This is the peer reviewed version of the following article:


which has been published in final form at

https://doi.org/10.1111/jmcb.12658

This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions.

© 2019 The Ohio State University
On the Relationship Between Domestic Savings and the Current Account: Evidence and Theory for Developing Countries*

Markus Brueckner, Wojtek Paczos, and Evi Pappa

September 14, 2018

Abstract: We examine the relationship between domestic savings and the current account in developing countries. Our three main findings are that in developing countries domestic savings have: (i) a small effect on the current account; (ii) a significant positive and quantitatively sizable effect on the trade balance; (iii) a significant negative effect on net-current transfers. We show that these findings hold in developing countries across different regions in the world. In order to give the results a causal interpretation, we use countries in the sub-Saharan African region as a laboratory for an instrumental variables approach. The IV approach exploits the significant positive effect of plausibly exogenous year-to-year variations in rainfall on domestic savings. We provide a small open economy model with financial frictions and altruistically motivated net current transfers to rationalize our empirical findings.

Keywords: Feldstein-Horioka Puzzle, Domestic Saving, Current Account, Transitory Shocks, Net Current Transfers, Exports, Small Open Economy Model, Financial Frictions

*Research School of Economics, Australian National University (Brueckner); Cardiff University (Paczos); Universidad Carlos III de Madrid and CEPR (Pappa). Contact e-mail: markus.brueckner@anu.edu.au; ppappa@eeco.uc3m.es. We would like to thank two anonymous referees and the editor for thoughtful comments that substantially improved this paper.
1 Introduction

The effect that domestic savings have on the current account is an important topic in open economy macroeconomics. At least since Feldstein and Horioka (1980), there has been a vast amount of research done on this topic. Yet, despite the vast amount of both empirical and theoretical research, one of the key issues that the literature struggles with is how to interpret and compare the empirical findings to the predictions from macroeconomic models (see, for example, Obstfeld, 1985; Obstfeld and Rogoff, 1995). This is because empirical research based on correlations between domestic saving and the current account makes it difficult to distinguish what types of shocks are driving the change in domestic savings. For example, are these permanent or transitory shocks; demand or supply-side shocks; anticipated or unanticipated? Moreover, in the cross-section of countries, where over long time-periods cross-sectional differences reflect primarily permanent relationships, there could be third factors that lead to a large positive correlation between domestic saving and investment. For example, cross-country differences in home-country investment bias, taxation, or demographic factors; some of which are difficult to measure in the data.

The fact that correlations are silent about what types of shocks are driving the variation in domestic saving is a key problem for relating the empirical results to predictions from theoretical models. This is because, in all theoretical models, one has to make assumptions about the types of shocks that are causing the change in domestic saving. Another key problem, that is perhaps more obvious, but nevertheless equally important for estimation purposes, is that the variation in domestic saving is not necessarily driven by exogenous factors. For example, there could be changes in economic policies that induce changes in domestic saving – and these changes in economic policies may arise precisely because political leaders perceive it as beneficial to stimulate domestic investment or, say, reduce a current account imbalance.

To circumvent these problems, we use in this paper year-to-year variations in rainfall to study how a transitory, exogenous, and unanticipated shock to aggregate output affects the relationship between domestic saving and the current account. We do this for a panel of 41 sub-Saharan African countries during the period 1980-2009. We focus on the group of sub-Saharan African countries because agriculture constitutes an important sector in these economies: the average agricultural GDP share is about one-third, and over two-thirds of the population are employed in agriculture (WDI, 2011). It is well documented that year-to-year variations in rainfall have a significant positive effect on sub-Saharan African countries year-to-year GDP growth (e.g. Miguel et al. 2004, Brückner and Ciccone, 2011). The novelty in this paper is to realize that because rainfall is a transitory shock to output, the permanent income hypothesis predicts that domestic saving should respond significantly to this shock as well. Indeed our panel data estimates yield a highly significant and positive effect of year-to-year rainfall on the domestic saving rate. A one percent above country-mean increase in the level of rainfall increases the domestic saving rate by around...
In the empirical part of our paper we pursue two complementary estimation strategies to study the relationship between a transitory shock to output that induces a significant change in domestic saving and the current account. The first estimation approach is an instrumental variables approach. In this estimation approach we use rainfall as an instrument for domestic saving. The main finding from the instrumental variables analysis is that changes in the domestic saving rate have a quantitatively small and statistically insignificant effect on the current account (also scaled by GDP). Controlling for country fixed effects, country-specific linear time trends, and year fixed effects the coefficient on the domestic saving rate in the current account equation is around 0.04 with a standard error of around 0.23.

An important economic feature of developing countries is the role of net current transfers as a source of external finance. For the average sub-Saharan African country during the 1980-2009 period net current transfers amounted to nearly 8 percent of GDP. In this context, it is useful to recall that the current account is the sum of net exports, net current transfers, and net factor income. During the 1980-2009 period the average sub-Saharan African country had a current account deficit of 5 percent, but the trade deficit was larger amounting to over 11 percent of GDP.

When we look at the components of the current account, we find that the net export response to the change in the domestic saving rate is positive and significant. The instrumental variables analysis yields a coefficient in the net export equation on the domestic saving rate that is around 0.54 (standard error 0.28). On the other hand, for the net current transfer equation IV estimation yields a negative and significant coefficient on the domestic saving rate of around -0.61 (standard error 0.28). Hence, the significant positive response of net exports to the change in the domestic saving rate gets closer to the predictions from basic models of the intertemporal approach to the current account; however, the overall current account response is far off.

We develop a small open economy model of an aid-dependent country using a one sector, growth model with frictions in the international capital markets. The economy faces transitory and persistent rainfall shocks, and transitory productivity and interest rate shocks and receives an endogenous transfer of tradable goods known as aid. Following Carter et al. (2015) the dynamic aid allocation is postulated as a problem of weighted global welfare maximization. Domestic households can borrow abroad to smooth consumption one-period bonds but they face costs of adjusting their foreign asset position as in Neumeyer and Perri (2005) and Uribe and Yue (2010) and they can also invest in the domestic capital stock. Hence, the representative household engages in precautionary saving through accumulation of capital stock and foreign bonds. A productivity shock in this framework increases output on impact and households react by increasing savings and, hence, net exports. Yet, the increase in net exports does not lead to a similar increase in current account balance since foreign aid (i.e., net current transfers) reacts countercyclically. This is because the optimal aid policy stemming from the rich Donor country prescribes that aid flows to
SSA increase after a transitory negative productivity shock (e.g. draught), but that they also decrease after a positive, transitory shock to productivity (e.g. rainfall). The response of aid flows almost matches the response of net exports, hence, the response of the current account becomes negligible, as in the data. When assuming exogenous fixed aid, saving increase much more after a transitory productivity shock, the current account becomes more procyclical and consumption much more volatile.

Hence, the reaction of the benevolent Donor and the resulting endogeneity of transfers can explain both qualitatively and quantitatively our empirical findings. The focus on transfers has not been explored in the existing theoretical literature and, was never explored in conjunction with rigorous empirical analysis. The structural model allows for causal analysis. We show that identification of shocks is crucial: no shock that increases output and savings on impact, other than temporary rainfall, produces the zero correlation between savings and the current account.

