Essays on the Role of Household Wealth and Social Determinants in Aspirational Consumption

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Summary

The aspirational consumption in base of pyramid countries - which constitute the poorer two-thirds of the world's population - has recorded a significant increase in recent years. The consumption continues to rise for the base of pyramid consumers while it already remains proportionately higher in comparison to the consumers of richer economies. To help answer whether such a rise may be subject to a leveling effect seen in developed economies or not, we examine the determinants of aspirational consumption amidst wealth inequalities in sub-Saharan Africa. The presented chapters thus focus on the role played by social determinants, household wealth and urbanisation levels on aspirational consumption in two sub-Saharan African economies. The first two empirical chapters explore quality in food and education expenses using consumer survey data from Tanzania and Nigeria - while a final theoretical chapter focuses on the consumption of status-enhancing goods to comment on whether the aspirational consumption may continue to rise with income gap in the developing economies or not. The three chapters draw a set of independent conclusions on the role of wealth and social factors for consumption in developing economies. The first empirical chapter observes that household wealth does influence the food quality in Tanzania and that the wealth, alongside with availability of electricity in the country, may have a segregating effect on food quality. The next empirical chapter revisits the significance of wealth effects and finds that educations expenses - as a particular type of non-durable consumption that may improve future household income and wealth - are also significantly influenced by household wealth. The chapter also notes the strong relevance of lack of accessibility to secondary education, the differences in urbanisation levels across the two economies and certain social factors. Viewing education as a particular type of aspirational consumption that serves both as means of status signaling and as investments toward higher future wealth, a theoretical exploration of the effect of wealth differences on consumption in the third chapter considers an intertemporal framework where status goals of the consumer are treated the same as her economic goals. Factoring in the probabilistic returns in a setting of a hierarchy of positions that consumers are able to move between, the conditions for a long-term equilibrium described in the chapter reveal that the positional contests can become uncompetitive as the inequality rises.

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Part I

Demand for Food Quality in Tanzania

Abstract

At a time when aspirational consumption can be seen increasing in sub-Saharan Africa, the nutritional diversity in food remains poor overall and varies significantly across households in the region. To investigate the role of socioeconomic status (SES) in demand for food quality and the implications for nutritional diversity in Tanzania, we focus on demand substitution in quality across food commodities in the economy. Comparing SES effects with that of prices of food commodities, we find a higher price-based quality in meats and fruits to be aligned with the distribution of wealth as well as with the availability of electricity in Tanzania - suggesting that the access to urban amenities also significantly influences consumption of higher quality food items in the economy.

1 Introduction

Food policies in the developing world often recommend a higher diversity in food towards nutritional health of the population. A more diverse diet - particularly during the early stages of life - indicates nutritional adequacy and has implications for the long-term health (Mirmiran *et al.* (2004); Nti (2011); Khamis *et al.* (2019); Motbainor *et al.* (2015); Moursi *et al.* (2008); Rah *et al.* (2010)). A common issue for food policies concerned with nutritional inadequacies is a strong association of dietary diversity with household socioeconomic status (SES) [1] (Hatløy *et al.* (2000); Hoddinott & Yohannes (2002); Arimond & Ruel (2004); Modjadji *et al.* (2020); Hailu & Woldemichael (2019); Obayelu & Osho (2020); Ruel (2003); M'Kaibi *et al.* (2017)). The issue of an extreme variation in dietary diversity is often different from that of food insecurity. In sub-Saharan Africa (SAA), where absolute food shortages are less often the cause for food insecurity, it is in fact the poverty status of the households that is more often responsible for the poor dietary diversity (DD) in consumption (Crush *et al.* (2012)). The presented chapter sets out to examine this variation in quality of food consumption in Tanzania from a DD perspective - while focusing on the role played by SES levels, availability of basic amenities and urbanisation levels across the economy.

The analysis of variation in food quality across SES levels relies on a robust framework for quality in demand - where a measure for quality across commodities (such as fruits, fat, meats-proteins etc.) upholds the theoretical restrictions imposed by aggregation of demand across various goods (such as coconut, mango etc. that may be classified within a commodity:fruits) that are part of a commodity group (such as fruits). More specifically, the method follows the restrictions implied due to the Hick's commodity theorem (Hicks (1946); Deaton & Muellbauer (1980b); Nelson (1991)) which requires the physical quantities of goods consumed to be weighted by unchanging (relative) prices of the constituent goods before the quantities can be aggregated into the demand for group whose quality is measured. Thus, the quality of fruits as commodity - for example - can be evaluated only as long as the goods - coconut, mango etc. that may constitute the fruits commodity - exhibit a stable relative price-structure. To avoid confusion in the terminology associated goods and quality, we have used the nomenclature provided by Cramer (1973) where "goods" or "items" are variants with different quality that all fall under a certain "commodity" (Cox & Wohlgenant (1986)).

