Habits, Rule-of-Thumb Consumption and Useful Public Consumption in Sub-Saharan Africa: Theory and New Evidence

John Nana Francois

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Habits, Rule-of-Thumb Consumption and Useful Public Consumption in Sub-Saharan Africa: Theory and New Evidence

By

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Abstract

I derive and estimate a structural consumption model for a panel of 34 sub-Saharan Africa countries from 1960–2018 to uncover three important aggregate consumption behaviours: habit formation, rule-of-thumb consumption and the complementarity of government consumption in private utility. The following findings emerge: (1) There is evidence of habit formation in consumption. (2) Approximately 38% of consumers follow the rule of thumb of consuming their current income. This rule-of-thumb consumption behaviour in the data is driven by the period before the mobile money era that emerged post-2000s. (3) Public consumption complements private consumption in an Edgeworth-Pareto sense. This suggests that increases in government consumption can stimulate aggregate demand via a positive marginal utility channel.

JEL Classification: C23, E7, E21, E62, H5, O55

Key words: Habits; Edgeworth complementarity; Rule-of-thumb agents; Fiscal and monetary policy; sub-Saharan Africa

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1. Introduction

Knowledge of the aggregate consumption behaviour of household agents is central in informing the design, implementation, mediation and effectiveness of fiscal and monetary policy. For example, whether households internalize government consumption as a complement in the Edgeworth-Pareto sense is central to fiscal policy effectiveness. In this scenario, an increase in government consumption generates positive externalities that raises the marginal utility of private consumption. This increases private consumption, thereby offsetting the standard wealth effect induced by the rise in government consumption financed with taxes or deficits. The opposite effect applies when private and public consumption are substitutes. Other important characteristics, such as habit formation and rule-of-thumb behaviour by some consumers have important implications for both monetary and fiscal policy effectiveness (see, Bilbiie, 2008; Bouakez and Rebei, 2007; Caldara and Kamps, 2017; Fuhrer, 2000; Ganelli and Tervala, 2009; Monteiro et al, 2013; Morita, 2015). Despite its relevance to policy, systematic evidence of aggregate consumption behaviour in sub-Sahara Africa (SSA) remains scant.

This paper provides new and systematic insights into the aggregate consumption behaviour in SSA countries by uncovering: (1) the degree of habit formation; (2) whether public and private consumption are Edgeworth complements or substitutes in private utility; and (3) rule-of-thumb consumption behaviour. Specifically, I derive a structural consumption equation from a tractable consumption model with rule-of-thumb agents and a generalized utility function, which allows for habit formation and the direct role of government consumption in private utility. I then use dynamic panel methods to estimate the key parameters of the model for 34 SSA countries.

Investigating aggregate consumption behaviour in SSA countries is of first-order importance for policy and its relevance can be contextualized as follows: First, consider the concept of a direct role for government consumption private utility and, hence, Edgeworth complementarity (or substitutability) between private and government consumption.[1] One example is public education, traditionally a major component of public consumption in developing countries. Scaling up public education services can induce an increase in private demand for textbooks, pencils or school uniforms (Ercolani and Azevedo, 2014). Nonetheless, increased spending in public education can also reduce the demand for private schools or tutors. Furthermore, an increase in public health services, another important component of public consumption in developing countries, can induce good health, lower child mortality and raise the life

expectancy all of which generate positive externalities that can lead to investment in the education of healthy children. Beyond these traditional components of public consumption, pure public goods (i.e., goods that cannot be easily provided by the private sector) such as defence and public order and justice can induce positive externalities. For example, government spending on public order can ensure the absence of widespread criminal and political violence. This can lead to an increase in economic activity in the private sector and also increase the current and anticipated standard of living in developing countries (Francois and Mata, forthcoming). These simple examples suggest that, on aggregate, public consumption may not be wasteful but can be useful instead, i.e., by entering a private utility directly. Hence, public consumption can substitute for or complement private consumption in an Edgeworth-Pareto sense depending on its composition. Consequently, an understanding of whether public consumption is an Edgeworth substitute or a complement to private consumption in private utility is critical in altering the standard wealth effect channel that follows an increase in government consumption financed with taxes. In particular, through a positive marginal utility channel, an increase in government consumption can directly increase private consumption if the two consumption goods are Edgeworth complements (Bouakez and Rebei, 2007). This is important, because if the degree of complementarity is high enough, the positive marginal utility of private consumption can offset, and possibly outweigh, the standard negative wealth effect arising from financing the increase in public consumption with taxes.[2] The opposite occurs when private and public consumption are Edgeworth substitutes. Uncovering this private-public consumption relationship in private utility can therefore help inform the effective design of fiscal policy involving government consumption. That is, under a scenario where private and government consumption are Edgeworth substitutes, countries facing fiscal consolidation may experience some degree of demand-side offset to the cuts in public consumption; hence, leading to a subsequent moderation in the effect of austerity on real GDP. Conversely, Edgeworth complementarity, will reinforce the negative effect of fiscal consolidation on output.

Beyond its immediate implications for fiscal policy, Edgeworth complementarity/substitution has direct and indirect implications for foreign aid effectiveness. A unique characteristic of SSA economies is their dependence on foreign aid to fund government expenditures, i.e., government consumption and investment. The role of Edgeworth complementarity/substitutability in mediating the economy-wide impact of changes in aid provides an additional and important motivation for uncovering whether government consumption is useful in private utility and what its relationship is with private consumption. Specifically, when public and private consumption are Edgeworth substitutes, an increase in aid-financed public consumption generates a fall in the marginal utility of private consumption, which negatively impacts aggregate demand. This negative impact, via the marginal utility channel, can diminish the well-known positive effect of aid on output induced by public investment. Moreover, in the presence of general fungibility – defined as the share of aid that ends up financing an increase in government consumption rather than the intended increase in government

investment – the negative impact generated by Edgeworth substitutability will be further exacerbated (Dawood and Francois, 2018). If public consumption instead complements private consumption in utility, an increase in government consumption funded directly or indirectly by foreign aid will reinforce the positive effect of aid induced by aid-funded public investment. This can lead to a larger increase in the macroeconomic impact of aid on output.

Second, consider the idea of the presence of habit formation in private utility. Allowing habits in private agents' utility has been widely shown to help the workhorse general equilibrium models fit the data better (Fuhrer, 2000). Specifically, Fuhrer shows that by including a habit consumption specification in a monetary policy model, the responses of both spending and inflation to monetary policy actions are significantly improved by this modification. Furthermore, the growth literature supports habit formation models. More precisely, an important phenomenon that has widely been investigated in the growth literature is the finding that growth Granger causes savings, which is essential for capital formation and economic development. The finding that growth Granger causes savings strongly violates the permanent income hypothesis (PIH). This is because a PIH consumer would save less today in the face of strong growth that augments lifetime resources (Fuhrer, 2000). Conversely, when habits are present, it suggests that agents will sluggishly increase their consumption to positive income shocks implying some degree of consumption smoothing (Carroll and Weil, 1994). Hence, growth in income can exceed consumption growth in the short run, thereby raising savings, while private agents gradually respond to the increase in income. Beyond these points, the presence of habits has also been shown to have important implications for tax policy and asset pricing models (see Bernasconi et al, 2020 and Fuhrer, 2000, for a fuller discussion).

Third, several SSA countries face socioeconomic issues including poverty and lack of access to financial and banking services. It is, therefore, only natural to assume a priori that there is a sizable fraction of the region's population that follows rule-of-thumb consumption behaviours (also known as hand-to-mouth or non-Ricardian agents). Uncovering the size of rule-of-thumb agents can shed light on how strong the Ricardian equivalence holds in SSA countries; hence, informing policy makers of the effectiveness of an expansionary fiscal policy involving changes in government consumption. In particular, non-Ricardian agents consume all their current income and cannot borrow or save. Thus, their presence weakens the standard Ricardian equivalence, which arises following an increase in government spending financed with taxes (or a deficit). As wages rise after an increase in government consumption, these hand-to-mouth consumers raise their consumption. If the fraction of non-Ricardian households is large enough, it can generate a net positive response for consumption following the increase in government consumption (Galí et al, 2007). On the monetary policy side, several studies have shown that the presence of rule-of-thumb households, if large enough, can impact monetary policy design and effectiveness (see Bilbiie, 2008; Colciago, 2011; Galí et al, 2004; Rossi, 2014). For example, Galí et al (2004) discuss the standard Taylor principle becoming too weak a criterion for stability when the share

of rule-of-thumb consumers is large. Galí et al (2004) point out that the size of the inflation coefficient that is required to rule out multiple equilibria is an increasing function of the weight of rule-of-thumb consumers in the economy. Conversely, Bilbiie (2008) shows that in the presence of a high fraction of rule-of-thumb agents, determinacy may require passive monetary policy, whereby the central bank lowers the real interest rate in response to positive inflation. With the steady growth in the use of rule-based monetary policies in African economies (see O'Connell, 2012, for a discussion), knowledge of the size of rule-of-thumb agents from a macro-perspective will be necessary and important in designing monetary policy.

