus aid shocks, we compute forecast error variance decompositions of the REER at different time horizons. This quantifies the relative importance of the exogenous shocks to each of our variables on the REER at time $t + h$, compared to the forecast based on the information available at time t (averaged across all observations). Note that in order to compute this metric we slightly modify our outcomes system, that is, we include commodity prices in the endogenous vector y, instead of as a fully exogenous variable as previously. While this adds a number of parameters to be estimated and hence reduces the precision of our remaining estimates, it allows us to obtain a direct comparison of the relative importance of shocks. In line with the economic smallness of our countries, we put commodity prices first in our variable ordering, making them pure price takers in the short run (inverting the ordering between commodity prices and aid hardly has any numerical repercussions). The commodity price data are country-specific commodity price indices based on constant trade shares as computed by Eberhardt and Presbitero (2018).

The results in Table 6 suggest a substantial amount of heterogeneity between countries. While, in the long run (infinite horizon), in Botswana 27.4% of the unexpected fluctuations in the exchange rate are attributable to commodity price fluctuations against 2.8% for aid, these figures are 1.4% and 7.6% in Burkina Faso, respectively. In seven out of the 10 countries in our sample, commodity price fluctuations dominate those fluctuations emanating from aid shocks, typically by a substantial margin. On average across all 10 countries, the exercise suggests that 11.4% of unanticipated REER variation is driven by commodity prices versus 5.5% driven by aid. It is worth noting that this result is even more pronounced in the very short run, with commodity prices accounting on average for 5.3% of REER fluctuations versus 0.7% for aid, suggesting that commodity prices feed into the real exchange rate faster. Note also that the two other factors included in our system, the balance of trade and the interest rate, typically contribute a similar share to variations in the REER as foreign aid. On average across countries, commodity prices stand out as the main driver of the REER by quite some margin.

6 CONCLUSION

This study constructed a novel dataset of key fiscal and macroeconomic variables at a monthly frequency for 10 sub-Saharan African countries for the 2001 to 2017 (for two countries starting 2001; 2003-05 for three countries, and starting 2007 or 2008 for the other five). It employed country-specific time series analysis to investigate the monetary and macroeconomic dynamics induced by foreign aid inflows (represented by shocks equivalent to 10% of the average value of aid over the period).

The investigation consisted of two parts: first, we establish the typical policy response to aid inflows by recipient countries by estimating the impulse response functions of key policy variables (claims of the central bank on the central government, M2 and international reserves). Second, we estimated the trajectory of key outcomes following aid surges, namely the real exchange rate, the interest rate, and the balance of trade. Impulse responses are estimated for four periods: month 0, month 6, month 12 and month 36.

The coefficients for the effect of aid on the REER are positive for six countries, zero for one (Kenya), and negative for three. The negative (depreciation) estimate is only significant for Uganda. The positive (appreciation) estimate is only consistently significant for Burkina Faso (a country with a fixed exchange rate), and significant in one period only for Ghana, Mauritius and Tanzania. Generally the point estimates are insignificant (even at the 10% level) so it is reasonable to infer that aid is not associated with appreciation in most countries since the 2000s (the coefficient is not significantly

different from zero). The broad finding that aid is associated with appreciation is consistent with the theoretical literature, but the general insignificance of the effect suggests that countries are better able to accommodate aid shocks (mostly through sterilisation) than often assumed in theoretical models.

Most recipient countries employ aid inflows towards the accumulation of reserves at least to some degree, as well as towards the reduction of their budgetary deficit. The latter observation is empirically difficult to separate from another policy strategy of foreign aid management, that is, the sterilisation of foreign aid inflows via contractionary open market operations; looking at the evolution of money supply as an auxiliary information, it appears that this strategy is also widespread across recipient countries. Given the importance of the Dutch disease narrative in the theoretical literature, we consider the real exchange rate our main variable of interest, and indeed we mostly (but not exclusively) observe an appreciation following an increase in foreign aid. However, the amplitude of these appreciations is rather moderate and rarely reaches statistical significance at conventional levels. In contrast to a large part of the literature, our results suggest that in most cases, foreign aid inflows are followed by a decrease in interest rates. This is consistent with the observation that most countries appear to employ aid inflows towards deficit reduction at least to some degree.

In a final exercise, we quantified the importance of aid shocks versus those emanating from fluctuations in commodity prices using forecast error variance decomposition. The results suggest that while aid shocks do, in many countries, explain a sizeable share of REER fluctuations, commodity prices typically dominate the picture.

The main takeaway, however, is that there appears to be a large degree of heterogeneity both in how recipient countries manage their aid inflows, as well as in how this translates into macroeconomic outcomes. Generalising statements according to which foreign aid systematically undermines recipient countries' competitiveness obscure this heterogeneity, and ignore the variety of contexts and policy responses that shape the macroeconomic implications of aid inflows. Adam (2013) also concludes that the evidence that aid causes real exchange rate appreciation is weak, in part because actual aid surges are rarely large and in part because there are effective policy responses. That the concern still attracts considerable attention may be because 'the language of the Dutch Disease – the idea that an unrequited transfer may be welfare-reducing – continues to be commonly used as a metaphor for the wide range of political-economy concerns associated with aid surges' (Adam, 2013: p 7). Now that the magnitude of aid inflows is lower, and 'shocks' are typically mild, constructive policy analysis of the macroeconomics of aid can move on from Dutch Disease concerns.

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APPENDICES

A1. COMPARISON OF AID MEASURES

We use grants as reported by recipients on a monthly basis, whereas donors report aid on an annual basis. We annualise the monthly grants measure (MRS) to compare with for aid measures reported by donors on an annual basis:

Country Programmable Aid (CPA OECD),

Aid (ODA) commitments to countries and regions [DAC3a], from which we use only the amount of grants (henceforth: Grants Committed)

Aid (ODA) disbursements to countries and regions [DAC2a], from which we use only the amount of grants (henceforth: Grants Disbursed)

Net official ODA Aid (Net Aid, World Bank).

Table A1 reports the average ratios of our measure to the other four. MRS is closest to Grants Disbursed overall (1.14), and in 8 out of 10 countries (except Kenya and Mauritius), the mean for Grants Disbursed is the closest to one. MRS appears to overstate grants for Kenya and Mauritius, perhaps because the recipients include grants from non-DAC donors. In contrast, MRS appears to understate grants allocated to Burundi, Malawi and Tanzania. For the other five countries it is reasonably close (about 0.8 or above) to grants disbursed.

Table A1. MRS as a Ratio of Other Aid Measures

Country	MRS/CPA	MRS/Grants D	MRS/Grants C	MRS/Net Aid
Botswana	0.55	0.78	0.51	0.61
Burkina Faso	0.44	0.92	0.51	0.41
Burundi	0.33	0.51	0.27	0.24
Ghana	0.36	0.83	0.59	0.36
Kenya	1.18	1.76	1.39	1.16
Lesotho	0.48	1.01	0.61	0.53
Malawi	0.33	0.54	0.31	0.30
Mauritius	0.96	4.06	1.51	2.55
Tanzania	0.38	0.58	0.46	0.34
Uganda	0.66	1.01	0.79	0.60
Average	0.58	**1.14**	0.70	0.68

Notes: Our monthly grants data are annualized (MRS) and the calculated as a ratio of the other aid measures for each year. Reported country averages are the mean ratio for available years, and the overall average is the mean of all country years.