The particular theoretical approach is important for our analyses for two reasons. First, it is preferable over an arbitrary or intuitive aggregation of quality from groups that does not follow the aggregation restrictions in a demand equation. Such restrictions may limit our ability to talk about substitution in quality across commodity groups. Second, a robust aggregation based on market-prices also helps circumvent problems with unavailability of

[1] SES has often been measured using assets or durable goods owned by the household in the studies.

detailed prices of each good (by relying on the prices of one good in each commodity group) and the measurement issues arising out of use of unit-prices(Gibson & Kim (2019)).

The primary criterion of grouping the demand from goods consumed into a commodity group using the approach is a stable relative price-structure of market prices that are available in the consumption survey[2]. A classification of food items into commodities for which quality metrics are calculated is thus undertaken using past observed-market prices of all goods available in the survey alone - where a quality metric is associated with each food commodity such that the constituent goods of every commodity (which quality is calculated for) move together in terms of their annual prices[3] from 2008 to 2014. The condition of a stable relative prices structure (due to Hicks Commodity Theorem) drives a clustering of relative price changes across all goods for food in the survey that we describe in 3.1. To provide a DD perspective, the commodity groups thus obtained from the clustering are further divided based on the twelve FAO (Food and Agriculture Organization of the United Nations) categories - (i) cereals, (ii) vegetables, (iii) fruits, (iv) meat, (v) eggs (vi) fish and other sea foods (vii) legumes, nuts and seeds, (viii) milk and milk products (ix) oil and fats, (x) sweets (xi) spices, condiments and beverages and (xii) tubers and roots (Kennedy *et al.* (2011)). The resultant commodities for which quality is evaluated are fat, meats-proteins, cereals, vegetables, milk, starches, complements[4], tubers, fruits, fish and chicken - steps that are further described in Section 3.1. The direct use of market-observed prices also has the advantage that it avoids using unit-values (price-deflator) as price controls in our analysis. More specifically, the market-prices - used as controls in the analyses - avoid the measurement errors that arise with the use of unit-values (which approximate the price of an item with the average of item expenditure divided by its quantity consumed).

The quality measure associated with every commodity in the analysis effectively treads a middle-path between the counting-based overall DD measures[5] used in health studies and the approaches that rely on simple sums of physical quantities as measures of demand for commodities (Deaton (1988)). The diversity score approaches based on FAO categories (Kennedy *et al.* (2011)) commonly used in nutrition studies (Ogechi & Chilezie (2017); Modjadji *et al.* (2020); Obayelu & Osho (2020)) are essentially aggregate measures that do not factor in the quantities consumed by a household. On the other hand, an approach to combine quantities of goods consumed into the demand for a commodity - based on an arbitrary or intuitive grouping of goods - may not follow separability in demand or other

[2]The prices observed in local markets are those in the district where the household - whose consumption is recorded for budget shares and quality measures - is located.

[3]A locally observed price associated with an item is one that is observed for the item in the district where the household is located.

[4]Complements include miscellaneous items such as tea, sugar, coffee, spices and salt - that are not considered in other categories.

[5]A single count corresponds to whether a household consumes one of the items in the FAO identified categories - (i) cereals, (ii) vegetables, (iii) fruits, (iv) meat, (v) eggs (vi) fish and other sea foods (vii) legumes, nuts and seeds, (viii) milk and milk products (ix) oil and fats, (x) sweets (xi) spices, condiments and beverages and (xii) tubers and roots - or not.

restrictions of demand analysis either (Deaton & Muellbauer (1980b)). As Nelson (1991) points out, an approach to consider a simple sum of quantities consumed from across items (or goods) within a commodity group (Deaton (1988)) may only make sense if one imposes severe restrictions on consumer preferences. The quality measure based on Hick's commodity theorem that relies on market-observed prices remedies such issues without imposing restricting assumptions on consumer demand (Hicks (1946); Nelson (1991)). The measure also avoids intuitive grouping of goods into commodities - thus avoiding the use researcher's own judgment of substitution within commodity-groups.