The contribution of this study is, therefore, threefold: First, it contributes to the stylized empirical facts about aggregate consumption in SSA and pushes the existing literature forward by examining the aforementioned aggregate household consumption behaviour in a generalized and unified framework. Second, it investigates whether this aggregate consumption behaviour will help uncover "new" channels (e.g., the marginal utility channel of government consumption) of policy effectiveness that have not been studied adequately in the context of SSA. Third, by contributing to the stylized empirical facts about aggregate consumption in SSA, this study would be useful in calibrating workhorse general equilibrium models for monetary and fiscal policy analysis.

The empirical estimates from the study uncover the following: There is evidence of a moderate degree of habit formation (i.e., the estimated habit parameter is less than 0.7 but greater than 0.5).[3] Moreover, there is strong evidence of rule-of-thumb agents, with estimates revealing that about 38% of consumers do not smooth consumption. These two results suggest a strong deviation from the permanent income hypothesis, which is in contrast to older studies such as Raut and Virmani (1989) that focus on developing countries. Lastly, public consumption is an Edgeworth complement to private consumption. This complementarity is in sharp contrast to studies such as those by Evans and Karras (1996) and Dawood and Francois (2018) who, under more stringent model assumptions, find that the two consumption goods are Edgeworth substitutes in developing countries including SSA countries. However, the finding is in line with the results from Karras (1994) who finds that private and government consumption are best described as complementary goods for a mix of countries. Karass (1994) concludes that substitutability seems to be the exception and not the rule in the sample of countries employed for the analysis. These key results are robust under different model specifications and when controlled for age dependency, which proxies for taste shifters in utility. Importantly, the estimated preference relationships uncovered in the baseline results are structurally stable, suggesting that they are not subject to the Lucas critique and hence can be considered as "deep parameters".

The rest of the paper is structured as follows: Section 2 provides a brief review of the existing literature, Section 3 introduces and describes the theoretical model to motivate the empirical estimation, Section 4 presents the empirical methodology, Sections 5 and 6 present the baseline results and robustness exercises, respectively, and Section 7 discusses the policy implication of the results and concludes.

2. Literature review

Historically, the extensive empirical literature on household aggregate consumption behaviour has often focussed on non-African countries.[4] For example, on the relationship between private and government consumption, the literature has focussed predominantly on non-African countries, or on generally studying a panel of countries across different regions (e.g., Amano and Wirjanto, 1997, 1998; Aschauer, 1985; Auteri and Costantini, 2010; Brown and Wells, 2008; Chiu, 2001; Evans and Karras, 1996, 1998; Ho, 2001; Jalles and Karras, 2021; Karras, 1994; Kormendi, 1983; Kwan, 2009; Nieh and Ho, 2006; Okubo, 2003; Raut and Virmani, 1989). These studies suggest that patterns of substitutability vary across countries and may be correlated with structural features that include development levels and the composition of public spending. Recently, however, studies such as those by Dawood and Francois (2018) have focussed exclusively on African countries. Dawood and Francois (2018) estimate the intratemporal elasticity (IES) between private and government consumption from a constant elasticity of substitution (CES) aggregator function for 24 African countries. The authors combine their estimates of the IES with plausible values of the intertemporal elasticity of substitution and find that private and public consumption are Edgeworth substitutes in African countries. It is worth noting that Dawood and Francois (2018) make an assumption of permanent income hypothesis. They do not allow for the coexistence of Ricardian and non-Ricardian agents, which is likely to be the norm rather than the exception in SSA countries. Moreover, the authors do not include the possibility of habit formation behaviour by households. Other studies, including those by Nkansa Asante et al (2021), have further narrowed down the question of substitutability between private and government consumption in SSA countries. However, similar to preceding studies, Nkansa Asante et al (2021) do not allow for habit formation, rule-of-thumb agents, or how households respond to changes in interest rates. Furthermore, older studies such as those by Evans and Karras (1996) and Jalles and Karras (2021) have estimated the Edgeworth substitutability/complementarity between private and public consumption in selected developing countries and OECD countries, respectively, while allowing for rule-of-thumb consumers. These authors assume a linear aggregator function for effective consumption.[5] As Kwan (2009) and Dawood and Francois (2018) discuss, the linear aggregator function for effective consumption is stringent and requires additional assumptions to ensure that government consumption is indeed a good in private utility. Instead, these studies specify a CES aggregator function for effective consumption to

uncover the intratemporal elasticity of substitution. Nonetheless, the intratemporal elasticity by itself only captures gross substitutability or complementarity – it needs to be combined with the intertemporal elasticity of substitution in order to draw any definitive inferences on Edgeworth substitutability (or complementarity). More importantly, the estimation of the intertemporal elasticity in these studies depends on the estimated value of the IES. This suggests that if the IES is not accurately estimated, it can impact the estimated value of the intertemporal elasticity. Indeed, recent studies such as those by Barthel and Francois (2021) show, theoretically and empirically, that the estimate of the IES is biased in studies that employ a standard CES aggregator function with an assumption of homotheticity, which several existing studies assume (see, for example, Amano and Wirjanto, 1997; Dawood and Francois, 2018; Kwan, 2009). This raises serious inference problems when studying the relationship between public and private consumption (Barthel and Francois, 2021). Hence, while previous research is informative and has expanded our knowledge of aggregate household consumption behaviour, there are still several problems that need addressing, particularly in the context of SSA.

To avoid the pitfalls of previous studies, in this paper I do not make any specific assumptions of how private and government consumption are aggregated in private utility. In the manner of Fiorito and Kollintzas (2004), I only rely on the standard preference properties with no temporal utility specification. This does not only provide flexibility in the estimation of the key relationships, it avoids the tight theoretical restrictions placed on parameters by a specific utility function, which is standard in existing studies (e.g., Dawood and Francois, 2018; Kwan, 2009). This strategy provides a generalization of the results. In summary, I allow for habit formation in the model, focus exclusively on SSA countries, include rule-of-thumb consumers, and employ more recent data for the empirical estimation. I also present extended robustness checks and a battery of standard and newer post-estimation tests to ensure the findings are valid and reliable. The features of the paper are not shared with existing studies.

3. Theory: A simple consumption model

The study is set in the following simple model: Two agents, non-Ricardian (rule-of-thumb) households, denoted by *n*, and Ricardian households (who can borrow and save), *r*, are present in an endowment economy with exogenous aggregate income Y_t. Ricardian and non-Ricardian agents earn Y^r and Y^n, respectively. Allowing heterogeneous agents in the model captures an important feature of a typical developing country in SSA, where a sizable fraction of its agents behave in a hand-to-mouth fashion. The model is described below. Note that because I focus on the household side of the economy, I do not endogenize income in the economy (i.e., I abstract from the production sector). While stringent, this assumption is primarily made to ensure tractability. In the empirical analysis, I treat income rightfully as an endogenous variable. The full model is described below.

Ricardian household: This agent maximizes life-time utility given as

$$U = E_0 \sum_{t=0}^{\infty} \beta^t u(C_t^r, G_t, H_t^c \quad (1)$$

subject to

$$C_t^r + R^{-1} B_{t+1} + \tau = Y_t^r + B_t \quad (2)$$

where $\beta \in (0, 1)$ is the discount factor and E0 is the expectation operator at time zero. Bt is the quantity of nominally riskless one-period bonds carried over from period t − 1, and paying one unit of the numeraire in period t. Rt is the gross real interest rate of return on bonds in the economy. The instantaneous utility function $u(.)$ is a function of current consumption C^r, G_t, which is useful government consumption, and H^c, which is external habits (i.e., past aggregate consumption). Habits formation can be rationalized as creating a positive link between current and lagged expenditure growth, which originates from consumers' gradual adjustment to permanent income shocks.[6] The standard preference properties such that the first derivative u_i with $i \in \{C^r, G\}$ is greater than zero so that all items in the utility function are goods. Additionally, the second derivative $u_{ii} < 0$. Furthermore, with respect to the relationship between

private and government consumption, we have that when $u_{C^r,G}$ is greater (less) than zero private and public consumption are complements (substitutes) in the Edgeworth pareto sense. If on the other hand $u_{C^r,G} = 0$, then the two goods are independent and changes in G does not alter the marginal utility of private consumption in any direction.