A2. DUMMIES ACCOUNTING FOR OUTLIERS

Country	Date	Type of outlier	Notes
Botswana	2005:06	REER drop	12 percent nominal devaluation of the Pula.
Botswana	2013:03	Aid surge	Uncommented in bank reports, odd entry. No unusual behaviour of other variables.
Botswana	2015:03	M2 surge	Generally loose monetary policy, potentially measurement issue.
Burundi	2007:12	Aid surge	Debt write-off by Central Bank.
Burundi	2012:01	REER surge	Debt write-off by Central Bank.
Ghana	2015:06	Aid surge	Unusually large disbursment (~7SD).
Kenya	2004:01	BoT drop	Uncommented in CB reports. Likely adjustments at the beginning of the year.
Kenya	2005:01	BoT surge	Uncommented in CB reports. Likely adjustments at the beginning of the year.
Kenya	2014:06	Reserves surge, Claims drop	Sale of the USD 2 billion sovereign bond in international financial markets.
Kenya	2015:11	Interest drop	Coincides with IMF Stand-By Arrangement.
Malawi	2012:05	REER drop	President Mutharika dies; successor Joyce Banda devalues currency to satisfy IMF requirements.
Mauritius	2012:11	Aid surge	Unusually large disbursment (~4SD).
Mauritius	2009:11	Aid surge	Unusually large disbursment (~4SD).
Tanzania	2011:05	M2 surge	Not reflected in CB report, probably measurement issue (ca. 9SD outlier).
Uganda	2008:01	Aid drop, BoT surge	Likely adjustments to BoT at beginning of the year, coinciding with unusually large aid disbursment (influential).

A3 AUGMENTED DICKEY-FULLER TEST

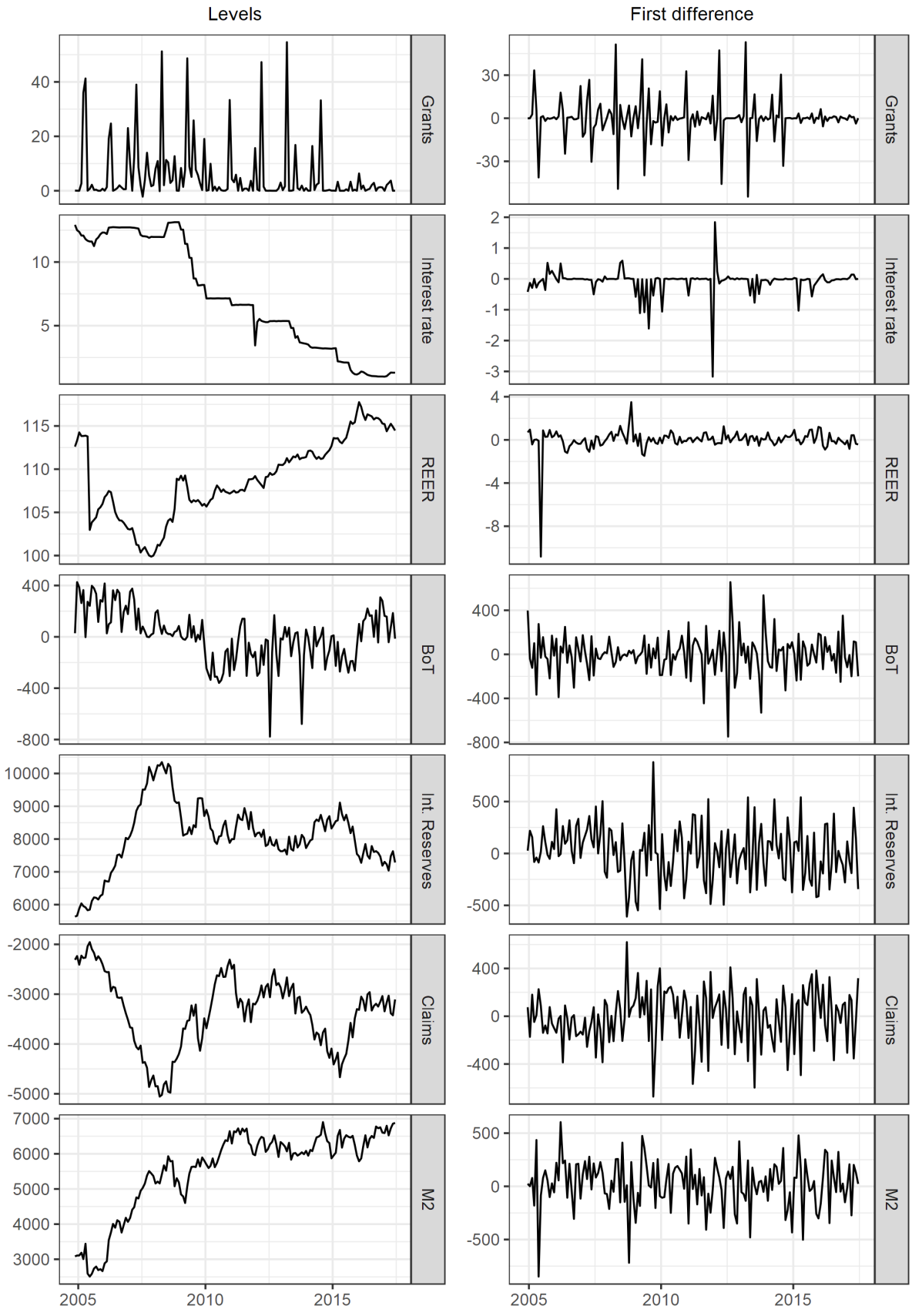
		Levels				First Difference			
Country	Series	Trend	Test stat.	5% CV	Unit Root	Trend	Test stat.	5% CV	Unit Root
Botswana	Grants	Trend	-6.15	-3.43	No	None	-7.24	-1.95	No
	Interest	None	-1.50	-1.95	Yes	None	-3.23	-1.95	No
	REER	Trend	-6.16	-3.43	No	None	-8.73	-1.95	No
	BoT	None	-2.22	-1.95	No	None	-5.62	-1.95	No
	Reserves	Drift	-3.20	-2.88	No	Trend	-4.37	-3.43	No
	Claims	Drift	-3.39	-2.88	No	None	-3.46	-1.95	No
	M2	Drift	-2.47	-2.88	Yes	None	-4.90	-1.95	No
Burkina Faso	Grants	Drift	-4.63	-2.88	No	None	-5.85	-1.95	No
	Interest	None	-0.21	-1.95	Yes	None	-3.55	-1.95	No
	REER	None	-3.55	-1.95	No	None	-3.08	-1.95	No
	BoT	Drift	-3.08	-2.88	No	None	-5.07	-1.95	No
	Reserves	Drift	-3.15	-2.88	No	None	-5.23	-1.95	No
	Claims	None	-1.13	-1.95	Yes	None	-5.42	-1.95	No
	M2	Trend	-3.49	-3.43	No	None	-3.53	-1.95	No
Burundi	Grants	Drift	-4.68	-2.88	No	None	-6.82	-1.95	No
	Interest	Drift	-1.93	-2.88	Yes	None	-5.74	-1.95	No
	REER	Trend	-2.61	-3.43	Yes	None	-3.80	-1.95	No
	BoT	Drift	-2.04	-2.88	Yes	None	-5.54	-1.95	No
	Reserves	Trend	-1.40	-3.43	Yes	Trend	-1.40	-3.43	Yes
	Claims	Trend	-1.40	-3.43	Yes	None	-4.66	-1.95	No
	M2	Trend	-2.99	-3.43	Yes	None	-2.65	-1.95	No
Mauritius	Grants	Drift	-5.52	-2.88	No	None	-6.10	-1.95	No
	Interest	Drift	-4.02	-2.88	No	None	-4.18	-1.95	No
	REER	Trend	-2.52	-3.43	Yes	None	-3.68	-1.95	No
	BoT	Drift	-2.17	-2.88	Yes	None	-5.42	-1.95	No
	Reserves	Trend	-2.25	-3.43	Yes	None	-2.98	-1.95	No
	Claims	None	-2.98	-1.95	No	None	-3.69	-1.95	No
	M2	Trend	-2.73	-3.43	Yes	None	-3.20	-1.95	No
Ghana	Grants	Trend	-4.14	-3.43	No	None	-6.62	-1.95	No
	Interest	None	-1.17	-1.95	Yes	None	-2.98	-1.95	No
	REER	None	-0.53	-1.95	Yes	None	-4.73	-1.95	No
	BoT	None	-2.71	-1.95	No	None	-3.72	-1.95	No
	Reserves	Drift	-2.55	-2.88	Yes	None	-3.87	-1.95	No
	Claims	None	-0.66	-1.95	Yes	None	-2.38	-1.95	No
	M2	Drift	-1.97	-2.88	Yes	None	-3.75	-1.95	No
Kenya	Grants	None	-3.15	-1.95	No	None	-8.26	-1.95	No
	Interest	Drift	-3.52	-2.88	No	None	-4.90	-1.95	No
	REER	Trend	-2.54	-3.43	Yes	None	-5.67	-1.95	No
	BoT	None	-5.67	-1.95	No	None	-6.24	-1.95	No
	Reserves	None	-6.24	-1.95	No	None	-4.38	-1.95	No
	Claims	None	-4.38	-1.95	No	None	-6.32	-1.95	No
	M2	Trend	-2.62	-3.43	Yes	None	-3.51	-1.95	No
Lesotho	Grants	None	-0.97	-1.95	Yes	None	-6.59	-1.95	No
	Interest	None	-0.43	-1.95	Yes	None	-3.32	-1.95	No
	REER	Drift	-1.24	-2.88	Yes	None	-4.84	-1.95	No
	BoT	None	-0.96	-1.95	Yes	None	-4.88	-1.95	No
	Reserves	Drift	-2.65	-2.88	Yes	Trend	-4.98	-3.43	No
	Claims	Drift	-2.16	-2.88	Yes	Trend	-5.02	-3.43	No
	M2	Drift	-1.99	-2.88	Yes	None	-4.71	-1.95	No
Malawi	Grants	Trend	-3.74	-3.45	No	None	-5.61	-1.95	No
	Interest	None	-5.61	-1.95	No	None	-3.67	-1.95	No
	REER	Drift	-1.65	-2.89	Yes	None	-4.05	-1.95	No
	BoT	Drift	-2.81	-2.89	Yes	None	-5.94	-1.95	No
	Reserves	None	-5.94	-1.95	No	None	-3.81	-1.95	No
	Claims	Trend	-2.58	-3.45	Yes	None	-3.48	-1.95	No
	M2	Drift	-2.19	-2.89	Yes	None	-3.91	-1.95	No
Tanzania	Grants	Drift	-4.96	-2.88	No	None	-7.58	-1.95	No
	Interest	Drift	-2.25	-2.88	Yes	None	-5.72	-1.95	No
	REER	Trend	-2.18	-3.43	Yes	None	-5.52	-1.95	No
	BoT	None	-5.52	-1.95	No	None	-4.25	-1.95	No
	Reserves	Drift	-1.44	-2.88	Yes	None	-4.57	-1.95	No