Many of the sub-Saharan African countries in our sample face significant barriers to private financial flows (as in the spirit of Alfaro et al., 2008; Papaiouannou, 2009). In this regard, the finding of a near zero response of the current account to domestic saving in sub-Saharan African countries may not be surprising. However, as our empirical results and theoretical model make clear, a closer look into the components of the current account reveals that the lack of financial integration of the sub-Saharan African region with the rest of the world would be too shallow of an explanation. This is because net exports do respond significantly positively to the rainfall shock, and the question arises how that is possible. The answer we provide, both theoretically and empirically, is that net-current transfers respond significantly negatively, therefore financing a significant part of the real international resource transfer. It is important to note in this regard that net current transfers, in contrast to private financial flows, are international capital flows without a quid pro quo. Our finding of a significant negative correlation between net current transfers and domestic saving therefore does not contradict the literature which argues for significant (institutional) barriers to private financial flows.

The significant positive response of net exports to a change in domestic saving is a common feature of even the most basic intertemporal models of the current account. As our model makes clear, however, it is the (countercyclical) net current transfers that enable the sub-Saharan African economies to smooth consumption. Output changes that are due to changes in rainfall are then, primarily, reflected in changes in net exports, which are mirrored by changes in net current transfers, so that the overall current account response is near zero. The bottom line of our research is that open economy models of developing countries – where net current transfers play an important role – need to incorporate both, financial frictions and a response of net current transfers to domestic output shocks.

Our paper is related to literature on the response of the current account to economic shocks. The majority of papers in this literature, which have been both of empirical and theoretical nature, have focused on industrialized countries and
emerging market economies. Examples include the classic paper by Feldstein and Horioka (1980), and the more recent papers by Blanchard and Giavazzi (2002), Kraay and Ventura (2000, 2003), and Tille and Van Wincoop (2010). The typical empirical finding in these papers is that, on average, there is a high correlation between domestic saving and investment, and a close to zero correlation between domestic saving and the current account. This finding is commonly perceived as one of the major and empirically most robust puzzles in open economy macroeconomics (Obstfeld and Rogoff, 2000).

It is important to note that our paper's focus is on the group of sub-Saharan African countries. The empirical reason for this focus is that rainfall matters in the group of sub-Saharan African countries. The agricultural sector in the sub-Saharan African economies is large: over the past three decades agriculture’s GDP share exceeded one-third on average; even today more than one-quarter of GDP comes from agriculture and over two-thirds of the population are employed in the agricultural sector (WDI, 2011). Therefore, year-to-year variations in rainfall can have large effects on aggregate output in these economies. As empirical work by Barrios et al. (2010) makes clear, the significant effects of rainfall on GDP are limited to the group of sub-Saharan African countries. The limited effect of rainfall to the group of sub-Saharan African countries is the main reason why we focus in our paper on this particular group of developing countries.

Beyond the above empirical reason for using rainfall in the group of sub-Saharan countries, there is also a more substantive reason for our focus on these countries: sub-Saharan Africa is a focal point of economic development policy. This focal point is reflected, for example, in the World Development Millennium Goals. It is also reflected in recent reports by the World Bank, the European Commission, and the IMF. Understanding how sub-Saharan economies respond to economic shocks should be helpful in identifying what is essential for the macroeconomic modeling of these economies.

The remainder of the paper is organized as follows. Section 2 presents stylized facts contains a description of the data. Section 3 presents the estimation strategy. Section 4 discusses the main empirical results. Section 5 introduces the dynamic stochastic general equilibrium model. Sections 6 and 7 discuss the calibration and the theoretical results. Section 8 concludes.

2 Stylized Facts

2.1 Descriptive Statistics

Table 1 provides means and medians of current accounts (as a share of GDP) in developing countries of different regions in the world. The data are from the World Bank’s (2017) World Development Indicators. We call a country “developing” if in 2016 its GNI per capita was less than USD12500. This is the threshold above which, according to the World Bank, countries are classified as High Income Countries. The time period covered is 1960-2016.
From Table 1 one can see that on average developing countries: (i) ran current account deficits; (ii) trade deficits; (iii) and were net recipients of current transfers. Comparing the trade deficit (Panel A) to the current account deficit (Panel B) one can see that the former is quite a bit larger than the later: For the average developing country, the current account deficit is about two to three times the size of the trade deficit. Net current transfers are an important part of developing countries’ current accounts comprising around 5 to 10 percent of GDP. One can also see from the descriptive statistics in Table 1 that developing countries in the sub-Saharan African regions are not substantially different from developing countries of other regions with regard to the economic importance of net current transfers, the size of the trade deficit, and the current account deficit.

Historically, foreign aid was the most important component of net current transfers; however, in the past two decades migrant remittances have become increasingly important (Yang, 2013). In sub-Saharan Africa, the GDP share of aid received is about twice as large as the GDP share of remittances received, see Table 2. With regard to the composition of net current transfers, sub-Saharan Africa countries are somewhat different to other developing countries. In South Asia and Latin America migrant remittances are about as large as foreign aid; in North Africa and the Middle East migrant remittances as a share of GDP are about twice as large the GDP share of foreign aid.

2.2 Least Squares Regressions

Table 3 reports least squares estimates of a model with country fixed effects, country-specific linear time trends, and time fixed effects as controls. The right-hand side variable is the gross domestic savings rate. The dependent variables are the GDP shares of the current account (column (1)), net-exports (column (2)), net current transfers (column (3)), aid received (column (4)), and remittances received (column (5)). The different panels show estimates for different developing regions: sub-Saharan Africa (panel A), South Asia (panel B), Latin America (panel C), East Asia and Pacific (panel D), and North Africa and Middle East (panel E).

The first main result is that there is only a weak relationship between domestic savings and the current account. In only two of the five developing regions is the coefficient on the domestic savings rate significantly positive. In those two regions where it is significantly positive, the coefficient is far from unity: around 0.2 for sub-Saharan Africa and around 0.4 in Latin America. In South Asia and the Middle East and North Africa the coefficient on the domestic savings rate is virtually zero while in East Asia and the Pacific it is negative, around -0.2. These results are puzzling: at face value, they suggest that the current account does not move with domestic savings as suggested by a basic model of the intertemporal approach to the current account.

There is a strong positive relationship between domestic savings and the trade balance. This is the second main stylized fact. When the dependent variable is the GDP share of net exports, the coefficient on the domestic savings
rate is positive and significantly different from zero in all five developing regions. The largest coefficients on the domestic savings rate are in Latin America, the Middle East and North Africa, and sub-Saharan Africa; 0.7 and 0.6, respectively. This suggests that there is a substantial positive co-movement between the trade balance and the domestic savings rate in these developing regions. In other developing regions the co-movement is not as strong, but it is still positive and significantly different from zero. In East Asia and the Pacific the coefficient on the domestic savings rate is around 0.5, while in South Asia it is around 0.4.