Standard optimality condition for the Ricardian agent yields the consumption Euler equation:

$$U_{C^r}(C_t^r, G_t, H_t^c) = \beta E_t[U_{C^r}(C_{t+1}^r, G_{t+1}, H_{t+1}^c)R_{t+1}] \quad (3)$$

The log-linearised version of the Euler equation related to Ricardian household in Equation 3 is

$$\Delta\tilde{C}_{t+1}^r = \alpha_c\Delta\tilde{C}_t^r + \alpha_g\Delta\tilde{G}_{t+1} + \alpha_r\Delta\tilde{R}_{t+1} + \varepsilon_{t+1}, \quad (4)$$

where ~ represents the log deviation of a variable from its steady state,

$$\alpha_c = -\frac{U_{C^rH^r}}{U_{C^rC^r}} > 0,\ \alpha_g = -\frac{U_{C^rG}}{U_{C^rC^r}}\frac{U}{C^r} \gtreqless 0,\ \alpha_r = -\frac{u_{C^r}}{u_{C^rC^r}}\cdot\frac{p}{c} > 0 \text{ and } 0 \leq \lambda \leq 1$$

Also, $E_{t-1}\varepsilon_t = 0$ for all time t. Note the that these parameter restrictions are governed by the standard preference properties described earlier. The equation above implies

$$\Delta\tilde{C}_t^r = \alpha_c\Delta\tilde{C}_{t-1}^r + \alpha_g\Delta\tilde{G}_t + \alpha_r\Delta\tilde{R}_t + \varepsilon_t, \quad (5)$$

Non-Ricardian Household: Non-Ricardian households differ from Ricardian households in that they consume all their disposable income, Y^n. In this framework, non-Ricardian households do not optimize – neither intertemporally nor intratemporally. Therefore, the consumption for these agents is given as:

$$C_t^n = Y_t^n \quad (6)$$

Following Campbell and Mankiw (1990), among others, I assume that aggregate income Y in the economy is allocated as follows:

$$Y_t^r = (1-\lambda)Y_t$$
and
$$Y_t^n = \lambda Y_t$$

where λ is the fraction of rule-of-thumb of agents. Finally, by using a log-linear model, I follow Furlanetto and Seneca (2012) and specify aggregate consumption as a simple weighted average, given as: $\widetilde{C_t} = \lambda\widetilde{C_t^r} + (1-\lambda)\widetilde{C_t^n}$

To derive an estimable equation, I combine the log-linearized Euler equation in Equation 5 and combine it with the log-linearized aggregate equations of income and consumption to arrive at:[7]

$$\Delta \tilde{C}_t = \alpha_1 \Delta \tilde{C}_{t-1} + \alpha_2 \Delta \tilde{G}_t + \alpha_3 \Delta \tilde{R}_t + \lambda \Delta Y_t + \nu_t, \quad (7)$$

where $\alpha_1 = (1 - \lambda)\alpha_c > 0$, $\alpha_2 = (1 - \lambda)\alpha_g > 0$, $\alpha_3 = -(1 - \lambda)\alpha_r > 0$, $0 \leq \lambda < 1$, and $\nu_t = (1 - \lambda)\varepsilon_t$ given the full definitions of the parameter α_c, α_g, and α_r in Equation 5.

Before proceeding with the empirical estimations, it is important to define the economic interpretation of each parameter. The details are presented below.

1. If there are external habits in private consumption, then $\alpha_1 > 0$ and for model stability,

   $\alpha_1 \in (0, 1)$.

2. If $u(.)$ is a strictly concave in C^r, then the cross-partial derivative $u_C r\ G \in R$ guides the sign of $\alpha_2 = (1 - \lambda)\alpha_g$ where $\alpha_2 \in R$. Hence, if α_2 is less (greater) than zero, private and government consumption are substitutes (complements) in the Edgeworth pareto sense. When α2 is zero, private and government consumption are unrelated and changes in *Gt* do not alter the marginal utility of private consumption.

3. If $u(.)$ is strictly increasing and strictly concave in C^r, then α_3 is greater than zero. Note that α_3 captures the responsiveness of consumption growth to changes in real interest rates.

4. If rule-of-thumb consumers are present alongside Ricardian agents, then $\lambda \in (0, 1)$.

Various models are nested in Equation 7, which can be summarized as follows: Pure permanent income hypothesis implies $\lambda = 0$ and the parameter governing habit formation, α_1, is zero. A representative agent model with habit formation implies that only λ is equal to zero. A heterogeneous (i.e., two-agent with Ricardian and rule-of-thumb consumers) model with consumption smoothing (i.e., habit formation) implies α_1, $\lambda \in (0, 1)$. Because Equation 7 captures salient household aggregate behaviour, the estimation results will serve as a test of this particular model and also provide the general relevance of aggregate behaviours like the complementarity (or substitutability) of government consumption, habit formation in private consumption, rule-of-thumb consumption behaviour, and consumption's responsiveness to changes in interest rates. Equation 7, therefore, motivates the empirical estimation that follows.

4. Methodology and data

The main equation for estimation is the following structural equation:

$$\Delta C_{it} = \alpha_1 \Delta C_{it-1} + \alpha_2 \Delta G_{it} + \alpha_3 \Delta R_{it} + \lambda \Delta Y_{it} + \varepsilon_{it}, \quad (8)$$

where i and t represent each country in the panel and time, respectively. The variables C_t, G_t, and Y_t are the logarithm of private consumption, government consumption and real GDP per capita terms, respectively. R_t is the logarithm of the gross real interest rate in the economy. A variable ΔX captures the first difference of the level variable X. The parameter α_1 governs the degree of habit formation, the parameter α_2 captures the Edgeworth pareto relationship between private and government consumption in private utility, α_3 is consumption's response to the real interest rate, and λ captures the size of rule-of-thumb agents in the economy. Given the transformation of the variable governed by the theoretical model (i.e., log-linearization), the empirical specification by design accounts for country-specific effects through first difference of the data and precludes a constant term.

The estimable structural equation implied by the theoretical model in Equation 8 and the utilization of panel data suggest that dynamic panel model estimation is appropriate in this scenario. Moreover, given that the model employs first differenced data, it is natural to use the difference generalized method of moments (GMM) estimator by Arellano and Bond (1991) as the baseline estimator. In particular, Arellano and Bond (1991) proposed a dynamic panel GMM estimator that produces consistent estimates in the presence of dynamics and endogenous regressors (see Gaspart and Pecher, 2019, for a discussion). Note that government consumption and income are all likely to be endogenous rather than exogenous. For example, government consumption is likely to be correlated with the error term through global shocks and factors. Consequently, a standard ordinary least squares (OLS) method will likely yield biased estimates. The difference GMM estimator corrects for some of these standard empirical challenges. Specifically, the first difference transformation is used to expunge country-specific effects; thereby allowing earlier lags of the endogenous variables to be used as instruments. The GMM estimator proposed by Arellano and Bond (1991) provides consistent estimates for such models. I, therefore, employ the difference GMM estimator partly because of the guidance from the theoretical model and, more importantly, because there are no reasonable external instruments for the endogenous regressors in the model.[8]

To ensure that the results are generally valid and credible, results are reported from different model specifications as well as a battery of post-estimation tests as advised by Roodman (2009a). In summary, I report results from different specification including the one-step GMM estimator, the two-step GMM estimator, which is asymptotically efficient and robust to all kinds of heteroskedasticity, and Windmeijer-corrected standard errors as in Windmeijer (2005).[9] For each GMM specification, I report the Hansen J-test of instrument validity, and Arellano and Bond (1991) autocorrelation tests. Importantly, I follow Bazzi and Clemens (2013) and report the underidentification tests of Kleibergen and Paap (2006). A rejection of the null (a large test statistic) indicates that the model is identified (i.e., the excluded instruments are "relevant"). Failure to reject indicates that the model is underidentified.

Data and summary statistics

The model is estimated using unbalanced panel data comprising 34 sub-Saharan African countries over the period 1960–2018. The 34 countries in the panel were employed primarily due to data availability. Specifically, with the exception of South Africa where the the time period for data for the dependent variable (private consumption) spans the whole 1960–2018, data for several countries are sparse with data availability starting in the 1980s and 1990s. Despite these challenges with data scarcity, the number of countries in the sample represents more than 70% of the total number of countries in the region (i.e., 48) and its population. Consequently, the sample is a good representation of the region. The complete list of countries in the sample employed in the estimation is presented in Table A1 in Appendix A. Recall also that the baseline estimator, the difference GMM, is designed for small time horizons, T, and a large number of panel units, N. To meet these criteria, I average the data over a five-year period, which results in a total number of observations of 134. The averaging of the data does not only ensure that the maximum time horizon (T_{max} = 12) is less than the number of panel units (N = 34), but it also smooths cyclical fluctuations.[10]

As in Kraay (2014), all the variables are measured in local currency units, and are in real per capita terms of the country. The interest rate variable is the real interest rate. All the data are from the World Development Indicators (World Bank, 2021). A detailed description of each variable is provided in Table B1 in Appendix B.