	Claims	Trend	-2.03	-3.43	Yes	None	-5.01	-1.95	No
	M2	Drift	-0.78	-2.88	Yes	None	-3.11	-1.95	No
Uganda	Grants	None	-0.16	-1.95	Yes	None	-5.57	-1.95	No
	Interest	Drift	-3.91	-2.88	No	None	-4.57	-1.95	No
	REER	Trend	-3.29	-3.43	Yes	None	-5.32	-1.95	No
	BoT	None	-0.06	-1.95	Yes	None	-6.18	-1.95	No
	Reserves	Drift	-1.19	-2.88	Yes	None	-3.52	-1.95	No
	Claims	None	-0.58	-1.95	Yes	None	-4.34	-1.95	No
	M2	Drift	-0.76	-2.88	Yes	None	-3.71	-1.95	No

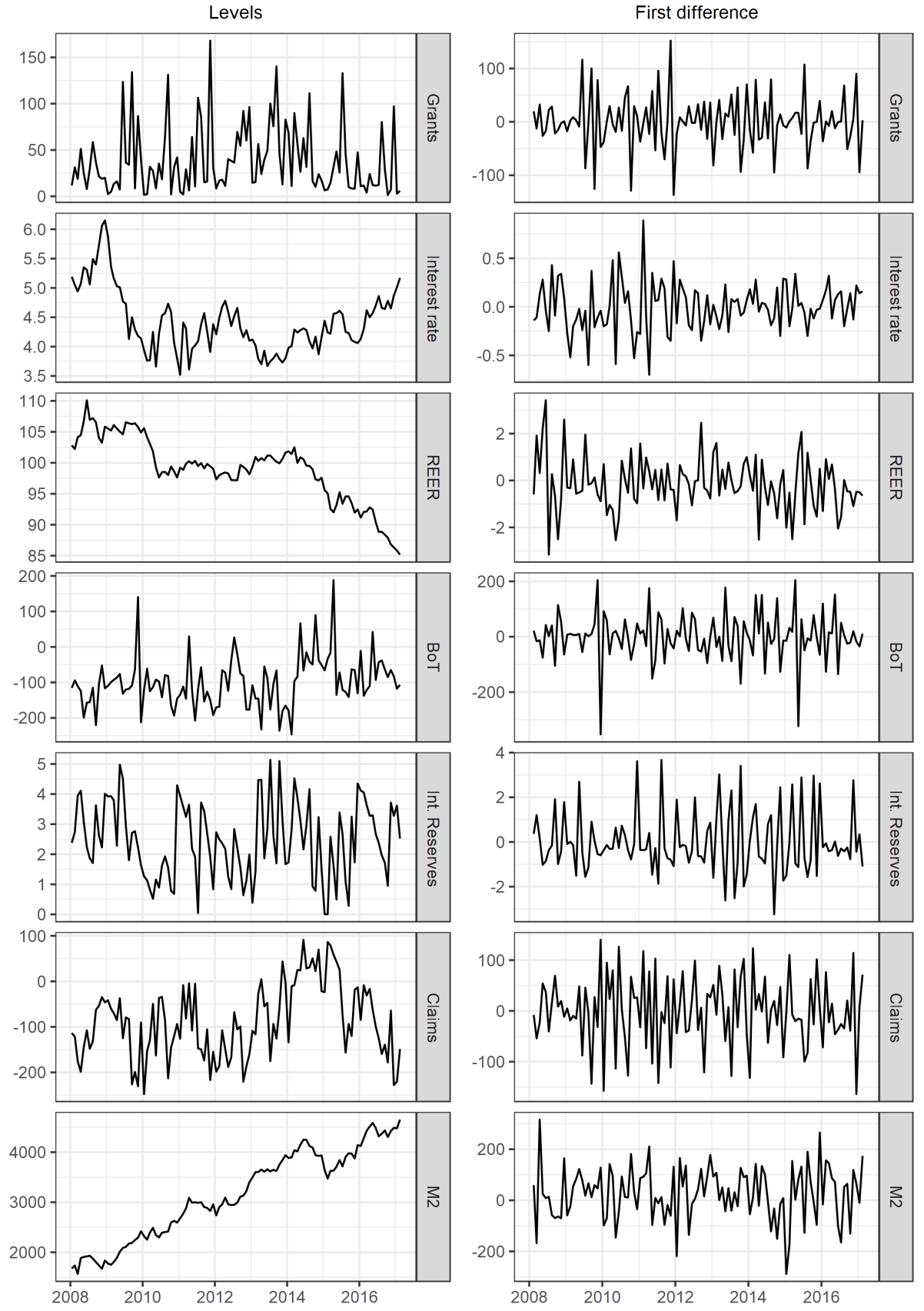
Notes: Test results are based on series in levels / first differences without further transformations. Results based on HIS / log-transformed series are qualitatively similar and can be obtained from the authors upon request.