The third stylized fact is that there is a substantial negative correlation between domestic savings and net current transfers. In all five developing regions, the coefficient on the domestic savings rate is significantly negative when the dependent variable is the GDP share of net current transfers. The largest coefficients (in absolute value) are obtained for sub-Saharan Africa, East Asia and the Pacific, and South Asia. In those regions, a one percentage increase in the domestic savings rate is associated with a decrease in the GDP share of net current transfers of around 0.4 to 0.5 percentage points. In Latin America and North Africa and the Middle East, its somewhat less; around 0.3 to 0.2 percentage points. Thus, when domestic savings in developing countries decline net current transfers to these developing countries increase; and when domestic savings in developing countries increase net current transfers to these developing countries decrease. The negative correlation between domestic savings and net current transfer is reflected in both a negative correlation between domestic savings and foreign aid (column (4)) and a negative correlation between domestic savings and remittances received (column (5)).

Table 4 shows that the effect of domestic savings on the current account differs between developing and developed countries. From column (1) of Table 4 one can see that in developed countries the coefficient on domestic savings is around 0.6. In developing countries the coefficient on domestic savings is around 0.1. One can reject the hypothesis that in columns (1) and (3) the coefficients on domestic saving are equal to each other at the 1 percent significance level. In developed countries there is a strong positive co-movement between domestic savings and the current account; but not so in developing countries.

Table 4 also shows that the effect of domestic savings on the trade balance is similar in developing and developed countries. From columns (2) and (4) one can see that the coefficient on domestic savings is around 0.6. In developing countries the co-movement between domestic savings and net-exports is similar to the co-movement between domestic savings and the current account. However, such is not the case in developing countries. Intuitively, the reason for why in developing countries there is no substantial difference in the co-movement between domestic savings and the current account and domestic savings and net-exports is that the transfers that developed countries make to developing countries are small relative to developed countries’ GDP (less than 1 percent).

Our definition of domestic savings follows the definition that is used by international organizations such as the World Bank’s World Development Indicators, i.e. gross domestic savings = GDP-Consumption. The WDI has a variable called gross savings that includes net current transfers, i.e. gross savings = GNI...
- Consumption + Net Current Transfers. When we use gross savings as the right-hand-side variable we find that the relationship between gross savings and the current account is positive and quantitatively sizable in developing countries. See column (3) of Appendix Table 1. However, the relationship between gross savings and net exports is virtually zero, see column (4). This is understandable since net exports and net current transfers are strongly negatively correlated in developing countries: when a developing country receives a transfer from abroad it uses that money to finance imports, which are then consumed. Table 5 documents that in developing countries there exists a significant negative relationship between net current transfers and net exports (Panel C); and a significant positive relationship between net current transfers and consumption, in particular, household consumption and to a smaller degree government consumption (Panels A and B).

3 Sub-Saharan Africa as a Laboratory

In this section we discuss results from an instrumental variables approach that exploits the significant response of domestic savings to year-to-year rainfall. The IV approach is suitable for the sub-Saharan African region as its agricultural sector is large, over half of the workforce are currently employed in agriculture and about one-quarter of GDP is generated by the agricultural sector. Of the five developing regions covered in the previous Section, sub-Sahara Africa is the region with the largest agricultural sector. Thus the sub-Saharan African region is particularly suitable as a laboratory for studying the effects of plausibly exogenous, rainfall-induced variations on domestic savings on the current account. In what follows, we will first provide a discussion of the estimation framework and data, and the discuss the empirical results obtained by the instrumental variables approach.

3.1 Estimation Framework

The estimating equation relates the GDP ratio of the current account, $CA_{ct}$, (and its components) to gross domestic saving scaled by GDP, $Saving_{ct}$:

$$CA_{ct} = \alpha_c + \beta_{ct} + \gamma_t + \theta Saving_{ct} + u_{ct}$$

(1)

where $\alpha_c$ are country fixed effects; $\beta_{ct}$ are country-specific linear time trends; $\gamma_t$ are year fixed effects; and $u_{ct}$ is an error term that we cluster at the country level to allow for arbitrary within-country serial correlation. We note that the country fixed effects, $\alpha_c$, account for time-invariant factors. Examples of these time-invariant factors are geography and history. These time-invariant factors could affect both, sub-Saharan African countries’ average savings rates and the current account.

---

1In developed economies, the distinction between gross domestic saving and gross saving does not matter much when relating these variables to the current account and net exports, see columns (1) and (2) of Appendix Table 1.
It is important to note that because we control for country fixed characteristics we identify the effects of domestic savings on the current account from the within-country variation of the data. In other words, we do not use average cross-country differences in domestic savings and the current account to identify the relationship. Average cross-country differences in domestic savings and the current account are likely to be a consequence of an array of factors, some of which are difficult to measure, such as ethnic divisions, social norms, and trust; all of these are likely to affect savings and possibly the current account beyond savings. In addition to the econometric issue that using average cross-country differences to identify the relationship between domestic savings and the current account gives rise to omitted variables concerns, the macroeconomic models available do not readily allow to incorporate these deep country characteristics as key features for studying the relationship between domestic savings and the current account.

Given that in our estimating equation we identify the relationship between domestic savings and the current account from the within-country variation of the data, it is important to realize that (leaving endogeneity issues aside for now) the least squares estimate, \( \theta^{LS} \), in equation (1) reflects the average response of the current account to domestic savings. That is, least squares provides an estimate of the relationship between domestic saving and the current account based on an average of persistent and transitory shocks that are inducing the within-country fluctuations in domestic saving. For comparison of the empirical estimates to theoretical models it is crucial to have a precise understanding of the types of shocks that are inducing the change in domestic savings (we will show this in Section 7).

In the group of sub-Saharan African countries, year-to-year variations in rainfall are known to have large effects on aggregate output (e.g. Miguel et al. 2004; Brückner and Ciccone, 2011). The large effect on aggregate output is not surprising: during the 1980-2009 period nearly one-third of GDP came from agriculture and more than two-thirds of the population was employed in agriculture (WDI). Given that the average sample AR(1) coefficient of year-to-year variations in rainfall is less than 0.1, we not only have an exogenous shock to aggregate output at hand; we also have a shock to output that is of highly transitory nature.

The permanent income hypothesis predicts that such a transitory output shock should have a large effect on domestic saving. In light of this hypothesis, Brückner and Gradstein (2013) document a quantitatively small and statistically insignificant response of private consumption to transitory, rainfall-induced aggregate output shocks.\(^2\) These authors also provide a rationale based on a game-theoretic model of net current transfers why, despite the severe frictions to private financial flows, consumption does not respond significantly to transitory output shocks in sub-Saharan African countries. In our instrumental variables estimation framework we exploit that, in line with the small effect of rainfall shocks to rainfall shocks; see, for example, Paxson (1992).

\(^2\)The authors findings are consistent with household data evidence on the response of savings to rainfall shocks; see, for example, Paxson (1992).
on private consumption documented in Brückner and Gradstein (2013), rainfall has a significant positive effect on domestic savings.