Table 1 provides summary statistics for all the variables employed in the regression estimations, as well as correlation between the dependent variable, consumption growth and the explanatory variables. As shown in the table, the mean consumption growth over the sample period considered is approximately 10.6%, implying that SSA countries in the sample have witnessed growth in consumption on average. However, the growth rate ranges between -61.2% and 55.74% with a standard deviation of 15.36%. Indeed, Table B1 (Appendix B), which presents the country-by-country averages, shows a large heterogeneity in per capita consumption growth. In particular, while consumption growth has fallen, on average, in Somalia (-5.4%) and South Sudan (-34%), Lesotho (39.6%), Liberia (18.7%), and Mauritius (20.6%), for example, have

on average seen a large growth in private consumption. Government consumption growth has an average value of 14.64% and ranges from -68.7% to 197.2% with a standard deviation of 30.3%. The large maximum value for government consumption growth is driven by Nigeria, the largest economy in Africa. With a standard deviation of 10.65%, output per capita growth is less volatile compared to private and government consumption growth. Although per capita government consumption has grown on average in several countries, countries such as , The Gambia, Madagascar, and Somalia have recorded a fall. The mean for GDP per capita growth is 8.36% with values ranging from -22.86% to 31.6%. Some of the countries in our sample have undergone periods of both substantial economic downturn and upturn in output per worker growth. For example, countries including Burundi, The Gambia, Madagascar, Somalia, and South Sudan have, on average, all recorded a fall in GDP per capita growth (see Table B1 in Appendix B). The average change in the real interest rate is 1.03 percentage points with a standard deviation of 8.3 percentage points. Finally, the change in the age dependency ratio, which is measured as the ratio of people younger than 15 or older than 64 to the working-age population, is -2.88 percentage points on average. This implies that there has been a reduction in the age dependency ratio on average. Table B1 in Appendix B further reports the country-specific average of the variables used in the estimation.

Table 1: Summary statistics of variables employed in regression

Variable	Mean	SD	Min	Max	Corr(ΔC_t, ΔX_t)
Key variables (in first difference)					
log private consumption per capita (ΔC_t)	0.1060	0.1536	-0.6115	0.5574	0.5292[a]
log government consumption per capita	0.1464	0.3030	-0.4942	1.9518	0.4769
log gross interest rate	0.0103	0.0830	-0.2261	0.6426	-0.0363
log GDP per capita	0.0836	0.1065	-0.2286	0.3160	0.6076
Robustness variable (in first difference)					
Age dependency ratio (% of working-age population)	-2.8834	3.2076	-11.44	3.4197	-0.1598

Notes: Author's computation of World Development Indicators data (World Bank, 2021). The data are transformed to match the version used for estimation. The real gross interest rate is computed as $\log 1 + \frac{\text{Real rate}}{-}$. Corr($\Delta Ct$, ΔXt) is the correlation between the consumption growth (ΔCt) and the explanatory variables, ΔXt. [a] Corr(ΔC_t, ΔC_{t-1})

The last column of Table 1 presents the correlation between private consumption growth and the explanatory variables. First, the relationship between changes in private consumption and public consumption is positive. In contrast, the relationship between the real interest rate and private consumption is negative but small. This is at odds with predictions from standard consumption models where the relationship between these two variables is positive. Meanwhile, there is a positive relationship between consumption growth and GDP per capita growth. Finally, the correlation between changes in the age dependency ratio and consumption growth is negative, implying that increases in the age dependency ratio is associated with a fall in consumption growth. While preliminary, these correlation results present a tentative guide to the relationship that the empirical estimation seeks to uncover in more detail.

5. Main results

The main findings are presented in Table 2. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. It is worth mentioning that the baseline model is one that assumes heterogeneous agents (columns 3 and 4). I report the results from the representative agent model partly for completeness and for comparison. As observed in the table, the estimated coefficients from the regressions, regardless of model assumptions, are well-defined in that they obey the standard preference properties imposed by the theory in Section 3. To discuss the results, I start with columns 1 and 2, where I assume the presence of only Ricardian agents in the model, i.e., a representative agent model. First, the table shows evidence of habit formation where the estimated parameter governing habits, $\alpha 1$, is around 0.83 and is statistically significant at the 1% level. Second, regarding the relationship between public and private consumption in private utility, the estimated coefficient, $\hat{\alpha}2$, is positive and statistically significant at conventional levels. The estimated positive parameter implies that private and government consumption are Edgeworth complements in private utility under the representative agent model. The coefficient on the real interest rate is, as expected, positive and statistically significant at conventional levels. This suggests that under the representative agent model, changes in private consumption responds to changes in interest rates.

Table 2: Baseline estimates of preference parameter

	Representative agent model		Heterogeneous agent model	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
Habits, $\hat{\alpha}_1$	0.826*** (0.104)	0.834*** (0.109)	0.584*** (0.0671)	0.585*** (0.0707)
Edgeworth complementarity, $\hat{\alpha}_2$	0.181*** (0.0482)	0.172*** (0.0521)	0.119*** (0.0427)	0.115*** (0.0444)
Real interest rate, $\hat{\alpha}_3$	0.336** (0.159)	0.387*** (0.135)	0.243* (0.144)	0.275** (0.121)
Rule-of-thumb, $\hat{\lambda}$			0.370*** (0.108)	0.376*** (0.118)
Observation	134	134	134	134
Hansen *J* test (*p*-value)	0.327	0.327	0.455	0.455

Serial correlation test (p-value)	0.507	0.509	0.377	0.394
Kleibergen-Paap LM test (p-value)	0.003	0.003	0.002	0.002

Notes: *** p <0.01, ** p <0.05, * p <0.1. Robust standard errors are in parentheses. $\Delta C_t = \alpha_1 \Delta C_{t-1} + \alpha_2 \Delta G_t + \alpha_3 \Delta R_t + \lambda \Delta Y_t + \varepsilon_t$. Columns 1 and 2 assume a representative agent model, hence precludes the term ΔY in the regression. Columns 3 and 4 assume a rule-of-thumb agent, hence includes this term. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. For the Hansen *J* test, the null hypothesis is that the instruments are not correlated with the residuals. For the serial correlation test, the null hypothesis is that the errors in the first difference regressions exhibit no second order serial correlation. The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is underidentified (i.e., the rank condition fails). The test uses a procedure from Kleibergen and Paap (2006). For the instrumentation strategy, a combination of curtailed and collapsed instruments were used, therefore, the number of lags of dependent and endogenous variables are limited to two and one, respectively.

Columns 3 and 4 in Table 2 include the more realistic and standard assumption of rule-of-thumb agents. Recall that this specification is also the preferred model. It is evident that the key results uncovered in the model with only Ricardian agents (i.e., representative agent model) hold. More precisely, there is evidence of habit formation as the estimated coefficient is 0.584 and 0.585 in columns 3 and 4, respectively. However, interestingly, it is clear that under the assumption of a representative agent who is Ricardian, the size of the estimated habit formation parameter is larger than the model where heterogeneous agents are introduced. This suggests that under the assumption of representative agent, the degree of habit formation can be over-estimated as it discounts agents who consume all the income. The latter is clearly due to the typical omitted variable bias. Moreover, the evidence of Edgeworth complementarity revealed in columns 1 and 2 still holds under the more relaxed assumption of the presence of non-Ricardian agents as the estimated coefficients are positive. The estimated relationship between private and government consumption in SSA countries is in stark contrast to studies such as the one by Dawood and Francois (2018) who uncover an Edgeworth substitutability relationship between the two consumption goods. Conversely, the finding supports the results in Karras (1994), who finds that private and government consumption are best described as complementary goods for a mix of countries. More importantly, the coefficient of income per capita, λ, which governs the fraction of non-Ricardian agents, à la Campbell and Mankiw (1989), is estimated to be 0.37–0.38. This captures that there is a non-trivial fraction of households who live hand-to-mouth in SSA countries. The size of this estimated parameter is sensible, and it is important to give some context to this value. Of the world's 28 poorest countries, 27 are in sub-Saharan Africa and they all have a poverty rate that is consistently above 30 per cent.[11] A natural hypothesis would seem to be that fewer people in poorer countries have access to the banking system which would mean they cannot smooth consumption as much as they would desire, and they therefore have to live hand-to-mouth. Albeit from aggregate data, it is therefore not surprising that the results uncover that approximately 38% of households in SSA follow a rule-of-thumb consumption. Importantly, the estimated rule-of-thumb agents is larger than those estimated for developed countries where recent estimates have

been found to be around 11% (see Havranek and Sokolova, 2020, for a discussion and evidence). Moreover, using aggregate consumption data, a more recent study by Jalles and Karras (2021) find no evidence of rule-of-thumb consumption behaviour in a set of OECD countries. Finally, the response of consumption growth to real interest rate changes is positive and statistically significant at conventional levels. Nonetheless, the estimated coefficients are smaller compared to the results from the representative agent model. This is not surprising because in the presence of rule-of-thumb agents who are "myopic" and do not respond to interest rate changes, one would expect that aggregate consumption will be less sensitive to changes in interest rates.