The relationship between food diversity and household socioeconomic status that we intend to explore with the quality framework is of a particular relevance for countries in SSA - given the recent changes in dietary patterns and food prices that have followed the trends of urbanisation and the movement away from subsistence farming in the region (Pingali & Sunder (2017); Wenban-Smith *et al.* (2016)). The nutritional concerns - such as consumption of higher quantities (and thus lower price-based quality) of starch or fatty foods in some SSA regions (Ogechi & Chilezie (2017); Agada *et al.* (2015)) - motivate the specific exploration of substitution in quality across food categories in the current study. With a recent urbanisation and an incomplete transition away from subsistence farming[6], Tanzania serves as an appropriate case-study for the discussion of SES effects on quality substitution and diversity across food commodities in SSA. The extreme differences in the urban and rural areas in the country also provide us an opportunity to investigate the differences in consumer diets across varied levels of urbanisation in the region.

Other than using the stable relative price-structure associated with a commodity (fat, cereals etc.), the quality metric for every household depends on the measurement of quantities of high vs low-price variants (goods) consumed within a food commodity (e.g. the quantities consumed of wheat, rice, maize for quality in cereals commodity). Considering a commodity-group of cereals comprising of rice, maize and wheat, for example, maize would contribute to lower quality of cereals-commodity than wheat and rice if the prices (per-kg) of wheat and rice are higher than that of maize. Other than the quality metric thus calculated for every food commodity (such as cereals), the budget shares per household for each of these commodities are used as dependent variables in the system of equations used for an AIDS estimation. In order to provide a comparison with a disaggregated view of goods consumed (Heien & Wessells (1990)) without any grouping into commodities, we also provide the results from estimation of price elasticities for a disaggregated set of goods consumed (see Appendix II).

The econometric method uses an AIDS formulation with both quality metrics and budget shares as dependent variables (see Deaton & Muellbauer (1980a)). This is the "Unrestricted Method" AIDS formulation used by McKelvey (2011); Andalon & Gibson (2017) - with the

[6]Despite 70 % of the mainland population of Tanzania being rural, the instances of urban agriculture are common (Wenban-Smith *et al.* (2016)).

total household expenditure - interpreted as permanent income - as the main explanatory variable in the regression. The base-prices - used as controls - are market prices directly observed in the survey - rather than unit-prices which the empirical quality assessments are often compelled to rely upon (despite issues with measurement errors - see Gibson & Kim (2019)). The interpretation of household's total expenditure as the permanent income measure in the study - is common in the literature and relies on the standard consumption theory (see Modigliani & Brumberg (1954); Friedman (1957)). To highlight the effect of wealth, we also present results from an alternative formulation where an SES variable - based on the logarithm of the reported value of total assets owned by the households - is used as the main explanatory variable. The use of owned assets (land, house, furniture, vehicles, electronics etc.) in wealth indices is also common in the health and consumption studies (Howe *et al.* (2008, 2010); McKenzie (2005); Booysen *et al.* (2008)).

Apart from the effect of SES on quality, the effects of particular energy sources as well as the prices of the cheapest-item within every food commodity [7] are also considered. This is based on the relevance of resources such as water towards food diversity that has been reported in the region (Hailu & Woldemichael (2019)). Our results indicate that a significant boost to the price-based food quality is related to availability of electricity. With electricity available is sparsely available in the urban areas of Tanzania, the effect of electricity usage together with urban residence seems strongly associated with the higher price-based quality and food diversity - despite controlling for permanent income (total expenditure) - in the economy.

The presented chapter contributes to the literature in three ways. First, it explains the role of SES on food demand from a DD perspective by using a framework more thorough and robust than the overall measures for diversity or intuitive classifications that are more commonly used in the literature. Second, it provides a feasible way to include food prices as controls to detail the effect of urbanisation effects and amenities. Lastly, it establishes a sound methodology relying on the Hick's commodity theorem by both sticking to theoretical constraints and avoiding use of unit-prices that often lead to severe measurement errors.

In the sections that follow, the Section 2 surveys the literature on quality of consumption, food diversity and the relevance of often overlooked market prices in measurement of quality. The approach to view quality across various commodities are presented in Section 3. The details of the data used in the study are provided in Section 4 and a discussion of the distribution of quality for food follows in Section 5.

[7] Since the prices of all items in the commodity move together, only the base-price i.e. the minimum price in the commodity is needed as a control.

2 Literature Survey

One of the earliest approaches for measurement of quality had been to treat it as a separate good (Houthakker (1952)) - thus decomposing the quality price elasticity of demand (quantity purchased) into a quantity price elasticity of expenditure on quality and an income elasticity of quality measure. The treatment of quality as a separate good has been widely used ever since (Deaton & Muellbauer (1980b)). A common example of the approach is a simple repackaging method (Fisher & Shell (1968)) - which interprets demand for a high-quality good as multiples of lower quality goods. More specifically, the demand for goods with a certain price using the repackaging approach is viewed in terms of a base-price and a quality parameter - the implicit assumption being that the variants in every category are perfect substitutes.