Under the exclusion restriction that rainfall only affects the current account through its effect on domestic savings, instrumental variables estimation of equation (1) captures the causal effect that a transitory, output-induced change in domestic savings has on the current account. In the instrumental variables estimation, the second-stage equation is simply equation (1), while the first-stage equation is:

\[
\text{Saving}_{ct} = a_c + b_t + d_t + \eta \text{Rainfall}_{ct} + \varepsilon_{ct}
\]  

(2)

where \(\text{Rainfall}_{ct}\) is the log of annual rainfall precipitation in country \(c\) and year \(t\). Note that we are using in the regression smooth variations in rainfall, and not an indicator variable for droughts or floods. In order to ensure that our results are not driven by extreme weather events, we will exclude the top and bottom 5th percentile of country-specific rainfall observations from all regressions.

We note that for the purpose of comparing the empirical results to the predictions from the theoretical model, it suffices to look at the reduced-form responses. That is, it suffices to look at the GDP-scaled net exports response as well as the investment, current account, net transfers and net factor income responses to rainfall – and compare the magnitude of the responses with each other. This is because, observing a large reduced-form effect of rainfall on net exports relative to the reduced-form effect of rainfall on, say, net current transfers is directly comparable with the size of the theoretical impulse response of net exports to a productivity shock relative to the theoretical impulse of net current transfers to that productivity shock. In other words, any scaling issues related to the size of the rainfall shock and how that rainfall shock affects individually the variables will not affect the magnitude of the relative responses.

In light of the above point, it is useful to recall that the IV estimator is simply the ratio of the reduced-form coefficient over the first-stage coefficient (see e.g. Wooldridge, 2002; this is, of course, only true for an exactly identified model as we are estimating). Formally, the IV estimator in equation (1) is:

\[
\theta^{IV} = \frac{\hat{\lambda}}{\hat{\gamma}}
\]

where \(\lambda\) is the effect of rainfall on the current account that is obtained from the reduced-form regression:

\[
\text{CA}_{ct} = f_c + g_t + h_t + \lambda \text{Rainfall}_{ct} + \varepsilon_{ct}
\]  

(3)

For comparison to the predictions from the model, the second-stage coefficient, \(\theta^{IV}\), should therefore be interpreted as the reduced-form effect of rainfall on the current account relative to the first-stage effect that rainfall has on domestic saving.
3.2 Data

3.2.1 Rainfall

Our data on year-to-year variations of rainfall are from the National Aeronautics and Space Administration (NASA) Global Precipitation Climatology Project (GPCP), version 2.1 (Adler et al., 2003). These rainfall data are available since 1979 and they come on a 2.5°x2.5° latitude-longitude grid. We aggregate the rainfall data to the country level by assigning grids to the geographic borders of countries. We use satellite-based rainfall data because these data have a number of important advantages over gauge-station based rainfall data. As pointed out in Brückner and Ciccone (2011), satellite-based rainfall data are less likely to suffer from measurement error that is due to the sparseness of operating gauge stations in sub-Saharan African countries (especially after 1990). Also, as Brückner and Ciccone (2011) point out, the number of operating gauge stations in a country may be affected by socio-economic conditions, which could lead to non-classical measurement error in gauge-station based rainfall estimates.

3.2.2 Macroeconomic Variables

For the subsequent empirical analysis we will report results based on macroeconomic data from two sources. Our first data source of domestic savings, investment, and net exports is the Penn World Table, version 7.0 (Heston et al., 2011). The PWT provides data on PPP GDP, private consumption, government consumption expenditures, and total investment. Based on the PWT data, and following common practices, we compute domestic savings as GDP less private and government consumption expenditures. We then calculate net exports as the difference between domestic savings and total investment. Appendix Table 2 shows the relevant descriptive statistics. According to PWT, the domestic savings rate for the group of sub-Saharan African countries is 0.10; the investment rate is 0.19; and the share of net exports in PPP GDP is -0.09.4

While an advantage of the PWT is that for the group of sub-Saharan African countries it provides the largest number of observations on domestic saving, investment, and net exports (about one-third more than the World Development Indicators, 2011), a disadvantage is that the PWT does not provide data on the current account. We, therefore, use data on the current account and its components from WDI (2011). Appendix Table 2 shows that, according to WDI, the current account to GDP ratio is -0.05. The current account is defined as the sum of net exports, net current transfers, and net factor income. The ratio of net exports to GDP is -0.11; the ratio of net current transfer payments to GDP is 0.08; and the ratio of net factor income to GDP -0.02. The WDI data also show that the bulk of private capital flows to sub-Saharan African countries

3See, for example, http://data.worldbank.org/indicator/NY.GDS.TOTL.ZS.
4In Table 1 the GDP share of net exports for sub-Saharan Africa is somewhat larger than in Appendix Table 2 because in Table 1 GDP is in US dollars whereas in Appendix Table 2 it is PPP. Sub-Saharan African countries’ GDP is larger when measured in PPP than in US dollars.
are in form of foreign direct investment which comprise about 2 percent of GDP on average. Sub-Saharan African countries’ average external debt to GDP ratio is around 0.99.

3.3 Empirical Results

3.3.1 Two-Stage Least Squares Estimates

In this section we present and discuss two-stage least squares estimates of the effect that a shock to domestic savings has on the current account. Before discussing the estimates, it is useful to recall that the current account is equal to the sum of net exports, net current transfers, and net factor income. Net exports are the difference between all exports of goods and services minus all imports of goods and services. According to the World Development Indicators, net current transfers are recorded in the balance of payments whenever an economy provides or receives goods, services, income, or financial items without a quid pro quo. These transfers mainly comprise foreign aid (including aid from NGOs) as well as migrants’ remittances. Net factor income represents earnings on foreign loans and investments minus payments made to foreign investors.

Column (1) in Table 6 shows that domestic savings have an insignificant effect on the current accounts of Sub-Saharan African countries. The second-stage coefficient on the domestic savings rate is 0.04 and its standard error is 0.23. We cannot reject the hypothesis that the second-stage coefficient in column (1) is equal to zero at the conventional significance levels. We can however reject the hypothesis that it is equal to unity a the 1 percent level. The current account response to domestic savings is quantitatively much smaller than the net export response, see columns (2) and (3). A corollary of this is that if we would have focused in our empirical analysis on the current account only we would have (mistakenly) concluded that shocks to domestic savings have no substantial effects on net trade of goods and services.

Columns (2) and (3) in Table 6 show two-stage least squares estimates that use rainfall as an instrumental variable for the domestic savings rate. In column (2) data on the domestic savings rate and the net exports to GDP ratio are from the PWT. The estimated second-stage coefficient on the domestic savings rate is in that case around 0.67 and has a standard error of around 0.15. We can reject the hypothesis that the second-stage coefficient is equal to zero (unity) at the 1 (5) percent significance level. In column (2) the data on the domestic savings rate and the net exports to GDP ratio are from the WDI. Two-stage least squares estimation yields in that case a coefficient on the domestic savings rate that is around 0.54 with a standard error of around 0.28. We can reject the hypothesis that the second-stage coefficient is equal to zero (unity) at the 5 (10) percent level. Quantitatively, these estimates imply that, on average, a one percentage point increase in the domestic savings rate leads to an increase in the net exports to GDP ratio of over 0.5 percent points.