Turning to post-estimation tests, it is evident throughout the table that the *p*-value of the Hansen *J* test is greater than the 5% significance level in all cases. This implies that one cannot reject the null hypothesis that the instruments are valid. Furthermore, the test focusing on serial correlation shows that the *p*-values of the Arellano and Bond AR(2) statistics are all above the 5% significance level. This confirms the absence of second-order serial correlation which, if present, would render our results inconsistent. For the Kleibergen-Paap LM test, the *p*-values show a rejection of the null, which indicates that the matrix is full column rank, i.e., the model is identified.[12]

6. Robustness

In this section, I conduct a battery of robustness exercises to ensure that the baseline findings are consistent across model specifications, such as the inclusion of demographic effects and a different lag structure employed for the internal instruments in the estimation. Additionally, I check for some evidence of structural stability by estimating the model for the 1990-2018 and 2000-2018 periods. Moreover, I employ an alternative measure of the aggregate macroeconomic variables used for estimation (i.e., constant US dollars instead of local currency measure). The section concludes by comparing estimates across models and reporting the confidence intervals of the point estimates of the parameters of interest to help validate the estimates.

Demography

In the spirit of Lawrance (1991), Dynan (2000), and Fiorito and Kollintzas (2004), I include a demographic factor of households, which also doubles as a taste-shifter, i.e., an exogenous variable that moves marginal utility.[13] I proxy for this variable using age dependency ratio of the country. Notice that the well-being (or utility) of households depends critically on the demographic composition of households. Consider a household that comprises large fraction of young and old relative to working age members, i.e., high dependency age ratio. Such a household will likely demand higher education and health services compared to a household with a smaller fraction of young and old. On aggregate, this can impact the composition of government consumption and hence, the latter's relationship with private consumption in utility. That is, a country with high dependency ratio may have a sizeable fraction of its government consumption comprising health and education. Consequently, if not explicitly controlled for, this can lead to an omitted variable bias, which can impact the estimated relationship between private and government consumption.

Table 3: Parameter estimates while controlling for demography

	Representative agent model		Heterogeneous agent model	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
Habits, $\hat{\alpha}_1$	0.736*** (0.165)	0.798*** (0.166)	0.566*** (0.0710)	0.572*** (0.0716)
Edgeworth complementarity, $\hat{\alpha}_2$	0.171*** (0.0414)	0.173*** (0.0443)	0.133*** (0.0453)	0.127*** (0.0459)
Real interest rate, $\hat{\alpha}_3$	0.325** (0.163)	0.371*** (0.144)	0.257* (0.147)	0.275** (0.130)
Age dependency, α_4	-0.00316	-0.000952	-0.00371	-0.00291
	(0.00427)	(0.00378)	(0.00276)	(0.00246)
Rule-of-thumb, $\hat{\lambda}$			0.242**	0.266**
			(0.123)	(0.126)
No. of observations	134	134	134	134
Hansen J test (p-value)	0.308	0.308	0.532	0.532
Serial correlation test (p-value)	0.518	0.511	0.430	0.422
Kleibergen-Paap LM test (p-value)	0.0365	0.0365	0.0094	0.0094

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses. $\Delta C_t = \alpha_1 \Delta C_{t-1} + \alpha_2 \Delta G_t + \alpha_3 \Delta R_t + \alpha_4 \Delta \text{Age}_t + \lambda \Delta Y_t + \varepsilon_t$. Columns 1 and 2 assume a representative agent model, hence precludes the term ΔY in the regression. Columns 3 and 4 assume rule-of-thumb agent, hence includes this term. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. For the Hansen *J* test, the null hypothesis is that the instruments are not correlated with the residuals. For the serial correlation test, the null hypothesis is that the errors in the first difference regression exhibit no second order serial correlation. The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is under-identified (i.e., the rank condition fails). The test uses a procedure from Kleibergen and Paap (2006). A combination of curtailed and collapsed instruments was used for the instrumentation strategy, hence the number of lags of dependent and endogenous variables are limited to two and one, respectively. I treat the age dependency ratio as an exogeneous variable as motivated by the theoretical model.

The results are presented in Table 3. I focus on the heterogeneous agent model but present the results from the representative agent for completeness. Generally, the results and main conclusions from the baseline model hold and the estimated size of the coefficients is fairly stable when I control for the demographic factor. In particular, habit intensity is moderate and estimated to be 0.57. Additionally, the coefficient on government consumption, $\alpha_{2,}$ is positive and statistically significant, which implies that private and government consumption complements each other in the Edgeworth pareto sense. Furthermore, consumption growth responds positively to changes in the real interest rate. Moreover, while there is evidence of the presence of rule-of-thumb agents in this version of the model, their estimated sizes (i.e., 0.24–0.26) are generally smaller compared to the baseline estimate. Interestingly, the point estimate for age dependency ratio is negative but statistically non-significant. Finally, the postestimation tests help validate the parameter estimates from the model specifications. That is, the null hypothesis of Hansen *J* and AR(2) tests is not rejected but the null of the underidentification test is rejected at all conventional levels.

Alternative lag treatment strategy for internal instruments

Recall that in the baseline model, I combined lag curtailment and the collapsing of instruments to reduce the number of lags employed as instruments for the estimation. This approach was used to mitigate the problem of "too many instruments", which often weakens several of the postestimation tests (e.g., the Hansen J-test) that help with assessing model validation (Roodman, 2009a, b). However, with difference GMM, results may be sensitive to a particular lag structure selection or strategy, and the results in this paper are subject to this potential lag treatment sensitivity. Indeed, Roodman (2009a, b) encourages practitioners to apply different lag strategies for the internal instruments to check the sensitivity of results to the latter. To further ensure that the result from the lag specification employed in the baseline model is stable and not sensitive to alternative lag specifications, I re-estimate the baseline model by collapsing the number of instruments, but I do not limit the number of lags utilized for instrumentation.[14]

The results are generally the same as the baseline finding and therefore reach the same conclusion. That is, there is evidence of moderate habits, Edgeworth complementarity between private and government consumption, responsiveness of consumption growth to the interest rate, and sizeable rule-of-thumb agents. Furthermore, the size of the estimated parameters is smaller under the model with rule-of-thumb agents. This is consistent with the theoretical prediction and the baseline results in Table 2. However, while the null hypothesis of the Hansen J and serial correlation are not rejected, which are desirable outcomes, the null hypothesis of the Kleibergen-Paap LM test not being rejected is not desirable. This is because it highlights that the structural equation is underidentified (i.e., the rank condition fails). This suggests that, while sensible, the estimated coefficient should be interpreted with caution as not all model properties are satisfied. Furthermore, as Roodman (2009a) discusses, a worrying sign for the validity of estimates is when the Hansen J test is too large and close to unity. The latter is a by-product of too many instruments, and in Table 4, the Hansen J tests in the last two columns are larger and closer to 1 compared to those from the baseline estimations.

Table 4: Parameter estimates under alternative lag strategy for internal instruments

	Representative Agent Model		Heterogeneous Agent Model	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
Habits, $\hat{\alpha}_1$	0.626*** (0.105)	0.624*** (0.108)	0.487*** (0.108)	0.496*** (0.106)
Edgeworth complementarity, $\hat{\alpha}_2$	0.170*** (0.0466)	0.172*** (0.0472)	0.110** (0.0484)	0.107** (0.0529)
Real interest rate, $\hat{\alpha}_3$	0.418*** (0.162)	0.411** (0.180)	0.210** (0.0883)	0.195** (0.0918)

Rule-of-thumb, $\hat{\alpha}$			0.454***	0.443***
			(0.126)	(0.127)
Observation	134	134	134	134
Hansen *J* test (p-value)	0.507	0.507	0.811	0.811
Kleibergen-Paap LM test (p-value)	0.3616	0.3616	0.4677	0.4677
Serial correlation test (p-value)	0.776	0.775	0.491	0.500

Notes: *** p <0.01, ** p <0.05, * p <0.1. Robust standard errors in parentheses. $\Delta C_t = \alpha_1 \Delta C_{t-1} + \alpha_2 \Delta G_t + \alpha_3 \Delta R_t + \alpha \Delta Y_t + \alpha_t$. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. For the Hansen *J* test, the null hypothesis is that the instruments are not correlated with the residuals. For the Serial correlation test, the null hypothesis is that the errors in the first difference regression exhibit no second order serial correlation. The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is underidentified (i.e., the rank condition fails). The test uses a procedure from Kleibergen and Paap (2006). For the instrumentation strategy, the number lags are not limited, but I collapse the instruments.