For most empirical studies, however, the perfect substitution turns out to be a stringent requirement since the variation in quality among goods within a commodity may be often extreme. As an example, even though quality consumed of electricity under energy commodity may be higher than that of kerosene, the substitution between electricity and kerosene may in fact be little - thus making it difficult to justify a view of a demand for electricity in terms of the units of kerosene consumed[8]. Nevertheless, simple-repackaging does turn out to be appropriate in the context of cost-of-living index problems where a substitution is implied (Fisher & Shell (1968)).

Some constraints on either consumer preferences or prices are needed - when perfect substitution isn't possible - so as to measure the quality using both quantities consumed and prices of goods within a commodity. As such, the problem of measuring quality of a commodity comprising of multiple goods is that of assigning a quality metric to the entire commodity group using the a combination of quantities consumed of the goods within the commodity group at prices known for every good. As Nelson (1991) explains, the approach to measurement of food quality in such a manner must either assume weakly separable preferences with homothetic within-group preferences (Cox & Wohlgenant (1986); Deaton (1988)) or a stable price-structure in a commodity group with a base-price associated with the commodity. The current chapter opts for the latter approach since it not only imposes fewer restrictions on the consumer preferences but also makes use of the market prices rather than the unit-prices[9]. It is worth emphasising that the homotheticity of within-group preferences presents an implausible constraint on the demand - since it implies either that the within-group income expansion path would be a straight line through the origin or that the group composition would remain independent of income - conditions. Such a restriction on preferences would mean - for example - that the ratio of electricity consumed to the kerosene consumed must be the same for both rich and poor consumers - a constraint that is

[8]While one may address this issue with use of an energy-budget (calories), the unavailability of quantities consumed or prices in the consumption data limit wider applications of such an approach.

[9]The unit-prices are the total expenditure divided by quantities consumed that are used prices as controls in a regression with budget, quantity or quality as dependent variables.

unlikely to hold empirically.

More formally, consider that in a generic sense, a quality-metric associated with a certain commodity (e.g. cereals, fat etc.) depends on a grouping of items - which the commodity comprises of - subject to certain homogeneity restrictions. Given the quantity consumed $\{q_i\}_{i\in[1,n]} = \{q_1, q_2, ..., q_n\}$ and respective prices $\{p_i\}_{i\in[1,n]} = \{p_1, p_2, ..., p_n\}$ food $1 \leq i \leq n$ goods, the quality-metric solves a problem equivalent to the following disaggregated optimisation problem (Nelson (1991)) for a direct utility $U(q_1, q_2, ...)$

$$\max U(q_1, q_2, ...q_n)$$
$$\sum_{i=1}^{n} p_i q_i = x \tag{1}$$

The quality metric problem is that of grouping the items $1 \leq i \leq n$ into groups $1 \leq G \leq M$ and assigning group-commodity price P_G so that the solution of the problem in Equation 1 is equivalent to that of the problem in Equation 2

$$\max U(Q_1, Q_2, ...Q_M)$$
$$\sum_{G=1}^{M} P_G Q_G = x \tag{2}$$

Such an aggregation requires that the M groups (commodities) are separable and that the demand for items within each group is a homogenous function of the goods it contains (Nelson (1991)). The approach followed by Deaton (1988) - using the sum of physical quantities as measure of demand - requires that the homogeneity restriction is put on the household preferences while assuming that the within-group preferences are homothetic. However, the approach from Deaton (1988) (as well as that from Cox & Wohlgenant (1986)) does not use the homogenous commodities assumption and in fact permits heterogeneity in its use of sums of physical quantities as the measure of demand (Nelson (1991)). The Hick's commodity theorem-based approach - which imposes a restriction only on prices of goods - does not suffer with the issue as it does not impose the stringent homotheticity assumption on preferences.

Simply put, the approach we adopt in the current chapter prevents considering chicken and eggs into one commodity unless the relative price structure for the two items (chicken and eggs) does not change. No other criteria - arbitrary or otherwise - is followed to group the goods into commodities. Subject to the restriction, the notion of quality is set to a price-weighted quantity (made possible due the availability of market prices) so that given the same expenditure, a lower quantity of the composite good (i.e. Q_G for the composite good G) corresponds to a higher quality and vice versa (see Section 3 for further details). The commodity groups thus selected are obtained by clustering goods into commodity groups based on similar price-changes over the years 2008, 2010, 2012 and 2014. A further step sub-divides the clusters thus obtained based on the FAO provided categories to assist interpretations from a DD perspective[10].