A4 PLOTS OF THE SERIES IN LEVELS AND FIRST DIFFERENCES

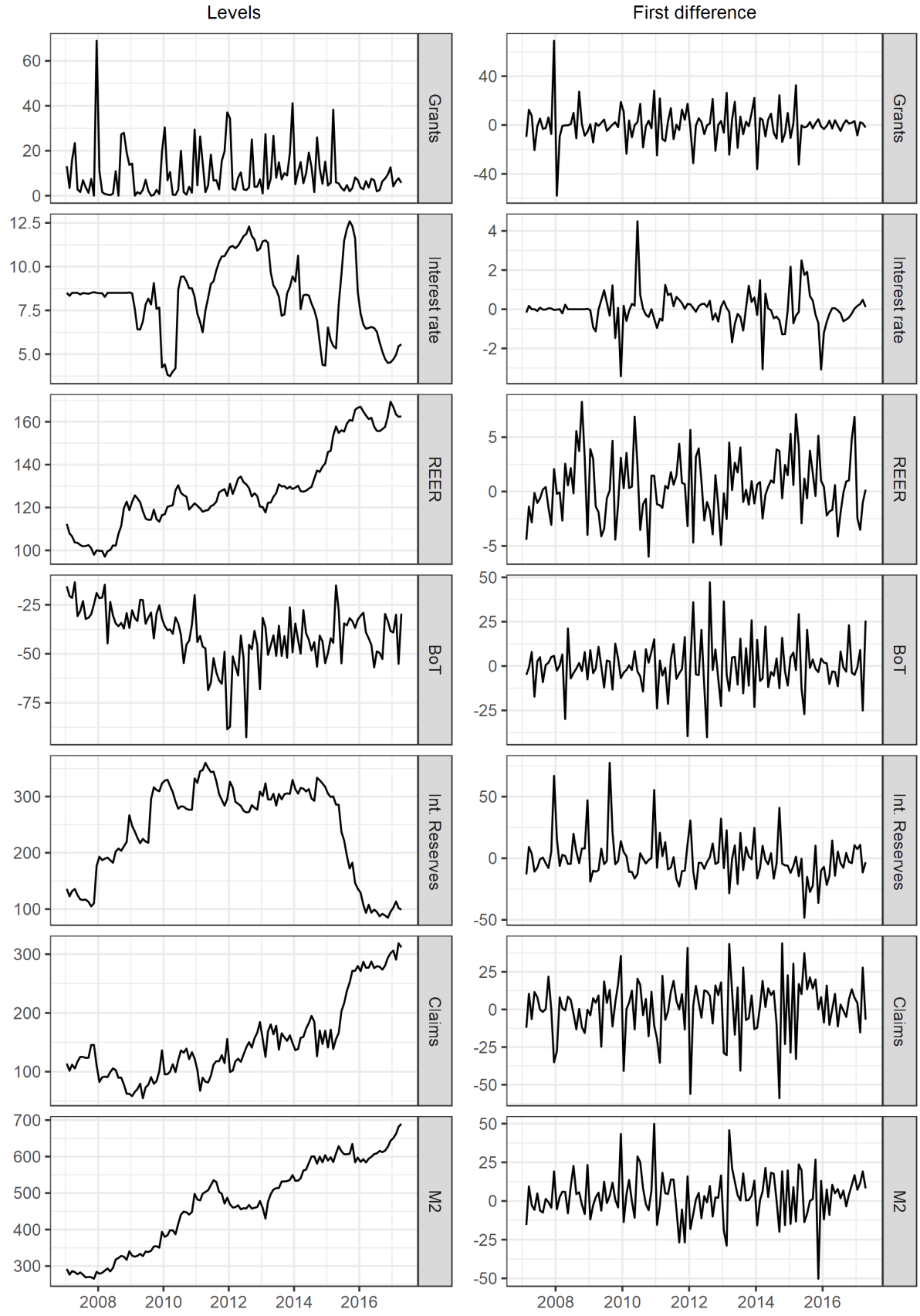
Botswana


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2005
2010
2015

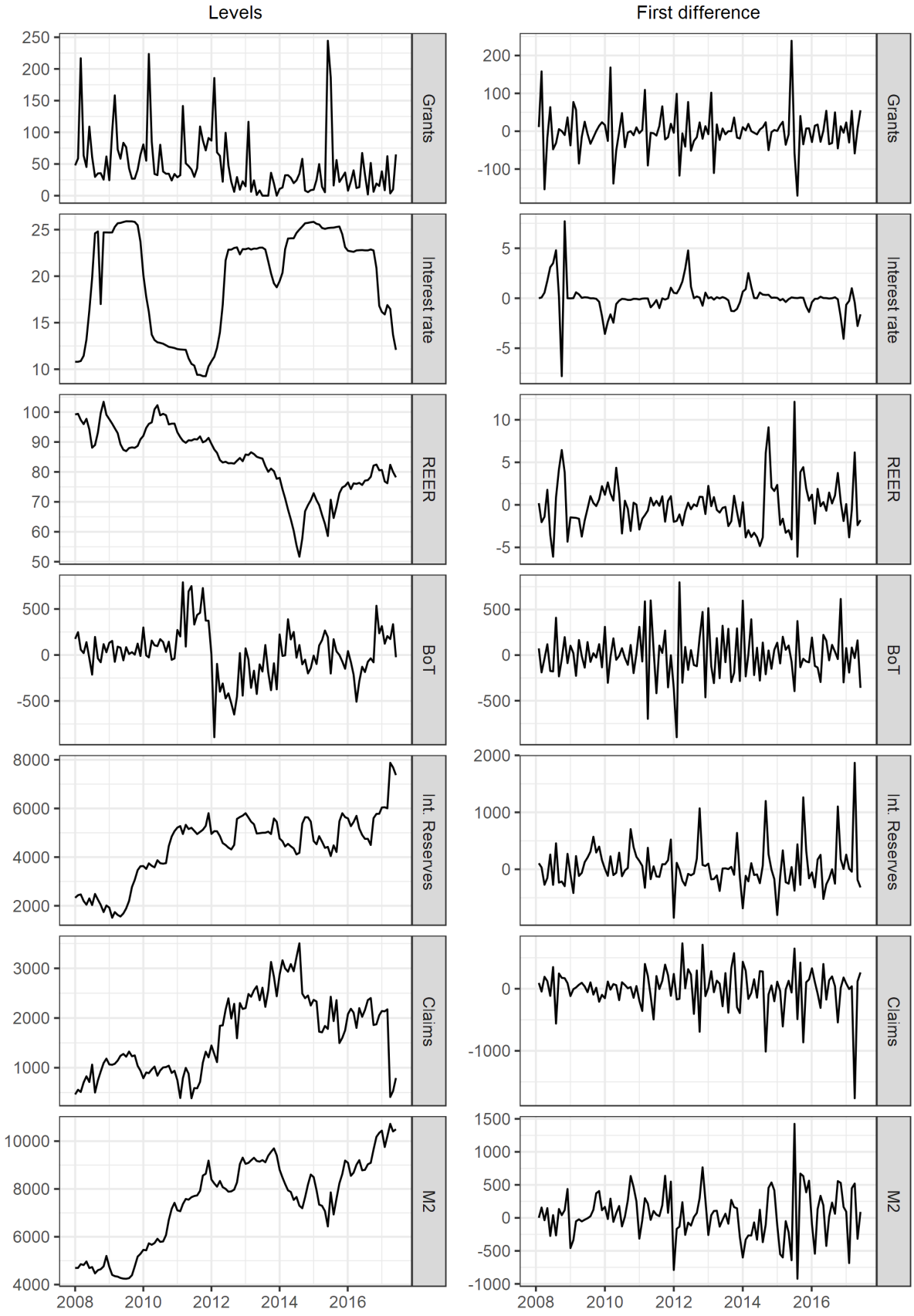
Burkina Faso



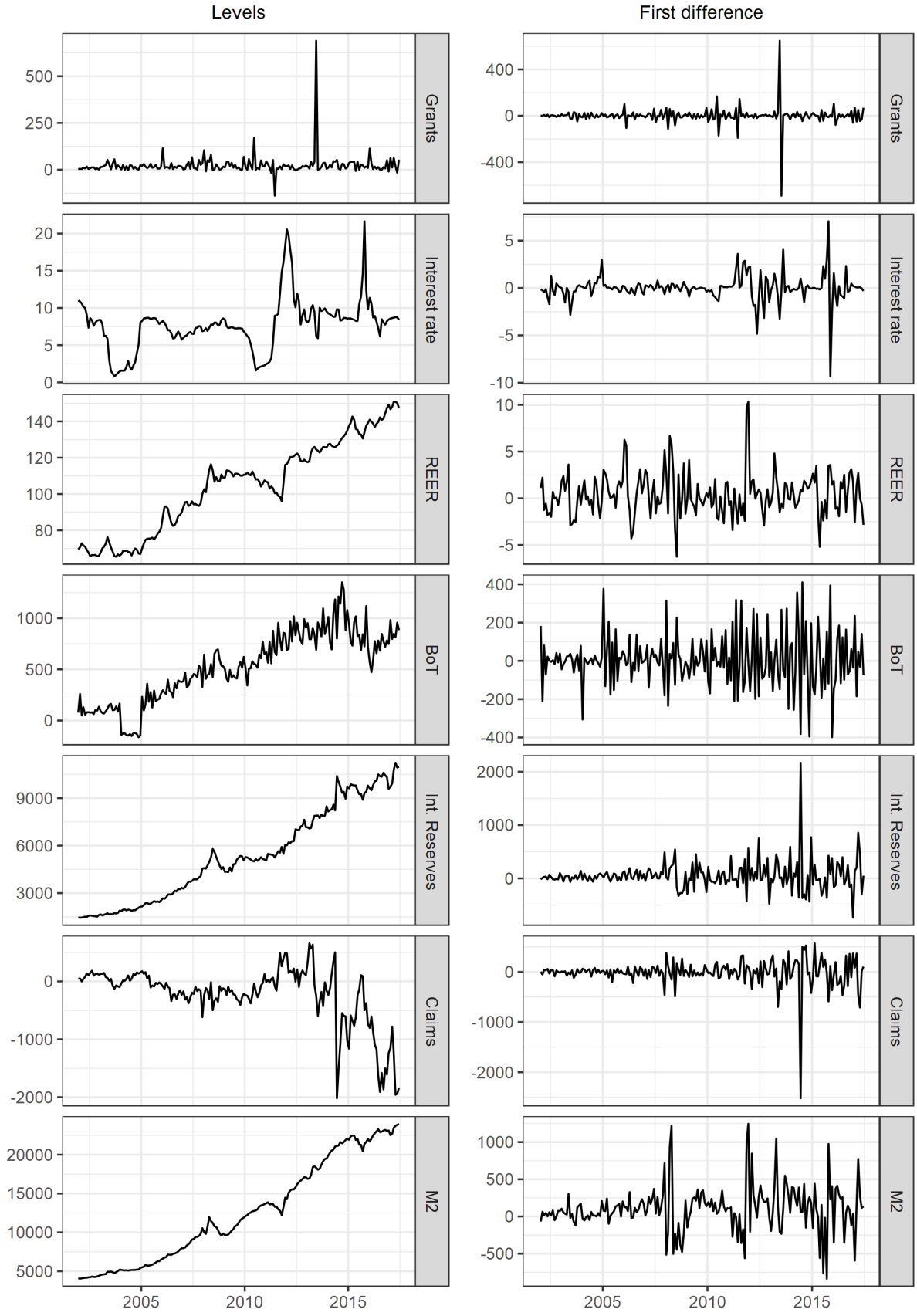
Burundi


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2008