Structural stability: Some evidence

A natural exercise for this study is to investigate whether the estimated preference parameters uncovered from the consumption equation is invariant to structural changes. Notice that it is well-documented that several developing countries, including SSA countries, have undergone structural change since the 1990s and the 2000s (see De Vries et al, 2015; Diao et al, 2019; McMillan et al, 2017, 2014; McMillan and Rodrik, 2011). More specifically, almost without exception, developing countries have become more integrated with the world economy since the early 1990s (McMillan et al, 2014). Given these structural changes, it is worth investigating the stability of the preference parameters over time. The latter is essential for the model to be immune to the Lucas (1976) critique.

Additionally, and perhaps more importantly, the general growth in access to different forms of financial services (e.g., money transfer systems and mobile banking) via mobile phone after the 2000s has eased access to finance in several SSA countries.[15] With the increase in access to finance, economic agents are more likely to be able to smooth consumption. This naturally suggests that there is a strong possibility that the fraction of rule-of-thumb agents may have fallen over time. To this end, an analysis of the post-2000 era is a first step to investigating the hypothesis of whether, over the period where mobile phones became widespread, the substantial improvement in access to the financial system via mobile banking has been reflected in the size of rule-of-thumb consumption behaviour.

Table 5: Parameter estimates for subsamples

	1990–2018		2000–2018	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
Habits, $\hat{\alpha}_1$	0.603*** (0.0722)	0.600*** (0.0728)	0.673*** (0.110)	0.659*** (0.121)
Edgeworth complementarity, $\hat{\alpha}_2$	0.136*** (0.0453)	0.134*** (0.0455)	0.119*** (0.0452)	0.125** (0.0520)
Real interest rate, $\hat{\alpha}_3$	0.288*	0.303**	0.610	0.236
	(0.155)	(0.138)	(0.936)	(1.062)
Rule-of-thumb, $\hat{\lambda}1$	0.322**	0.327**	0.183	0.173
	(0.129)	(0.130)	(0.162)	(0.172)
Observations	121	121	97	97
Hansen *J* test (p-value)	0.761	0.761	0.295	0.295
Kleibergen-Paap LM test (p-value)	0.0086	0.0086	0.1717	0.1717
Serial correlation test (p-value)	0.443	0.456	0.902	0.948

Notes: *** p <0.01, ** p <0.05, * p <0.1. Robust standard errors are in parentheses. $\Delta C_t = \alpha_1 \Delta C_{t-1} + \alpha_2 \Delta G_t + \alpha_3 \Delta R_t + \lambda \Delta Y_t + \varepsilon_t$. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. For the Hansen *J* test, the null hypothesis is that the instruments are not correlated with the residuals. For the serial correlation test, the null hypothesis is that the errors in the first difference regression exhibit no second order serial correlation. The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is underidentified (i.e., the rank condition fails). The test uses a procedure from Kleibergen and Paap (2006). The number of countries for the subsample analysis is 33. Somalia is the country excluded from the analysis due to lack of data after 1990.

Table 5 presents the results from the stability exercise. I focus exclusively on the heterogeneous agent model. First, for the 1990–2018 period (columns 1 and 2), it is evident that the results are strikingly similar to the parameter estimates from the baseline results in Table 2. In particular, the degree of habits is estimated to be 0.6, which is close to the estimated baseline value of 0.58. The relationship between public and private consumption as Edgeworth complements is preserved in this subsample analysis. Moreover, there is evidence of consumption responsiveness to changes in interest rates, and the estimated size of rule-of-thumb agents is approximately 33%. In contrast, when the subsample analysis is further restricted to the post-2000 era (i.e., 2000–2018), it is observed that the size of rule-of-thumb agents reduces but, more importantly, the estimated coefficients are not statistically significant at conventional levels (columns 3 and 4). This finding is not surprising in that the post-2000 period was characterized by growth in mobile phone usage and by the mid-2000s access to mobile banking and mobile money became widespread in African countries, including in rural areas. The latter suggests that a greater number of people in poorer countries have access to the banking system via mobile banking, and can now smooth consumption through savings or borrowing. This last result is also reflected in the size

of the habit parameter for the post-2000 period, which is relatively larger compared to benchmark estimates in Table 5. Furthermore, the complementarity between private and government consumption is still preserved for the post-2000 subsample period. The presence of habits, with fairly stable parameters, and the preservation of the complementarity between public and private consumption in utility suggest that these preference relations are stable over time.

This section concludes on a cautionary note: while all the post-estimation tests are satisfied for the 1990–2018 sub-period analysis, the story is not the same for the 2000–2018 subsample analysis. In particular, although the Hansen J-test and serial correlation test are satisfied, the null hypothesis of the Kleibergen-Paap test cannot be rejected for the 2000–2018 period, suggesting that the model is underidentified.[16] Consequently, the results in columns 3 and 4 in Table 5 should be interpreted with caution.

Alternative measure with variables in US dollar

Different measures of the data are employed for the estimation. In the baseline estimation, I follow Kraay (2014) and utilize aggregate data measured in the constant local currency of the countries in the sample. The primary reason for using this measure is that data are available for more countries compared to other competing measures. However, in this section I employ data measured in constant US dollars as an alternative measure. The exercise is to highlight that the baseline results are not sensitive to different measures of the data. When I employ the constant dollar measure of the data, the sample size reduces to 32 countries – Seychelles and Somalia are omitted due to lack of data.

The results are reported in Table 6. The key results from the baseline hold. In particular, there is evidence of moderate habit formation, public and private consumption are Edgeworth complements, and the presence of rule-of-thumb agents. In most of the model specifications presented in the table, consumption growth does not respond to the real interest rate. However, consumption growth responds positively to changes in the real interest rate at the 10% confidence level (column 4 in Table 6). Post-estimation tests are satisfied, which further help to validate the results from the model.

Table 6: Parameter estimates under alternative measure with USD

	Representative agent model		Heterogeneous agent model	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
Habits, $\hat{\alpha}_1$	0.757*** (0.121)	0.736*** (0.143)	0.561*** (0.0701)	0.555*** (0.0799)
Edgeworth complementarity, $\hat{\alpha}_2$	0.236*** (0.0579)	0.238*** (0.0717)	0.133** (0.0597)	0.137* (0.0705)

Real interest rate, $\hat{\alpha}_3$	0.124	0.152	0.101	0.125*
	(0.111)	(0.119)	(0.0663)	(0.0669)
Rule of thumb, $\hat{\lambda}$			0.404***	0.414***
			(0.120)	(0.151)
Observation	127	127	127	127
Hansen *J* test (p-value)	0.219	0.219	0.225	0.225
Kleibergen-Paap LM test (p-value)	0.0032	0.0032	0.0030	0.0030
Serial correlation test (p-value)	0.904	0.897	0.642	0.656

Notes: *** p <0.01, ** p <0.05, * p <0.1. Robust standard errors are in parentheses. $\Delta C_t = \alpha_1 \Delta C_{t-1} + \alpha_2 \Delta G_t + \alpha_3 \Delta R_t + \lambda \Delta Y_t + \varepsilon_t$. Odd and even numbered columns employ the one-step and two-step GMM estimator, respectively. For the Hansen *J* test, the null hypothesis is that the instruments are not correlated with the residuals. For the serial correlation test, the null hypothesis is that the errors in the first difference regression exhibit no second order serial correlation. The null hypothesis of the Kleibergen-Paap LM test is that the structural equation is underidentified (i.e., the rank condition fails). The test uses a procedure from Kleibergen and Paap (2006). The sample size comprises 32 countries – Seychelles and Somalia are omitted due to lack of data.

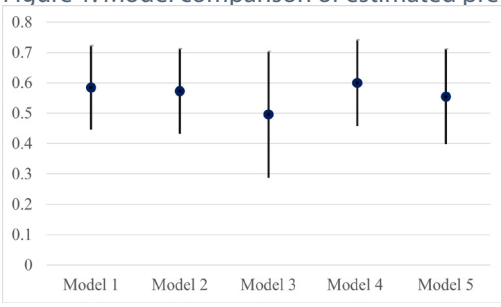
Model comparison

In this section, I present the estimates from all five models employed in the paper. In the spirit of Romer (2020), I also report the point estimates with their corresponding confidence intervals. This is particularly important because it sheds light on the viability of the model and estimates from the models considered in the paper. More precisely, consider the case of the estimates for the size of rule-of-thumb agents: by definition, and as highlighted by the theoretical model in Section 3, the estimated coefficient must be strictly positive but cannot be greater than 1. Consequently, even if the point estimates meet this criterion but the upper bound of the confidence band exceeds unity, it can be a signal of an inaccurate estimate. Importantly, the strength of the evidence against values close to zero also becomes relevant in this situation. To proceed with this exercise, I use estimates from the models in each table presented in the previous sections where the presence of rule-of-thumb agents is assumed and the more efficient two-step GMM estimator is employed.