The issue of unavailability of market prices - often sidelined in many empirical studies - has recently gathered some attention (see McKelvey (2011); Gibson & Kim (2019)). As such the measurement of quality is often performed without available market prices - by simply averaging over the expenditures (recorded costs) of a particular item in a given region (or over the entire population of households). This so-called unit-value (or price-deflator) method uses the average expenditure divided by quantity consumer for all the consumers as prices in the empirical analyses (see Lazaridis (2003); Tafere *et al.* (2010) for a recent implementation). While using unit-values as prices may be appropriate for certain empirical concerns, the measurement errors introduced by their can be severe and difficult to ignore for finer conclusions relating to price and income elasticities. More specifically, the quantity consumed appearing both in the dependent variable (as budget share's numerator) and in the control variable (as the denominator for unit-value used as price) cannot be always mitigated (see McKelvey (2011); Gibson & Kim (2019)).

The approaches such as the RDMP ("real" deviations from regional/quarterly mean prices) proposed by Cox & Wohlgenant (1986) that are implemented without using locally observed market prices also suffer with the same issue[11]. The availability of detailed market-observed prices in the survey - therefore not only helps with the fulfillment of Hick's Commodity theorem through stable relative structure of prices - but also mitigates the measurement errors that would be implied with the use of unit-values.

The econometric for the price-based quality metric uses the "Unrestricted Method" for the AIDS model (Deaton & Muellbauer (1980a); Andalon & Gibson (2017); Gibson & Kim (2019)). Based on PIGL approaches originally popularised by Barten (1964), Gorman (1953) and Muellbauer (1975), the AIDS model readily conforms to the demand function restrictions and can be extended for other panel data scenarios. For instance, the structural changes in the parameters over time are addressed with a dynamic AIDS formulation (see Anderson & Blundell (1983, 1982) for a first-order dynamic model) and the demographic variables are accommodated using a "demographic translation" approach (Pollak & Wales (1981)) . With prices p_j for commodities $1 \leq j \leq n$, total expenditure x, coefficients γ_{ij} , β_i for commodities $1 \leq i \leq n$ and the price-index P, the demographic translation for the linear AIDS formulation uses the following α_i intercept in AIDS regression equation

[10] The FAO provided categories are (i) cereals, (ii) vegetables, (iii) fruits, (iv) meat, (v) eggs (vi) fish and other sea foods (vii) legumes, nuts and seeds, (viii) milk and milk products (ix) oil and fats, (x) sweets (xi) spices, condiments and beverages and (xii) tubers and roots.

[11] For situations where market-prices are not available to such detail, there have been a few techniques to address the measurement errors arising from the use of price-deflators. Deaton (1988) - for instance - uses cluster-average fitted budget shares and unit-values in a cross-sectional analysis - an approach that has been elaborated by McKelvey (2011) for panel data analyses.

$$\alpha_i = \rho_{io} + \sum_{k=1}^{s} \rho_{ik} d_k \tag{3}$$

Specifically, the above intercept α_i for $1 \leq i \leq n$ goods , d_k are demographic variables and constants ρ_{io} , ρ_{ik} are used in the following AIDS regression where w_i is the budget-share for the item i

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln(p_j) + \beta_i ln(\frac{x}{P}) \tag{4}$$

Compared with the measurement of elasticities for every individual good, the advantage with the aggregation over commodity groups is that the latter does not present the issue of non-consumption of high-quality goods. More specifically, if one were to calculate the price elasticities for individual goods, an obvious issue that arises is that certain items (particularly those with high-quality) might not be consumed at all for a significant part of the population. Heien & Wessells (1990) address this issue by correcting for non-consumption using the inverse Mills ratio as instrument into the AIDS regressions. The Heien-Wells (HW) approach effectively treats the consumption on high quality goods "truncated" for a significant part of the population[12]. While HW approach may be well-suited for comparison of elasticities for specific goods (see Appendix II for empirical results using the approach), the comparison of quality across multiple commodities is a more appropriate interpretation for the overview of quality we seek in the current chapter. Since it is much less likely for no goods to be consumed within a broader commodity group (fruits-veg, protein etc.) over which the quality measure is calculated, the approach with quality aggregated over broader commodity groups also circumvents the issue of non-consumption. No correction related to non-consumption - as used in HW method - is therefore used with our approach that aggregates quality over groups classified with homogeneity restrictions (see Section 3.1).