The reason why the current account response to domestic savings is quantitatively much smaller than the net-export response is that there is a statistically
significant and quantitatively large negative response of net current transfers to domestic savings. This can be seen from the estimates reported in column (4) of Table 6. The second-stage coefficient on the domestic savings rate is -0.61 and has a standard error of 0.28. Quantitatively, the estimate implies that, on average, a one percentage point increase in the domestic saving rate is associated with a roughly 0.6 percentage points decrease in the GDP ratio of net current transfers. In other words, net current transfers are strongly counter-cyclical.

For purposes of studying sub-Saharan African countries’ trade responses to a transitory shock to domestic savings, the significant negative response of net current transfers is an important result for two main reasons. First, from an empirical perspective, the significant negative response of net current transfers to domestic savings implies that the response of the current account to domestic savings differs from the response of net exports. Second, from a theoretical perspective, understanding correctly the relationship between the current account and domestic savings calls for incorporating the behavior of net current transfers in theoretical models. In other words, even though a basic intertemporal approach to the current account contains the necessary ingredients, it may not be rich enough to correctly predict the response of the current account to domestic savings. We will demonstrate this point in Section 8.

For completeness column (5) Table 6 shows that the response of net factor income is positive, but not significantly different from zero. The second-stage coefficient on the domestic saving rate in column (5) is 0.11 and has a standard error of 0.14. Hence, we conclude that the main reason why the current account response to domestic savings is different from the net export response is the quantitatively large offsetting response of net current transfers.

Regarding the quality of our instrumental variables estimates, we note that the first-stage effect of rainfall on the domestic saving rate is positive and significant at the 1 percent level. The first-stage estimates, reported at the bottom panel of Table 6, imply that a ten percent increase in rainfall increases the domestic savings rate by around 1 percentage point. The Anderson-Rubin test indicates significance of the second-stage coefficient in columns (2) to (4) but not in columns (1) and (5). The Anderson-Rubin test results are thus always in agreement with the test results obtained from the 2SLS based t-values.

The assumption in the two-stage least squares regressions is that rainfall only affects the current account and its components through its effect on domestic savings, i.e. rainfall is uncorrelated with the error term in equation (1). In Table 7 we examine this exclusion restriction by using temperature as an additional instrument for domestic savings. Temperature like rainfall is plausibly exogenous to economic conditions in sub-Saharan African countries. With the two instruments in hand we can compute the p-value of the Hansen J-test. The Hansen J-test is a joint test that the instruments are uncorrelated with the second-stage error term. Table 7 shows that the p-value from the Hansen J-test is always in excess of 0.1. Hence, the Hansen J-test does not provide evidence

\footnote{The Anderson-Rubin test has correct size even when instruments are weak (see Andrews and Stock, 2005).}
that the instruments are correlated with the second stage error term.

To complete the picture, we report in columns (1) and (2) of Table 8 two-stage least squares estimates of the effects that domestic savings have on investment. The second-stage coefficient on the domestic saving rate is around 0.33 if we use PWT data and around 0.42 if we use WDI data. Both coefficients are significantly different from zero and unity at the conventional significance level. On the other hand, there is no significant effect of domestic savings on private capital flows. This is true if we consider only FDI (column (3)) or the total net flow of private capital to sub-Saharan African countries (column (4)). This latter result is consistent with the literature that has pointed to significant frictions to private capital flows in developing countries (Alfaro et al., 2008; Papaionnou, 2009).

3.3.2 Reduced Form Estimates

We now leave the instrumental variables analysis and turn to the reduced-form estimates reported in Table 5. Columns (1) and (2) of Table 9 show that rainfall has a significant positive effect on the net exports to GDP ratio. The coefficient (standard error) on the log of rainfall is 0.08 (0.02) in column (1) where the data on the net export to GDP ratio are from the PWT. In column (2), where the data on the net export to GDP ratio are from WDI, the coefficient on the log of rainfall is 0.05 (0.02). Rainfall also has a significant positive effect on the investment to GDP ratio, see columns (3) and (4). The coefficient (standard error) on the log of rainfall is 0.04 (0.02) in column (3) where the data on investment are from the PWT. In column (4), where the data on investment are from the WDI, the coefficient (standard error) on the log of rainfall is 0.04 (0.02). Quantitatively, the response of net exports to the rainfall shock is thus larger than the response of investment.

Moving to the current account and its components, columns (5)-(7) of Table 9 show the following: (i) the overall current account response to rainfall is insignificant; (ii) the net current transfer response to rainfall is negative and significant at the 1 percent level; (iii) the net factor income response is insignificant. In quantitative terms, the (absolute) net current transfers response is of almost similar magnitude as the net exports response. The net factor income response to rainfall is, on the other hand, quantitatively small.

For comparison to the predictions from the theoretical model presented in the next section, it is useful to consider also the empirical responses of other key macroeconomic variables. Column (8) of Table 9 documents the well-known positive effect of year-to-year rainfall on sub-Saharan African countries’ GDP per capita. The estimates imply that, on average, a one percent increase in rainfall increases GDP per capita in that year by around 0.07 percent. Column (9) shows that, despite this increase in GDP per capita, private consumption does not increase significantly. Columns (10) and (11) document that increases in year-to-year rainfall lead to a significant decrease in the real exchange rate and the external debt-to-GDP ratio.

In Figure 1 we plot the impulse responses of the different macroeconomic
variables to the rainfall shock. On impact the rainfall shock significantly increases output, domestic saving, net exports, and investment; it significantly decreases external debt and leads to a real exchange rate depreciation; the effects on consumption and net factor income while positive, are quantitatively small. After about five years the dynamic effects are zero for the majority of variables. External debt and the real exchange rate display the most persistent dynamics; for these variables the impulse responses are zero after about 10 years.

4 Model

The goal of this section is to rationalize the empirical findings with a use of a structural model. Using the model we show that the identification of a shock responsible for an increase in savings is the key to understand the relationship between savings and current account; the Feldstein-Horioka puzzle. To this end, we build a simple, almost frictionless neoclassical growth model with a minimum set of features and assumptions. A domestic, Sub-Saharan African economy (SSA) is one-sector, open, agricultural production economy. The economy receives aid transfers from the Donor economy (developed countries), that are decided endogenously, as in Carter, Poste-Vinay and Temple (2015). The SSA economy also has access to international capital markets, where it issues one-period bond at a risk premium. The model, even though minimalistic in design, lays itself to derive rich set of important insights about the mechanism in question both qualitatively and quantitatively.\(^6\)

4.1 SSA Economy

Households in SSA are infinitely lived and maximize the discounted stream of future utilities from consumption:

\[
\max_{\{C_t, I_t, D_t\}_{t=1}^{\infty}} E_0 \sum_{t=1}^{\infty} \beta^{t-1} \frac{C_t^{1-\sigma} - 1}{1 - \sigma}
\]

where \(C_t\) denotes the individual consumption in period \(t\) and utility is CRRA. Households have access to two types of assets, physical capital and an internationally traded bond. The capital stock is assumed to be owned entirely by domestic residents. Households have three sources of income: wages, capital rents, and interest income on financial asset holdings. Each period, households allocate their wealth to purchases of consumption good, purchases of investment