2010
2012
2014
2016

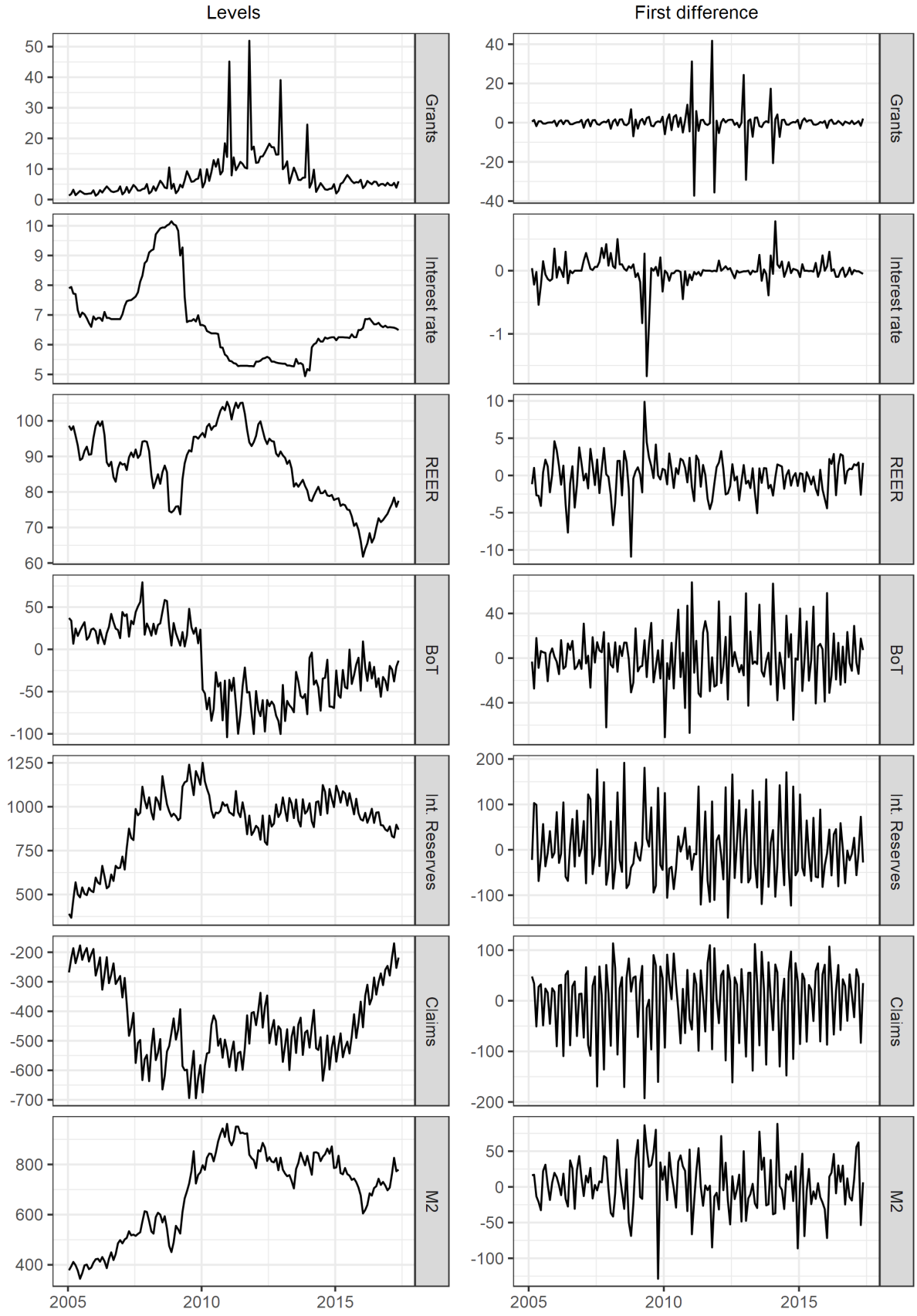
Ghana


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2008
2010
2012
2014
2016

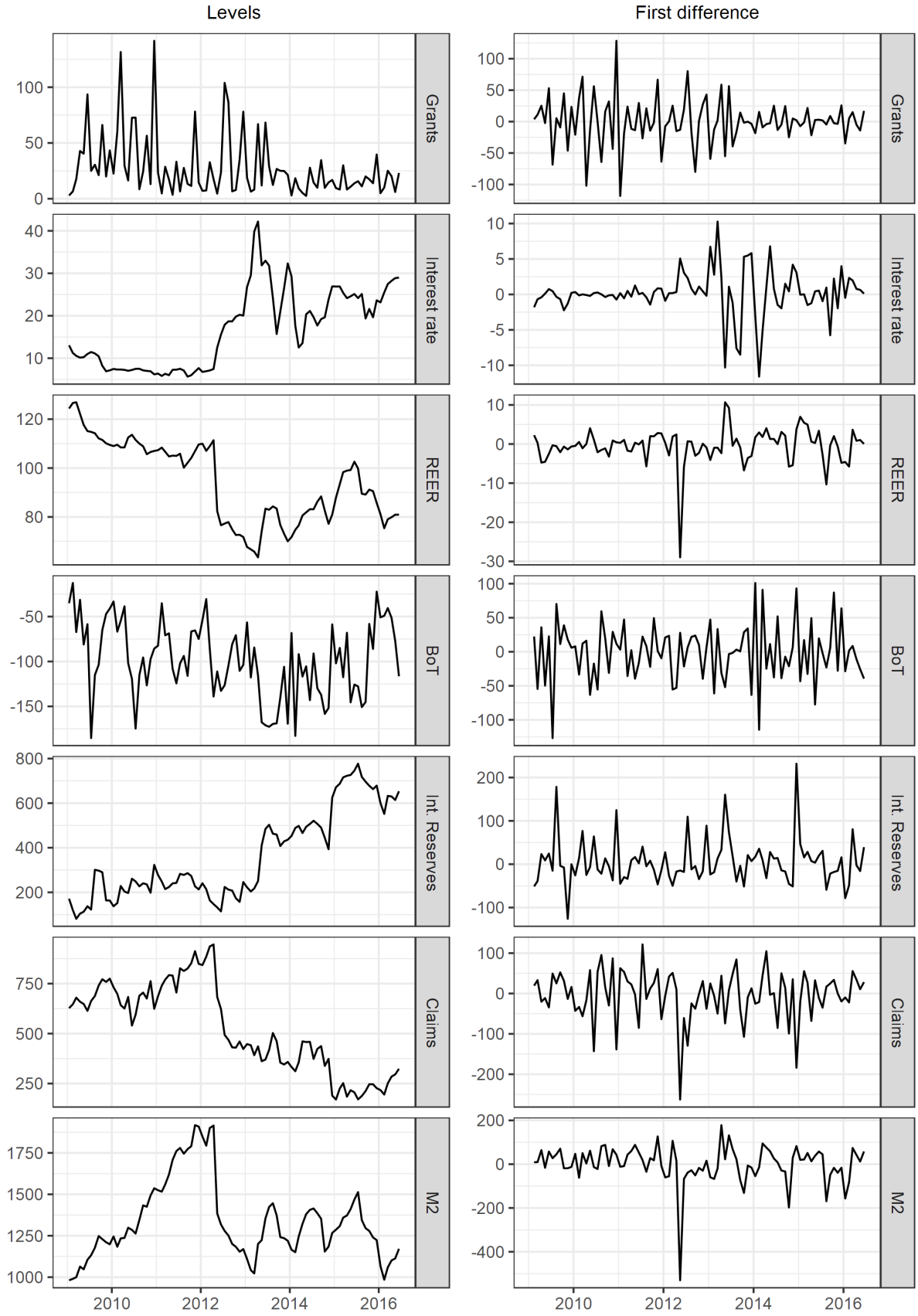
Kenya


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2005
2010
2015