The variation in quality across multiple food sub-categories is examined using the estimated income elasticities for quality using total household expenditure as the main explanatory variable and urban-amenities as key controls. (Kennedy *et al.* (2011)). The empirical analysis we pursue in the chapter thus addresses the concerns related with SES effects on food diversity that have been remarked by many empirical studies (Ruel (2003); Hatløy *et al.* (2000)). In particular, a lower within-country SES measure - whether it be in developed or developing economies - often corresponds to less healthy diets (Manyanga *et al.* (2017)). In a broad survey across low and middle-income economies, Mayen *et al.* (2014) also find that with the exception of fruits in diet, the residents of urban areas -

[12]Heien & Wessells (1990) also use the unit-values instead of (unavailable) market prices. Further, the unit-values obtained from the households using a good are used as prices for those who don't consume the good.

particularly with higher SES - have more calorie intakes as well as consumption of protein, fats and vitamins relative to starchy items. The exploration of variation in quality in the current chapter is aimed at addressing many such concerns.

Some empirical studies also find a relevance of the availability of amenities such as clean water on dietary diversity (Mekuria *et al.* (2017)). A control for amenities such as electricity are also used - other than total expenditure as our main explanatory variable - in the current chapter to examine the variation in food quality across Tanzania. In its particular context, rapid urbanisation seems to have brought challenges to food security for the lower-income households in the towns and cities within Tanzania - even though the country has managed to maintain a broad self-sufficiency in basic food items (Wenban-Smith *et al.* (2016)). The agricultural policy has also focused on a transition from subsistence farming to more efficient large-scale rural farming since urban farming seems common in the country (Wenban-Smith *et al.* (2016)). As such, a significant number of households dependent on self-farming in reportedly rural settings may obfuscate the relationship between urban and rural food demand that may be apparent from the conventional models for urban-rural migration (Harris & Todaro (1970)). The control for urban-rural disparities is thus an important one for our survey of food quality in the Tanzanian economy.

3 Econometric Model

The measure of quality used in the current chapter for each food commodity group (such as fat, cereals etc.) comprising of multiple items (maize, rice, wheat etc. for cereals etc.) relies on higher weights to high-priced items (rice given higher weight than maize based solely on price etc.) within each commodity group. The commodity groups over which the quality is calculated are based on the price-structure restrictions implied by the Hicks Commodity Theorem (more details to follow in Section 3.1). A further sub-classification - which does not disrupt the commodities identified based on similarity of price structure - is used to assist interpretation from a DD perspective and is guided by FAO categories recommended for food diversity. It is worth highlighting that instead of measuring an overall food quality across all of the food items consumed, we inspect quality only for different commodity groups whose constituents satisfy the Hick's commodity theorem. The quality across food can thus be seen as a vector associated with the set of food commodities. As we detail in the Section 3.1, the quality vector $\{V_{fat},\ V_{meats-proteins},\ V_{cereals}\ ,\ V_{vegetables}, V_{milk}, V_{starches},\ V_{complements}, V_{tubers}, V_{fruits}, V_{fish}\}$ is based on price-correlation requirement from the Hicks Commodity Theorem - while the groups based on movements are further subdivided based on FAO categories to assist interpretations from a DD perspective.

The data used for the classification as well as the inputs towards estimation are described in Section 4.

3.1 Classification in commodity groups

The main criterion of grouping of food items into commodity groups is the co-movement of prices. The prices - shown in Figure 1 - are taken from the wave corresponding to years 2008, 2010, 2012 and 2014 in the survey. An unsupervised k-means clustering is then used to group the items into commodities based on price changes - so that the items within every commodity group identified have "similar" relative price-changes. The groups based strictly on price-movements thus obtained are then split into further categories aligned with the FAO recommended categories i.e. (i) cereals, (ii) vegetables, (iii) fruits, (iv) meat, (v) eggs (vi) fish and other sea foods (vii) legumes, nuts and seeds, (viii) milk and milk products (ix) oil and fats, (x) sweets (xi) spices, condiments and beverages and (xii) tubers and roots. More specifically, the k-means clustering is performed on the relative price-changes from available prices. Considering beef as an example good, the prices for beef in the years 2008, 2010, 2012, 2014 (see Figure 1) are $p_{beef} = \{3500.0, 4000.0, 5000.0, 6000.0\}$ - which correspond to a relative price-change vector $r_{beef} = \{\frac{4000}{3500}, \frac{5000}{4000}, \frac{6000}{5000}\} = \{1.14, 1.25, 1.2\}$. The relative price-change vectors for all the items (beef, goat, fresh_milk etc.) thus obtained are clustered using the k-means method - where the number of selected clusters is guided by the within-cluster sum of squared errors - an approach commonly used in k-means applications (Pollard (1982)). The classification we use as the basis for commodity groups are arrived at by setting the number of clusters to 5 which is when the within-cluster sum of squared errors drops to less than unity[13]. The classification of items based on these FAO-categories and the correlated-price-movement is presented in Table 1.