\(^6\)An alternative to our minimalistic approach would be to build model of a two-sector economy with traded and non-traded sectors, where shocks to agriculture are modelled as shocks to traded sector. An even richer framework would include three sectors: traded agriculture, traded manufacturing and non-traded services. We have tried both alternative approaches. The results are qualitatively the same and are available upon request. We would like to thank two anonymous referees for suggesting the minimalistic approach.
good, and purchases of financial assets. The household’s period-by-period budget constraint in terms of traded goods is then given by: subject to a budget constraint:

\[ C_t + I_t + D_t(1 + r_t) + \Psi(D_{t+1}) = W_tE - U_tK_t + D_{t+1} - \frac{X_t}{L_t} D_t \] given, \( t \)

where budget outflows stand on the left-hand-side and budget inflows stand on the right-hand-side. \( D_t \) denotes the household’s maturing debt in period \( t \), \( r_t \) denotes the net interest rate faced by domestic residents in financial markets which is exogenous to the domestic agents and \( D_{t+1} \) is a new foreign debt taken out in period \( t \). \( I_t \) denotes gross domestic investment in the stock of physical capital \( K_t \), \( U_t \) denotes the rental rate of capital and \( W_t \) denotes the wage rate. Labor is supplied inelastically, and without a loss of generality we normalize \( L = 1 \). Finally \( X_t \) is the net current aid transfer expressed in per Donor capita, and \( L_t \) is the population of SSA relative to Donor.

Households face costs of adjusting their foreign asset position following the spirit of Neumeyer and Perri (2005) and Uribe and Yue (2010) who develop models in which country risk spreads are stochastic and interact with financial imperfections. Debt adjustment costs also eliminate the familiar unit root built in the dynamics of standard formulations of the small open economy model.\(^7\) The debt-adjustment cost function \( \Psi(D) \) is assumed to be convex and to satisfy \( \Psi(D) = \Psi'(D) = 0 \), for some \( D > 0 \). In particular, we assume the quadratic costs of adjustment of the form:\(^8\)

\[ \Psi(D_t) = \frac{\psi}{2} (D_t - D)^2. \]

The adopted functional form ensures stationarity of the foreign debt level in a log-linear approximation of the model and also rules out Ponzi-scheme optimal debt paths. Capital accumulates according to the standard law of motion:

\[ K_{t+1} = I_t + (1 - \delta)K_t \quad K_1 \text{given}, \]

where \( \delta \) is the rate of depreciation of physical capital. The first-order conditions with respect to consumption, tomorrow’s capital and tomorrow’s debt yield respectively:

\[ C_t^{\sigma} - \lambda_t = 0 \]

\(^7\)Schmitt-Grohe and Uribe (2003) compare a number of standard alternative ways to induce stationarity in the small open economy framework and conclude that they all produce virtually identical implications for business-cycle fluctuations.

\(^8\)The debt adjustment cost can be decentralized as follows. Suppose that financial transactions between domestic and foreign residents require financial intermediation by domestic, competitive banks. They capture funds from foreign investors at the country rate \( r_t \) and lend to domestic agents at the rate \( r^d_t \). In addition, banks face operational costs, \( \Psi(D_t) \), that are increasing and convex in the volume of intermediation. The problem of domestic banks is then to choose the volume \( D_t \) so as to maximize profits, which are given by \( r^d_t[D_t \Psi(D_t)] - r_tD_t \), taking as given \( r^d_t \) and \( r_t \). It follows that the interest rate charged to domestic residents is given by \( r^d_t = Y^d_t(\Psi(D_t)) \). Bank profits are assumed to be distributed to domestic households in a lump-sum fashion.
\[ \beta E_t[\lambda_{t+1}(1 - \delta + U_{t+1})] - \lambda_t = 0 \]  

\[ \lambda_t[1 - \psi(D_{t+1} - \bar{D})] - \beta E_t[\lambda_{t+1}(1 + r_{t+1})] = 0, \]  

where \( \lambda \) is a Lagrange multiplier associated with the budget constraint 4 and represents the shadow price of consumption. Firms operate under perfect competition. They employ immobile labor and hire capital to maximize profits, and produce agricultural output with a Cobb-Douglas, constant returns to scale technology:

\[ Y_t = \varepsilon_t^Y K_t^\alpha, \]  

where \( \varepsilon_t^Y \) is a TFP shock to SSA output. In particular, rainfall is modeled as a temporary, unexpected \( \varepsilon_t^Y \) disturbance. In equilibrium the wage rate equals the marginal productivity of labor and the rental rate of capital equals the marginal productivity of capital:

\[ W_t = (1 - \alpha)\varepsilon_t^Y (K_t)^\alpha \]  

\[ U_t = \alpha \varepsilon_t^Y (K_t)^{\alpha-1}. \]  

### 4.2 Donor economy

A key empirical finding in the development economics literature is that foreign aid and migrant remittances are a significant fraction of developing countries’ national income (e.g. Yang and Choi (2007), Yang (2008), Arezki and Brückner (2012), Brückner (2013), Brückner and Gradstein (2013)). In particular, this literature finds significant counter-cyclicality of net current transfers to transitory income shocks. An economic motivation of such counter-cyclicality is altruism: when donor countries care about life-time consumption of people living in poor countries (where there are significant frictions to adjusting capital and external debt) the flow of transfers will increase (decrease) when poor countries are hit by negative (positive) economic shocks.\(^9\) A similar argument can be made for migrant remittances.

We follow the benchmark version of the model in Carter, Postel-Vinay and Temple (2015) where dynamic aid allocation is postulated as a problem of weighted global welfare maximization. A representative household in the Donor economy maximizes the following objective function:

\[
\max_{\{C_t^D,X_t\}_{t=1}^\infty} \quad E_o \sum_{t=1}^\infty \beta^{t-1} \left( \frac{(C_t^D)^{1-\sigma} - 1}{1 - \sigma} + \phi L_h \frac{(C_t)^{1-\sigma} - 1}{1 - \sigma} \right),
\]  

\(^9\)See Appendix A of Brückner and Gradstein (2013) for a game theoretic model that formally shows this.
subject to SSA’s budget constraint 4, SSA’s Euler equation derived from 6 and 7 and Donor’s budget constraint:

\[ C_t^D + X_t = \xi_t^D, \]  

where \( C_t^D \) is per capita consumption of the Donor household, \( X_t \) is the international aid flow introduced earlier in equation 4, \( \phi \) is the relative weight that the Donor household places on SSA household’s utility. For simplicity, we assume the same risk aversion \( \sigma \) and time preferences \( \beta \) in SSA and Donor economies and that the relative population \( L_s \) does not change over time. To isolate dynamic endogenous responses of aid subject to shocks in SSA economy we shut down dynamic capital accumulation in Donor economy and assume instead, for simplicity, that households in Donor economy receive stochastic, i.i.d. endowments \( \xi_t^D \). It is straightforward to relax these assumption, but it is beyond the scope of this paper.

The choice of aid will matter through intertemporal budget constraints, reducing consumption in Donor and relaxing constraint in SSA. The Donor’s problem is postulated as a weighted global average maximization, which allows us to study how optimal aid policies arise endogenously, in particular, how those policies respond to shocks in SSA. This formulation also provides a mapping between generosity \( \phi \) and optimal capital accumulation and production decisions in SSA. Aid is distributed to SSA households, who are too small to internalize the effects of their actions on the optimal aid policies, hence, take \( X_t \) as given.