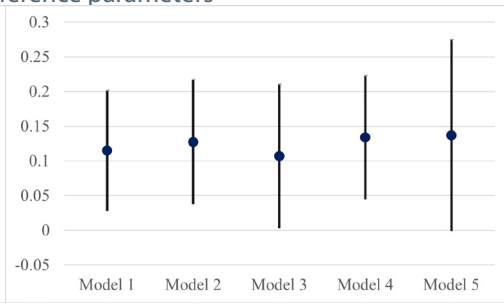
Figure 1 plots the point estimates and their corresponding 95% confidence interval for each model. It is evident from the figure that for each estimated preference parameter, the size of the parameter is fairly stable across models. Generally, the figure in Panel A shows that there is overwhelming evidence of habit formation with lower bounds being far away from zero and upper bounds, less than 1 but closer to 0.6. Additionally, Panel B of the figure shows that one cannot discount the internalization of government consumption in private utility and, therefore, its Edgeworth complementary relationship with private consumption. Specifically, with the exception of Model 5 where the point estimate is positive and statistically significant at the 10% level, but the confidence interval contains zero, the other four models uncover intervals that exclude zero. Furthermore, estimates from Panel C show that four out of five models provide evidence that consumption growth

responds positively to interest rate changes.[17] This is in line with the prediction from the theoretical model and supportive of previous studies such as the one by Raut and Virmani (1989). Finally, in Panel D, point estimates from all five models lend strong support to the presence of rule-of-thumb agents. More precisely, the point estimates range from 0.27 to 0.44 and the lower (upper) bounds of the parameter from all the models are greater (less) than zero (unity).[18]

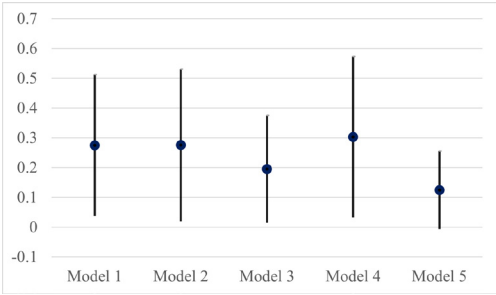
Figure 1: Model comparison of estimated preference parameters



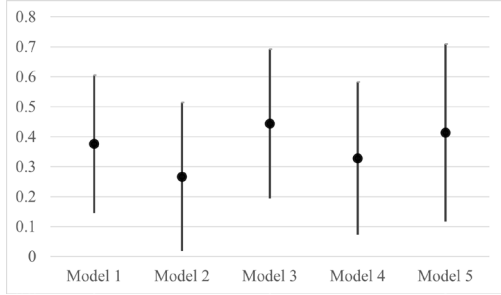
Panel A: Degree of habit formation



Panel B: Degree of Edgeworth complementarity



Panel C: Response to interest rate change



Panel D: Size of rule-of-thumb agents

Notes: The solid dot in the middle of each vertical line is the point estimate from a specified model. The corresponding vertical lines are the 95% confidence intervals of the point estimate of each parameter. *Model 1* is the baseline model, *Model 2* augments the baseline model with a demographic variable, age dependency ratio, *Model 3* is the baseline model under alternative lag specifications, *Model 4* estimates the baseline model for the subsample 1990–2018, and *Model* 5 estimates the baseline model with an alternative measure (i.e., constant US Dollars) of the macroeconomic variable. The estimation results from the subsample analysis for the 2000–2018 period is excluded from the summary partly because the estimates for the preference parameters (α_1 and α_2) from that analysis are generally represented by the 1990–2018 analysis and partly because the lower bound for the rule-of-thumb and interest rate parameters violate the theoretical restriction of these parameters imposed by the model in Section 3.

7. Conclusion and policy implication

This paper studies household consumption behaviour in sub-Saharan African countries using aggregate consumption data. Under a generalized utility function, I use dynamic panel data techniques to estimate a structural consumption model to uncover: (a) the degree of habit formation, (b) whether public consumption substitutes for or complements private consumption in private utility in an Edgeworth pareto sense, and (c) the rule-of-thumb consumption behaviour of private agents for 34 SSA countries. There is sufficient evidence of a moderate degree of habit formation. Moreover, the results show that there is evidence of rule-of-thumb agents with estimates revealing that about 27%–44% of the fraction of the population do not smooth consumption. These two results suggest a strong deviation from the permanent income hypothesis. The finding of the presence of rule-of-thumb agents in aggregate consumption data is not surprising. More precisely, SSA comprises several low-income countries and it is likely that fewer people in these poorer countries have access to the banking system and therefore cannot smooth consumption as much as they would desire. However, it is interesting that when I restrict the sample to the post-2000 period, where mobile phones and mobile banking have become widespread, I find no evidence of rule-of-thumb behaviour in the aggregate consumption data. Finally, I find that public consumption enters private utility directly, and it is an Edgeworth complement to private consumption implying that an increase in public consumption raises private consumption via a positive marginal utility channel.

The policy implications of the findings are as follows: First, Edgeworth complementarity between public and private consumption suggests that, all else being equal, fiscal consolidation involving cuts in government consumption can be self-defeating by decreasing private consumption via a negative marginal utility channel. Conversely, an expansionary fiscal policy involving an increase in government consumption can be effective by offsetting the negative wealth effect through a marginal utility channel of consumption. From the aid effectiveness perspective, the result that private and public consumption are Edgeworth complements implies that an increase in government consumption due to general fungibility will generate a positive marginal utility of private consumption and reinforce the positive effect of foreign aid for public investment. Consequently, if present, general fungibility will not have an adverse effect on aid effectiveness. Second, as Galí et al (2004) discuss, the standard Taylor rule becomes too weak a criterion for stability when the share of rule-of-thumb consumers is large. Galí et al (2004) point out that the size of the inflation

coefficient that is required to rule out multiple equilibria is an increasing function of the weight of rule-of-thumb consumers in the economy. The results in this paper suggest that a standard Taylor rule applied to developed countries cannot be applied one-for-one in SSA countries. Instead, monetary policy needs careful designing as the size of rule-of-thumb agents is found to be large. Third, in the context of tax evasion, Bernasconi et al (2020) show that for a constant level of risk aversion, consumers tend to reduce their levels of tax evasion over time because of habit formation. Furthermore, in the long term, consumers want to keep their standard of living, but they are less willing to bear the risk that payment of a fine will reduce their income and prevent them from consuming, at least, their habit. The authors show that habit formation has a dampening effect on tax evasion, and heavy fines are more efficient than frequent controls in reducing tax evasion. The results in this paper confirm that the presence of habits in consumption in SSA can help guide effective policies that target tax evasion in the region

Understanding household behaviour is clearly of first-order importance in both the policy and academic circles. In the context of SSA, this paper has uncovered a number of important aggregate household behaviour using aggregate consumption data. The use of aggregate data was necessary partly because of the lack of reliable and available micro-data in these countries and because macroeconomic policies often require an understanding of aggregate behaviour. As quality micro-data become available, however, future studies can complement the study in this paper by utilising rich micro-data to re-estimate the key parameters from the consumption model or at least shed light on what factors are driving these aggregate relationships. For example, micro-data will accurately capture the rule-of-thumb behaviour than aggregate data. Moreover, in the context of what role demographics play, micro-data can help shed light on some salient differences of consumption behaviour amongst different groups (e.g., old *versus* young). The latter can have important implications for policy design, which may include the design of the composition of government consumption. Relatedly, while the macro data used in this study captures important consumption patterns and comprises both durable and non-durable consumption both of which are important in quantifying habits, it has a limitation of not capturing demographic characteristics and may overestimate habits associated with Ricardian agents (Havranek et al, 2017). Given that the use of macro data rather than micro data is partly due to data availability, future studies can complement this study by revisiting the question of habit formation of Ricardian agents as micro-data become available.

Notes

1 Two goods are Edgeworth substitutes (complements) in utility if their cross-partial derivative is negative (positive), so that ceteris paribus, an increase in consumption of the first good reduces (increases) the marginal utility of the second (Amano and Wirjanto, 1998; Karras, 1994; Samuelson, 1974).

2 The implication of Edgeworth complementarity between private and public for the size of the fiscal multiplier have been extensively studied in general equilibrium models (see for example, Bouakez and Rebei, 2007; F`eve et al, 2013; Ganelli and Tervala, 2009; Leeper et al, 2017, amongst others).

3 Typically, high habit formation is estimated to be greater than or equal to 0.7 in the studies that employ macroeconomic data for estimation (see, for example, Fuhrer, 2000, who finds habit parameter estimates to be 0.9). See also Havranek et al (2017) for a summary of external habit formation parameter values from macroeconomic studies.