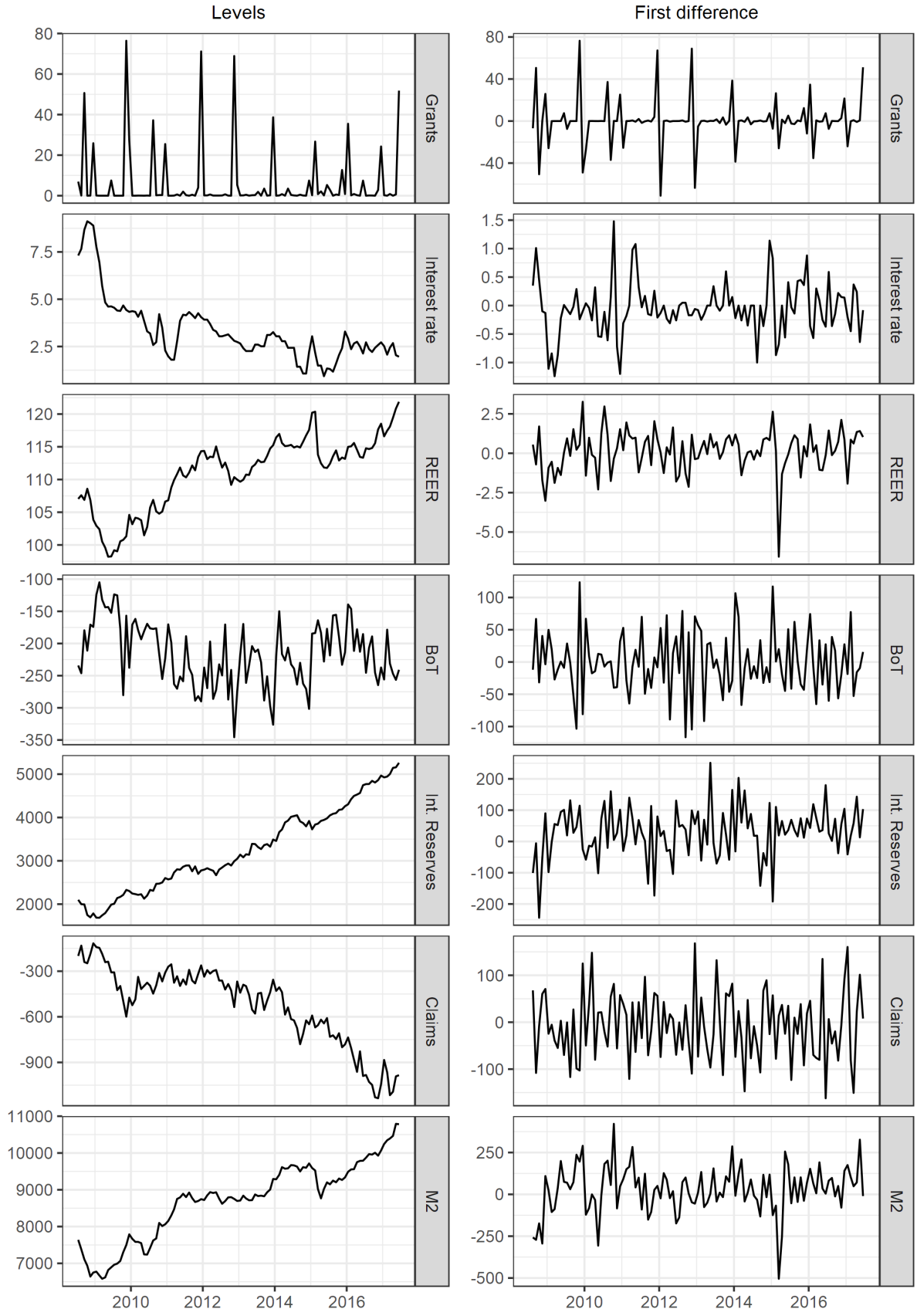
Lesotho


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2005
2010
2015

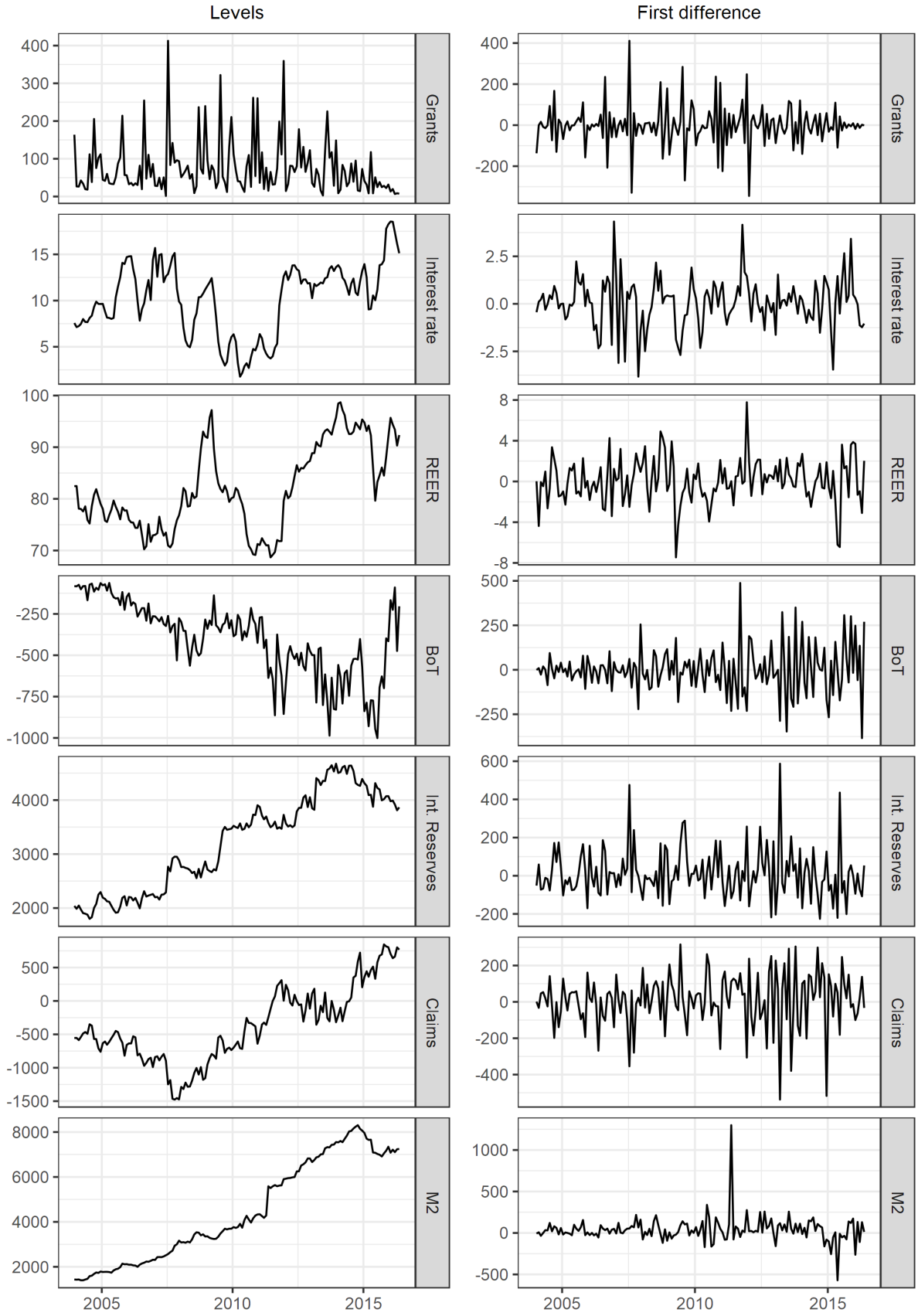
Malawi


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2010
2012
2014
2016

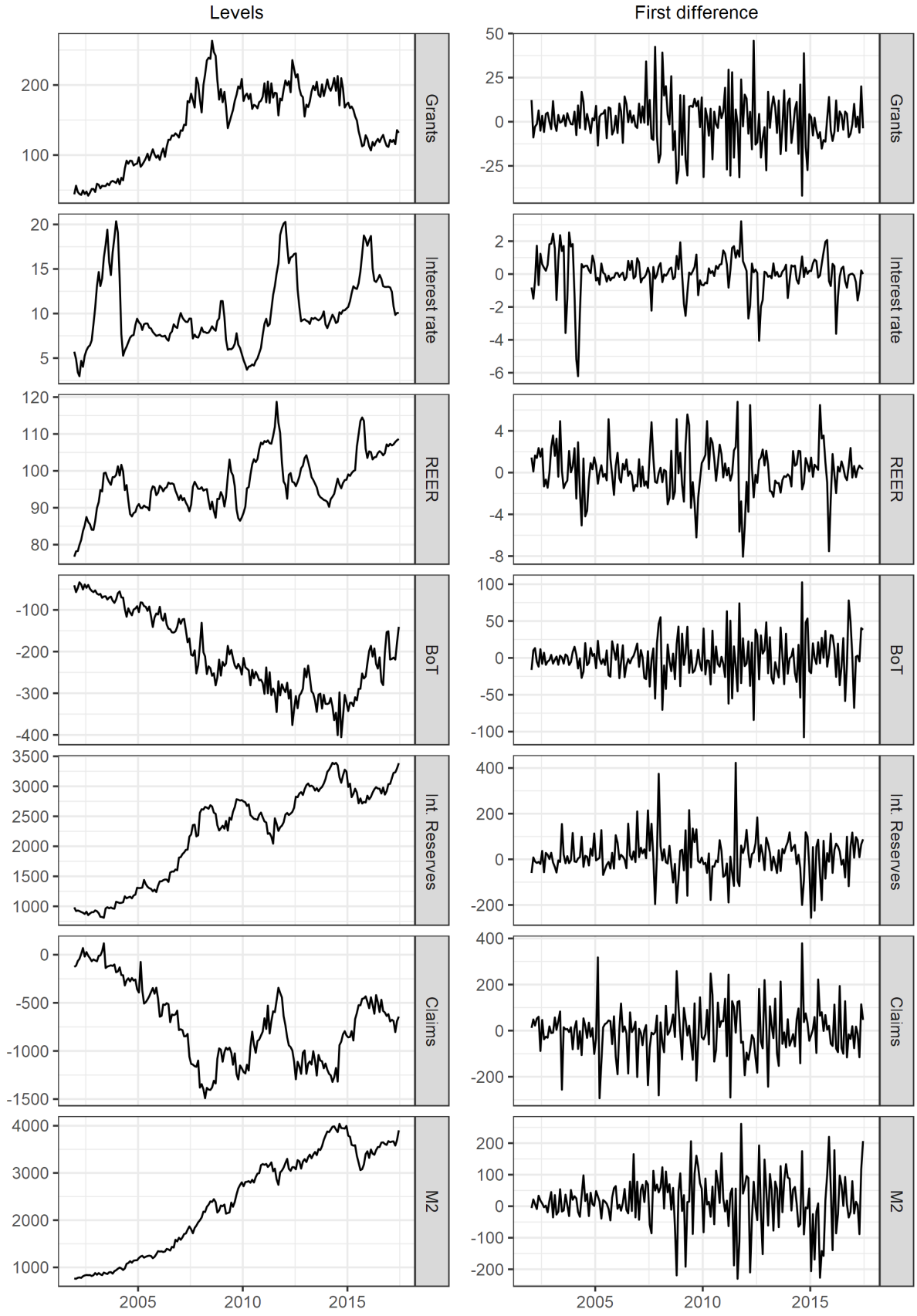
Mauritius


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2010
2012
2014
2016

Tanzania


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2005
2010
2015

Uganda


Levels
First difference
Grants
Interest rate
REER
BoT
Int. Reserves
Claims
M2
2005
2010
2015

A5 ALTERNATIVE SPECIFICATIONS

Figure 3: Policy reactions to a 1 unit increase in aid (USD)