The first order condition of the Donor’s maximization problem read:

\[ (C_t^D : ) \quad (C_t^D)^{-\sigma} - \xi_t^D = 0 \]
\[ (X_t : ) \quad - \xi_t^D + \xi_t^S = 0 \]
\[ (C_t^D : ) \quad \phi C_t^{-\sigma} - \xi_t^S + \sigma C_t^{-\sigma-1}[\zeta_t - \zeta_{t-1}(1 - \delta + U_{t-1})] = 0 \quad \forall_{t>1} \]

\[ \zeta_{t-1} = 0, \]

where Lagrange multipliers associated with Donor budget constraint, SSA budget constraint and SSA Euler equation are respectively \( \beta^t \xi_t^D, \beta^t \xi_t^S \) and \( \beta^{t-1} \zeta_t \). The three first-order conditions govern the optimal aid policy. The dynamics of the problem are governed by two mechanisms. The first one is the convergence to the steady-state from some arbitrary initial conditions. The second one are the dynamics inside the stochastic steady-state in response to exogenous shocks. Carter, Poste-Vinay and Temple (2015) study the first mechanism without considering stochastic disturbances. We, on the other hand, focus on the second and so we assume away initial convergence dynamics. Donor and SSA economies are in their respective stochastic steady states, which implies that \( \zeta_t = \zeta_{t-1} \forall_t \). In the stochastic steady state the optimal aid is governed by the following intratemporal condition:
\[(C^D)_t^{-\sigma} = \phi(C_t)^{-\sigma}.\] (13)

### 4.3 Definitions

Finally, we define the remaining model counterparts of variables studies in the empirical section. Savings are defined as disposable income minus consumption:

\[S_t = Y_t + \frac{X_t}{L_s} - C_t,\] (14)

the trade balance (or net exports) in the small open economy is defined as:

\[NX_t = Y_t - C_t - I_t - \Psi(D_{t+1}),\] (15)

and the current account is the sum of net exports, net factor income and net current aid transfers:

\[CA_t = NX_t - r_t D_t + \frac{X_t}{L_s}.\] (16)

The model is a dynamic system of 13 variables \((C_t, I_t, W_t, U_t, X_t, Y_t, \lambda_t, C^D_t, D_t, K_t, S_t, NX_t, CA_t)\) governed by 13 equations 4-16, subject to three exogenous shocks: a productivity (rainfall) shock in SSA \(\varepsilon_t^Y\), an endowment shock in Donor \(\varepsilon_t^D\), and an interest rate shock to SSA foreign debt \(r_t\). Since SSA households form expectations about future interest rates we assume that it evolves according to:

\[r_{t+1} = \bar{r} + \rho^R r_t,\]

where \(\rho^R\) is the parametrized persistence of the interest rate shock and \(\bar{r}\) is calculated to match the average steady-state level of interest rate paid by SSA economies on their foreign debt.

### 5 Calibration

The parameters in the benchmark model are calibrated to mimic a typical sub-Saharan African country and are presented in Table 10. In calibrating the model, the time unit is meant to be one year. We use standard values in the literature of \(\sigma = 2\) and \(\alpha = 0.3\). Using Penn World Tables 9.0 (Feenstra et.al., 2015) we set the depreciation rate at 7 percent per year and relative output in SSA to USA at 6 percent, while the steady-state productivity in SSA economy is normalized to one. We fix the relative population \(L_s\) to 1.1 using the the population of 996 million in Sub-Saharan Africa (World Population Prospects) and the population of 901 milion in developed countries using Carter et.al. (2015), although it should be noted that this parameter could be normalized to one without a loss of generality, since what matters is the relative size of \(\phi/L_s\). We set \(\phi = 0.0038\) to match the average aid inflow of 12% of SSA output as reported in Table 2.
The time discount factor $\beta$ is set to 0.8, which is lower than usual values of above 0.9 used in the calibrated models of developed economies. Aguiar and Gopinath argue that for studies of developing economies with risky debt significantly lower values should be used and use even lower value of $\beta = 0.8$ quarterly. Our calibration is yearly and results in a risk-adjusted interest rate of 25%, which is well within the range of values reported for Sub-Saharan Africa economies.

We use equation 16 and grand ratios of current account to output $\frac{CA}{Y} = -0.07$, net exports to output $\frac{NX}{Y} = -0.15$ reported in Table 1 and aid to output $\frac{NX}{L} = 0.12$ reported in Table 2 to obtain net factor income of $\frac{rD}{Y} = 0.04$. Using this, we calibrate $D = 0.1556$ to be consistent with $r = 25\%$. This leaves us with one free parameter, the adjustment costs of debt. We estimate $\psi$ by studying the responses of consumption to a transitory shock to income. We set $\psi = 0.1$, which results in the marginal propensity to consume of 0.3 when the aid channel is shut off. Higher values of $\psi$ do not increase the MPC much further, while lower values of $\psi$ induce slow, counterfactual convergence of foreign debt, which motivates households to counterfactual high savings out of transitory income. Schmitt-Grohe and Uribe (2003) use much lower values of 0.00074 to 0.001. It should be noted however, that: i) their framework includes a richer set of frictions, while in our model $\psi$ by construction approximates for all frictions faced by households, and ii) their calibration targets developed economies, while frictions in developing economies are widely believed to much more severe. Hence, we find a value of $\psi = 0.1$ a reasonable fit for the model.

The rainfall shock is modelled as a transitory, unexpected shock to the SSA productivity. We set persistence to 0.1 to reflect its transitory nature. We additionally study the responses of the SSA economy to transitory shocks: to output in Donor and to the interest rate, setting the same persistence of 0.1, and to persistent shock to output, where we increase the persistence parameter to 0.9. Since shocks are modelled as unexpeced, one off disturbances, their volatilities do not need to be calibrated as they do not enter into households expectations. To ensure convergence of the interest rate after a shock back to its steady-state value, given the above persistence, we calculate $r = (1 - \rho^2)r = 0.225$. To facilitate comparison between empirics and theory, we calibrate the size of each shock to give 0.07 percent increase in output on impact, as reported in the empirical part (Section 3.3.2 and Table 9).

6 Results
In Figure 2 we present the impulse responses of the SSA economy to a rainfall shock. The rainfall shock is modelled as a transitory productivity shock and is calibrated to result in a 0.07 percent increase in output on impact. Response of output is measured in percent deviation from the steady-state, while responses of all other variables are measured in percentage points of GDP deviations from the steady-state. Solid lines show responses of variables in the model with endogenous foreign aid. The patterns in Figure 2 replicate empirical responses
depicted in Figure 1 both qualitatively and quantitatively. The theoretical responses of savings-to-GDP, foreign aid-to-GDP, current account-to-GDP, net exports-to-GDP and net factor income-to-GDP closely mimic their data counterparts, although none of those variables was used in the calibration of the model.