4 At the micro-level, studies such as those by Harrower and Hoddinott (2005) have examined consumption smoothing in the Zone Lacustre in Mali. The authors find that idiosyncratic shocks appear to have little impact on consumption. However, a stronger test of consumption smoothing shows that controlling for covariate shocks, changes in household income lead to modest changes in consumption.

5 Effective consumption here is defined as $C^e = C + \alpha_g G$, where C and G are private and public consumption, respectively, and α_g less (greater) than zero governs Edgeworth complementarity (substitutability) of the two consumption goods. It is worth mentioning that Jalles and Karras (2021) also estimate habit formation in the model for these OECD countries. However, they preclude consumption's response to interest rates.

6 Since the work of Abel (1990), external habit formation has become known as "catching up with the Joneses". The external form of habit persistence simplifies the optimization problem of the consumer because the evolution of the stock of habit is taken as exogenous by the individual.

7 It is worth mentioning that with the log-linearization approach employed in this paper, the parameter λ can no longer be precisely interpreted as the fraction of agents who consume their current income. However, one can view the model I estimate as the log-linear approximation to the true model. Thus, the interpretation of the results is not substantially affected (see Campbell and Mankiw, 1989, for further discussions).

8 The difference GMM is not without its weaknesses. More specifically, Arellano and Bover (1995) point out that the lagged levels can be poor instruments for first differences. Additionally, Roodman (2009a) notes that the difference transformation of the data magnifies gaps in unbalanced panels that have gaps. Fortunately, the data employed for estimation do not contain gaps.

9 As Roodman (2009a) discusses, in difference GMM regressions on simulated panels, the two-step efficient GMM performs better than the one-step in estimating coefficients, with lower bias and standard errors. Additionally, the reported two-step standard errors, with Windmeijer's correction, are quite accurate, so that the two-step estimation with corrected errors seems modestly superior to cluster-robust one-step estimation.

10 I also average the data using 4-year averages. The preliminary results for the estimation using this data treatment are similar to the results when the 5-year average is used. However, the estimates from the 5-year average treatment of the data were more stable.

11 See Patel (2018) for details.

12 The underidentification test is a Lagrange-multiplier (LM) test of whether the equation is identified, i.e., that the excluded instruments are relevant, meaning correlated with the endogenous regressors.

13 Following Dynan (2000) and Fiorito and Kollintzas (2004) the instantaneous utility function in Equation 1 can be modified as $u(C^r, G_t, H^c; \psi_t)$, where ψ_t corresponds to a demographic variable, in this case age dependency ratio.

In the log-linearized model ψ_t becomes another variable in the estimation equation.

14 See Roodman (2009a) and Kripfganz et al (2019) for a discussion on different strategies to limit lags of endogenous regressors used as internal instruments in dynamic panel models. It is important to add that I estimate the model with several alternative lag specifications for instruments. Specifically, I estimated the model in the case where I curtail the lags for instruments, but do not collapse instruments. Furthermore, I estimated the model for a case where I place no restriction on the number of lags of endogenous variables that can be used as internal instruments (i.e., I do not curtail nor collapse the instruments). While results were similar in most cases, the postestimation tests were severely weakened, hence invalidating the results.

15 Mobile phone banking began in the early 2000s in Kenya. Today, mobile money systems are ubiquitous in SSA countries, and 72% of people have a mobile money account in Kenya. For an additional discussion, see https://www. vox.com/future-perfect/21420357/kenya-mobile-banking-unbanked-cellphone-money.

16 This conclusion from the Kleibergen-Paap test for the 2000–2018 analysis is not unique to this particular model specification. I employed several alternative specifications, including different lag structures for the internal instruments. While the results were strikingly similar, the Kleibergen-Paap test consistently showed that the models were underidentified.

17 The results from the 2000–2018 subsample analysis, which is not reported in the summary, also uncovers statistically insignificant estimates of the coefficient of interest rate changes.

18 Results from the 2000–2018 subsample period are not reported because the lower bound values of the confidence interval for the size of rule-of-thumb agents violates the positive parameter restriction imposed by the theoretical model.

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Appendix

Appendix A: List of countries in the sample

Table A1: Countries employed for estimation

Angola	Gambia, The	Namibia	Tanzania
Benin	Guinea-Bissau	Niger	Togo
Botswana	Kenya	Nigeria	Uganda
Burkina Faso	Lesotho	Rwanda	Zimbabwe
Burundi	Liberia	Senegal	
Cabo Verde	Madagascar	Seychelles	
Comoros	Mali	Sierra Leone	
Congo, Dem. Rep.	Mauritania	Somalia	
Côte d'Ivoire	Mauritius	South Africa	
Eswatini	Mozambique	South Sudan	

Appendix B: Summary statistics by country

Table B1: Summary statistics by country

Country	ΔC_t	ΔG_t	ΔR_t	ΔY_t	ΔAge_t
Angola	0.165	-0.067	-0.055	0.023	-0.414
Benin	0.024	0.098	0.012	0.063	-2.553
Botswana	0.192	0.201	-0.004	0.168	-6.275
Burkina Faso	0.075	0.179	0.012	0.119	-2.446
Burundi	0.017	0.345	0.015	-0.014	-4.636
Cabo Verde	0.070	0.020	-0.007	0.040	-5.275
Comoros	0.026	0.039	0.005	0.030	-4.387
Congo, Dem. Rep.	0.090	0.109	-0.092	0.136	0.671
Côte d'Ivoire	0.253	0.117	-0.070	0.226	-3.278
Eswatini	0.152	0.240	0.000	0.134	-6.129
Gambia, The	0.001	-0.017	-0.013	-0.027	-2.771
Guinea-Bissau	0.058	0.177	-0.025	0.051	-1.998
Kenya	0.047	0.084	0.002	0.048	-4.043
Lesotho	0.396	0.587	0.005	0.123	-5.663
Liberia	0.187	0.575	0.020	0.076	-2.635
Madagascar	-0.033	-0.103	0.046	-0.026	-2.882
Mali	0.126	0.063	0.016	0.052	0.448

Mauritania	0.013	-0.144	0.013	0.002	-2.361
Mauritius	0.206	0.136	0.008	0.200	-2.847
Mozambique	0.168	0.426	-0.004	0.212	0.106
Namibia	0.180	0.096	-0.008	0.101	-4.380
Niger	0.060	0.106	0.019	0.083	1.255
Nigeria	0.117	0.304	0.016	0.098	-0.762
Rwanda	0.201	0.276	0.017	0.217	-2.417
Senegal	0.033	0.026	0.015	0.063	-0.835
Seychelles	0.090	0.110	-0.005	0.108	-4.817
Sierra Leone	0.043	0.008	0.080	0.010	-1.708
Somalia	-0.054	-0.033	-0.034	-0.074	-0.093
South Africa	0.061	0.068	0.001	0.025	-3.182
South Sudan	-0.340	0.049	-0.044	-0.333	-3.466
Tanzania	0.104	0.153	0.025	0.155	-0.696
Togo	0.050	0.338	-0.037	0.124	-1.635
Uganda	0.124	0.097	0.128	0.150	-0.539
Zimbabwe	0.069	0.501	-0.136	0.100	1.490
Total	0.106	0.146	0.010	0.084	-2.883

Note: The table presents the means of the key variables employed in the estimation for each country.

Source: Author's computation of World Development Indicators.

Appendix C: Long definition of key variables and sources)

- Household and (NPISH) final consumption expenditure (constant local currency unit). Household and NPISHs final consumption expenditure (formerly private consumption) is the market value of all goods and services, including durable products (such as cars, washing machines and home computers) purchased by households. It excludes purchases of dwellings, but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments to obtain permits and licenses. This indicator includes the expenditures of non-profit institutions serving households even when reported separately by the country. Data are in constant local currency. Data available at: https://databank.worldbank.org/source/world-development-indicators
- General government final consumption expenditure (constant local currency unit). General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation. Data are in constant local currency. Data available at: https://databank.worldbank.org/source/world-development-indicators
- Real interest rate (%). Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. However, the terms and conditions

attached to lending rates differ by country, limiting their comparability. Data are available at: https://databank.worldbank.org/source/world-development-indicators

- GDP per capita (constant local currency unit). GDP per capita is gross domestic product divided by mid-year population. GDP at purchasers' prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without deducting the depreciation of fabricated assets or for depleting and degrading natural resources. Data are in constant local currency. Data available at: https://databank.worldbank.org/source/world-development-indicators
- Age dependency ratio (% of working-age population). Age dependency ratio is the ratio of dependents – people younger than 15 or older than 64 – to the working-age population aged 15–64. Data are shown as the proportion of dependents per 100 working-age population. Data are available at: https://databank. worldbank.org/source/world-development-indicators.

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