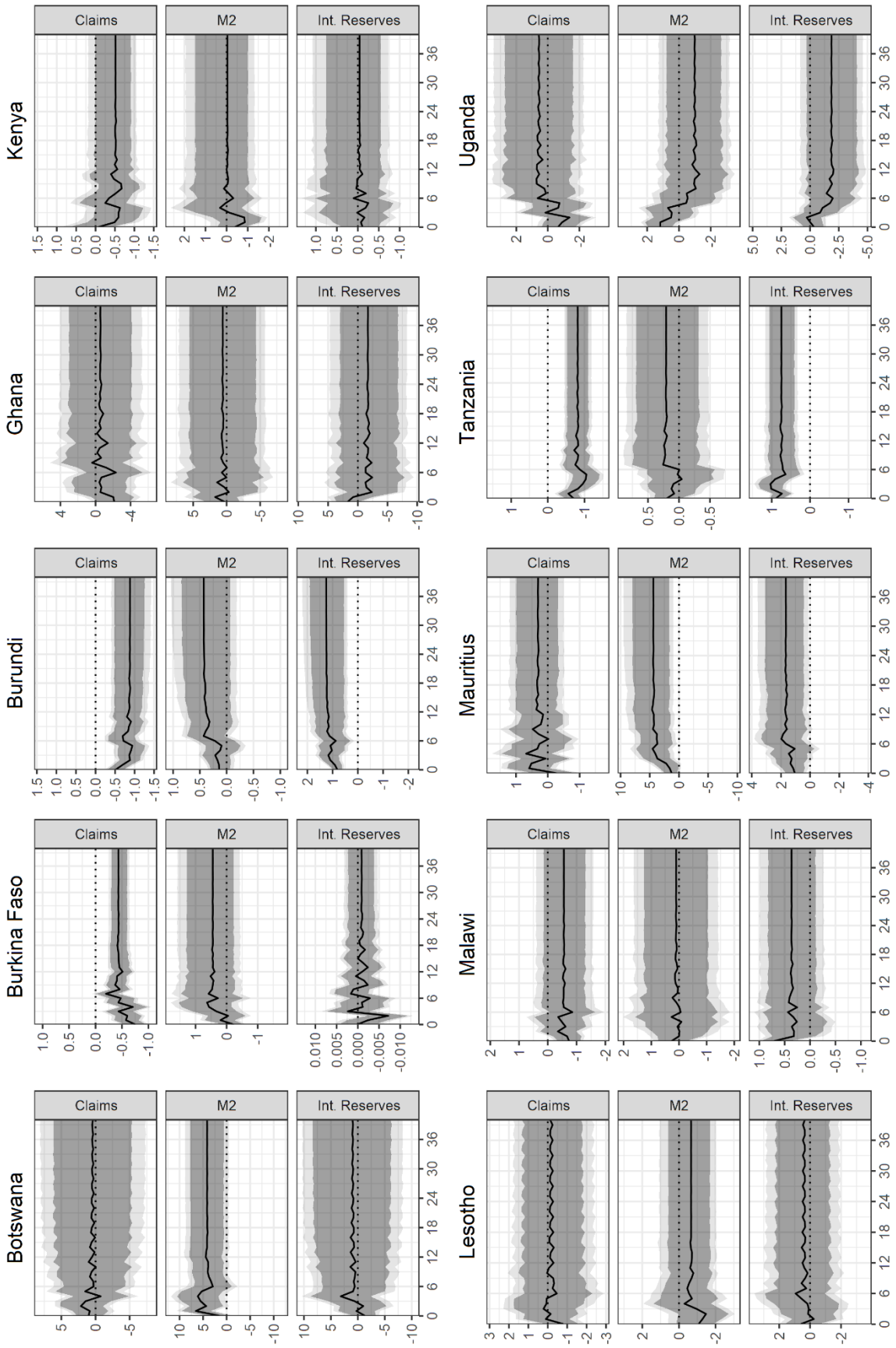
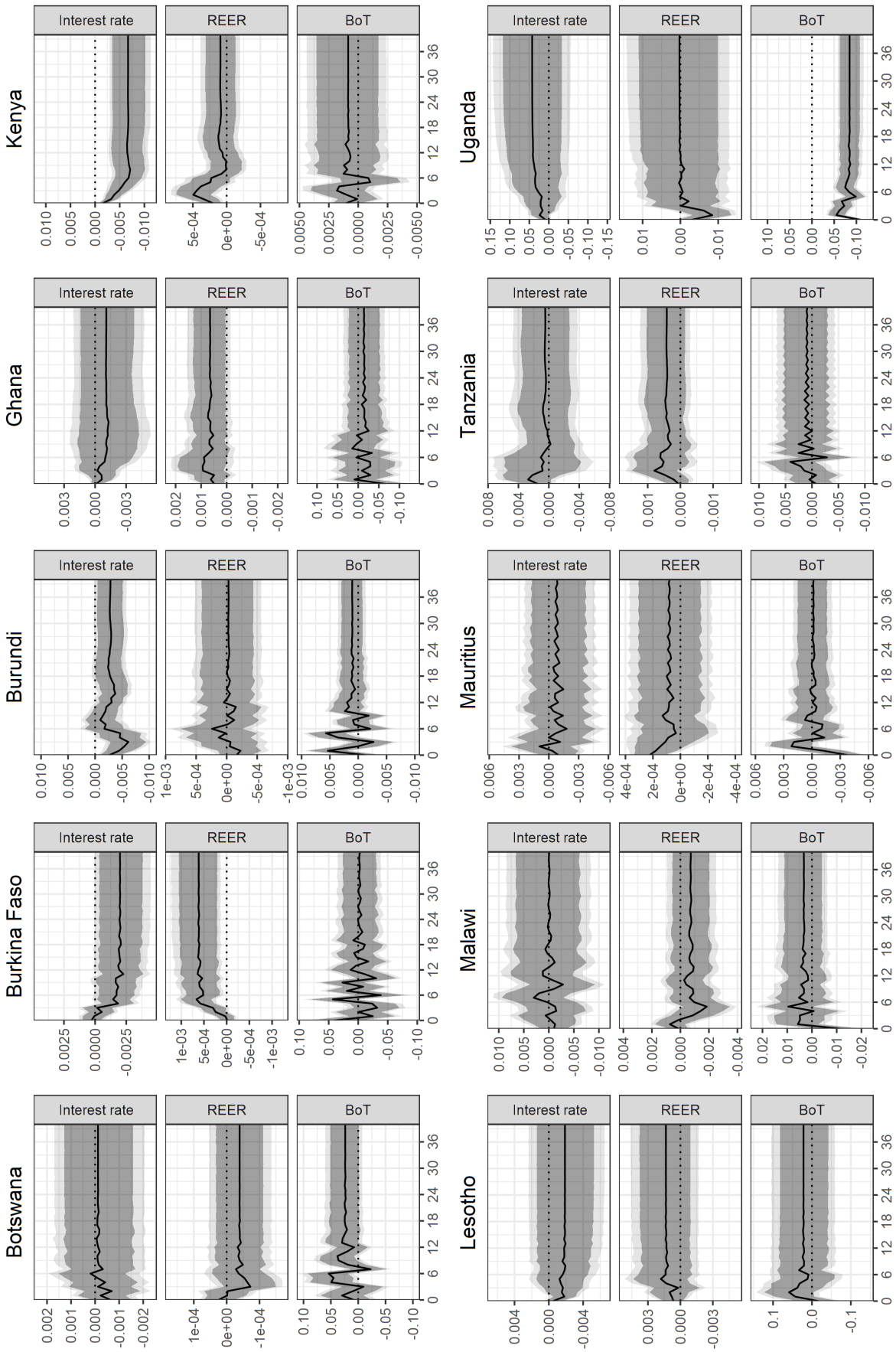

Kenya
Uganda
Ghana
Tanzania
Burundi
Mauritius
Burkina Faso
Malawi
Botswana
Lesotho
Claims
M2
Int. Reserves

Figure 4: Response of outcome variables to a 10% aid shock (Inverse hyperbolic sine)


Kenya
Ghana
Burundi
Burkina Faso
Botswana
Uganda
Tanzania
Mauritius
Malawi
Lesotho
Interest rate
REER
BoT
0 6 12 18 24 30 36