It is worth emphasising that the partition of commodity groups identified from the unsupervised k-means clustering into further sub-groups based on FAO categories does not pick goods from disparate clusters into a new sub-group. Instead, the further partition into sub-groups based on FAO categories is based on the observation that that the price-changes of goods within sub-groups formed by splitting a particular group identified by clustering would also be correlated with each other. The groups obtained by the classification based on correlation prices (shown in Table 2) are thus split into further sub-groups aligned with the FAO groups in Table 1. More specifically, the commodity cereals-milk-greens is split into milk, veg and cereals, fruits-fish is split into fruits and fish, startches-fats-complements is split into starches, fats and complements while the categories tubers and meatsproteins are retained. The resulting categories are therefore i) cereals ii) veg iii) fruits iv) meats-proteins v) fish vi) milk vii)fat viii) complements ix) tubers x) chicken and xi) starches whose constituents are shown in Table 1.

As explained before, the basis for the quality metric associated for every commodity G (corresponding to the left side of the Table 1) is the Hick's commodity theorem (Hicks (1946)) which states that a group of goods behave as if they were a single commodity so long as the the prices of the group of goods changes in the same proportion. Simply put, a constant relative

[13]A higher number of clusters does not significantly reduce the within-cluster sum of squared error.

food group	food items
fat	cooking_oil, eggs
meats-proteins	beef, goat, pork, pulses, onion, salt, canned_milk, wild_birds, wild_meat
cereals	rice_husked, maize_green, maize_grain , wheat, maize_flour
vegetables	greens, othervegstarch
milk	fresh_milk, milk_products
starches	sugarcane, millet_grain, rice_paddy, potatoes, canned_drink, sweet_potato, bread
chicken	chicken
complements	sugar, tea, coffee, sweet, miscdrinkpowder, readymade_tea_coffee, honey, spices
tubers	yam, millet_flour, banana_green, cassava_flour
fruits	banana_ripe, cassava_fresh, peanuts, citrus, coconut, cashew_almonds,dried_canned_veg, nut_products, mangoes
fish	dried_canned_fish, fish_seafood, packaged_fish

Table 1: Food items classified into commodity groups after considering both price-movements and FAO categories

food group	food items
meats-proteins	beef, goat, pork, pulses, onion, salt canned_milk, wild_birds, wild_meat
cereals-milk-greens	rice_husked, greens , othervegstarch, maize_green, maize_grain , wheat, maize_flour , fresh_milk, milk_products
starches-fats-complements	cooking_oil, eggs, sugar, tea, sweet, sugarcane, coffee, chicken, bread, potatoes, sweet_potato, canned_drink, miscdrinkpowder, readymade_tea_coffee, honey, spices, millet_grain, rice_paddy
tubers	cassava_flour, yam, millet_flour, banana_green,
fruits-fish	banana_ripe, cassava_fresh, peanuts, citrus, coconut, mangoes, dried_canned_veg, dried_canned_fish, cashew_almonds, nut_products, fish_seafood

Table 2: Food items classified into commodity groups based on price-movements (without splitting into FAO-based categories)

price structure allows us to factor out the quantity of the composite commodity consumed from the demand function for the variants (goods) within the commodity - allowing the price of quality to be interpreted in terms of a composite price P_G for the commodity aggregate G and the price-structure p^*_G from n goods with prices $p_G = \{p_{i,G}\}_{i \in [1,n]}$. With E_G as the total expenditure on group G, the constant relative price-structure permits us to write the commodity-aggregate specific demand function $g(E_G, p_G)$ in terms of the price-structure p^*_G as follows

$$g(E_G, p_G) \equiv g(\frac{E_G}{P_G}, p^*_G) = g(Q_G, p^*_G) \tag{5}$$

The formulation in Equation 5 depends both on the quantity $Q_G \equiv \frac{E_G}{P_G}$ and a quality variable V_G[14]. The essential appeal of aggregation is the simplified view of demand across all items. Consider for example, if we were to represent demands for items {wheat, rice, yam,coconut, eggs, beef, chicken, fish, goat, honey}. As such these items would each correspond to a demand function so that 10 functions describe the demand for all the 10 items. The aggregated view allows us to view demands for commodities {carb, protein and complements} - where the 10 goods are encompassed in just 3 respective functions for the 3 commodity groups. A key requirement for the validity of such a quality metric - however - is that the prices of goods within the commodity group have a constant relative price-structure i.e. a relative prices ratio that can be factored out of the observed prices (see Deaton (1988); Nelson (1991); Gibson & Kim (2019)). This condition - due to the Hicks commodity theorem - drives the k-means grouping of items described above.