Productivity shock increases output on impact. Output is used to increase savings, which leads to an increase in net exports. Importantly, the increase in net exports does not lead to a similar increase in current account balance; which could be interpreted as a version of the Feldstein-Horioka puzzle for Sub-Saharan Africa economies. Our, both empirical and theoretical, solution to this puzzle points to the role of foreign aid (or, equivalently for SSA, net current transfers). In the data foreign aid drops after positive, transitory shock to the SSA output induced by an increased rainfall. In the model we have proposed that aid is decided by a benevolent, representative household located in the rich Donor economy. The optimal aid policy stemming from this formulation prescribes that aid flows to SSA increase after a transitory negative productivity shock (e.g. draught), but that they also decrease after a positive, transitory shock to productivity (e.g. rainfall). The response of aid flows almost matches the response of net exports, hence, the response of the current account is small positive, but negligible number, as in the data. Later, we further explore the consequences of this optimal aid policy design.

The increase in domestic saving also reduces the amount of foreign debt; albeit less so than in the data. This in turn leads to small increases in net factor income. Consumption, due to counteacting effect of increased output and decreased foreign aid, is almost unchanged. Hence, the impact responses of the model reflect the picture we see in the data: domestic saving as a percentage of GDP increase on impact and net exports react much more to the shock relative to the current account and investment.

**Foreign Aid as Insurance Mechanism**

In Figure 2 we also plot usign dashed lines impulse responses of an identically calibrated model, albeit with fixed, instead of endogenous foreign aid. The results show that endogenous aid is crucial in explaining the SSA version of the Feldstein-Horioka puzzle. With fixed aid savings increase much more, this is used for investment in capital that keeps output above its steady-state level for much longer. More importantly, with fixed aid, consumption-to-GDP increases on impact by 0.02 percentage points and stays above steady-state level for long. The reverse happens after a negative shock, consumption is depressed. With fixed aid consumption in SSA is much more volatile, hence endogenous aid serves as an insurance mechanism.

Compared with endogenous aid scenario, with fixed aid net export increase by half and current account increases twice more. The responses of current account-to-GDP and net exports-to-GDP are thus similar in value and Feldstein-Horioka puzzle, counterfactually, does not hold anymore.
Persistence of the Productivity Shock

The distinction between transitory and persistent shocks is crucial for understanding the relationship between domestic saving and the current account. In our empirical analysis, we used plausibly exogenous variations in year-to-year rainfall to provide an estimate of the causal relationship between domestic saving and the current account that emerges from a transitory productivity shock. We then compared the empirical responses to the predictions from a dynamic stochastic general equilibrium model. The theoretical model also permits us to investigate the relationship between the current account and domestic savings when the shock is of more permanent nature.

In Figure 3 we depict impulse responses of the model after a productivity shock with persistence parameter increased to 0.9. Expecting long-lasting increase in productivity, households in SSA invest in capital, which further boosts output in the second period. Output remains much above its steady-state level for periods exceeding forecast scenario. Increase in output naturally results in an increase in savings. Endogenous foreign aid works gradually, to keep consumption unchanged. It decreases ever more for the first four years, only to slowly revert to its steady-state level after that. To make up for the expected reduced future aid inflows, debt must increase on impact. This in turn affects current account, that becomes countercyclical (turns negative on impact). After a persistent productivity shock savings and current account move in opposite directions. With fixed aid - without insurance mechanism - after a persistent productivity shock net exports become negative and the current account continues to behave countercyclically, while savings increase on impact.

Identification of Shocks

The discussion in the previous paragraph has also highlighted the importance of shock identification. A measured correlation between savings and the current account depends not only on an institutional design (in this case: the endogeneity of aid flows) but also on the nature of a shock that is responsible for an increase in savings. A transitory productivity shock (e.g. rainfall shock) with endogenous aid produces almost zero correlation between savings and the current account, in line with our empirical findings. Contrary to the empirical findings, the same shock with fixed aid would produce a positive correlation. A permanent shock however, would result in a negative correlation: savings go up and the current account goes down, both with endogenous and fixed aid, as can be seen in Figure 3. In what follows, we study how other shocks resulting in output increase, affect the correlation and volatility of savings and the current account.

In Figure 4 we plot impulse responses to an alternative supply shock, a positive shock to output endowment in Donor economy. The shock is passed to SSA through increased aid inflow, which in turns feeds into savings and capital accumulation. Hence, an increase in SSA output occurs only in the second period, when new investment becomes productive. The graphs have
been rescaled compared to Figures 2 and 3 for visual purposes. Evidently, an aid flow shock (resulting from Donor output shock), results in much higher volatility of savings, net exports, debt the current account, than a comparable rainfall shock. Also, due to a large decrease in debt and simultaneous large increase in aid, the current account goes up, even though net exports go down. An aid flow shock hence induces opposite movements in net exports and the current account, as well as positive correlation between savings and the current account.

In Figure 4 we plot impulse responses to yet another positive supply shock: a negative shock to the interest rate that SSA economy pays on its foreign debt. Since borrowing will become relatively more attractive from period 2 onwards, the economy increases its debt position in period 2. Along with expectation of more resources available to the SSA households, the aid flows drop on impact, but then increase to compensate for lower net factor income (higher debt expenditures). With endogenous aid consumption is almost perfectly smooth, but this comes at an expense of highly volatile aid, savings, net exports, debt and the current account, that all switch signs between periods 1 and 2. Along with a peak in output (in period 2), all of: savings, net exports, debt and foreign aid are above their steady-state levels. After a shock to interest rate not only is Feldstein-Horioka puzzle absent (the current account moves more, not less than savings), but also the positive correlation between savings and foreign aid is counterfactual. Figure 5 shows yet again how endogenous foreign aid serves as insurance mechanism: with fixed aid an increase in consumption is significant and long-lasting. This is financed with higher imports in the short run and lower debt in the long run.

A structural model lays itself to conduct a causal analysis of the mechanisms driving the comovements between savings and the current account. With a use of a simple model with minimalistic assumptions we have examined the role of foreign aid that serves as insurance mechanism for SSA economies and the crucial role of shocks.

7 Conclusion

This paper examined the relationship between domestic saving and the current account in developing countries. In contrast to advanced economies, net current transfers are an important component of developing countries’ current accounts. The basic model of the intertemporal approach to the current account focuses on net exports only. It, therefore, misses out on an important component of the current account of developing countries.

The missing out of the basic intertemporal model of the net-current-transfer component of the current account matters, in particular, in terms of the model’s predictive power of how the current account reacts to a change in domestic saving. According to the basic model, a transitory output shock that leads to a significant increase in domestic saving should be accompanied by a substantial increase in the current account. In the empirical part of the paper, we showed
that there is a near zero correlation between domestic saving and the current account. We instrumented domestic saving with year-to-year variations in rainfall to ensure that this correlation reflects a causal effect of domestic saving on the current account. The empirical findings are thus inconsistent with the prediction from the basic intertemporal model of the current account.

In the theoretical part of the paper we extended the intertemporal model of the current account to include net current transfers. We showed that with an endogenous response of net current transfers to developing countries’ transitory output shocks, the intertemporal model’s predictive power of the current account response to a change in domestic saving substantially improves. Within the model, we also studied alternative scenarios that will lead to an increase in savings. The analysis shows that identification of shocks is crucial to understand the comovements of savings and the current account.
References