In summary, the commodity aggregates used in the study are based on a *price-movement* sense (based on the Hick's commodity theorem) - while a further splitting of groups is guided by a *functional* sense implied by FAO categories. Every commodity aggregate on the left side of Table 1 has goods with a similar price-movement *and* the same functional significance while every commodity aggregate G on the left side of Table 2 has items that have only a similar price-movement[15] . To explain with particular example goods, consider two pairs of items with similar price-movements - with sugar and tea being the first pair that have similar price changes (see Table 2). Let the second pair be rice and cooking-oil - who also have price changes similar to each other (see Table 2). Notice however that not only do sugar and tea have similar price changes, they also have a similar functional sense implied by FAO categories. Therefore, they are classified in a group *complements* in the Table 1. Rice and cooking-oil on the other hand are split into two categories based on the different functional sense implied by FAO-categories (see Table 1). Other categories such as meatsproteins, fruits etc. are similarly based foremost on price-movement correlations before considering the functional

[14]The income elasticity of composite quantity Q_G is the sum of income elasticity of quality V_G and the income elasticity of physical quantity q_G. This is further explained in Section 3.2 (see Nelson (1991) for more details).

[15]A similar analysis of rice varieties is conducted by McKelvey (2011) .

sense implied by FAO categories for interpretation from a DD perspective.

3.2 Price-based quality

The vector of quality for every household comprises of the quality $\nu_{G \in \mathscr{G}}$ associated with the commodity group $G \in \mathscr{G}$ where $\mathscr{G}$ is the set of all commodities relevant for the household $\mathscr{G}$=$\{cereals$, veg, $fruits$, $meats\_proteins$, $fish$, $milk$, fat, $complements$, $tubers$, $starches\}$. Based on the local market-observed prices of the goods within the commodity group $G \in \mathscr{G}$ (such as cereals, fat etc.), the quality metric for the household ensures that a household who buys more of the high-priced good within a commodity group is viewed as one consuming higher quality of the commodity G. This is why no quality is considered for chicken, the only good within its own commodity group. As we've explained in Section 3.1, the k-means clustering interprets the restriction that there is a constant relative price structure on the constituent items of commodity group (the Hicks aggregation condition).

To calculate the quality associated with a group $G \in \mathscr{G}$ (such as the items : beet and goat in the commodity: meatsproteins) that have a constant within-group relative price-structure, a base-price P_G for the group G (meatsproteins) is selected as the minimum price of the items among the commodity aggregate constituents (e.g. among beef and goat). This is based on the approach suggested by Nelson (1991). The base-price P_G is then used to assign i) an aggregate-quantity of a composite good (for meatsproteins) comprising of quantities consumed of the items constituted in G (beef, goat) and ii) a quality metric corresponding to G (based on the proportion of goat and beef consumed). In other words, with the quantities consumed for beef and goat under meatsproteins commodity available to us, a quantity of "meatsproteins" is associated with the particular set of quantities consumed for beef and goat. The aggregate-quantity of "meatsproteins" is then calculated by relative-prices-weighed averages of beef and goat consumed (see details below). If beef per unit-weight is cheaper than goat-per-unit-weight, then this quality metric would evidently be lower when more beef is consumed for the same expenditure. This notion of higher-quality is thus based solely on price alone so that a more expensive item within the commodity group contribute to higher quality of the commodity.

In more formal terms, quantity-price tuples $(q_1, p_1), (q_2, p_2), (q_3, p_3)...$ within a commodity thus correspond to a quantity and quality pair (Q_G, P_G) as well as a quality metric V_G. We define the total physical sum of quantities consumed q_G as follows

$$q_G = \sum_{j \in G} q_{j,G}$$

Further, with $p_{i,G}$ as the prices for good i in commodity group G observed in the market, we represent the price-structure ratios for the the good i in a group G as $p^*_{i,G}$. The ratio $p^*_{i,G}$ is effectively a price-multiple with respect to the base-price P_G (the price of the base-commodity in the group G with respect to which the quality in G is being considered) so that the observed prices $p_{i,G}$ of the items within the group G bear the following relationship:

$$p_{i,G} = (P_G \times p^*_{i,G}) \forall i \in G \tag{6}$$

The quality metric V_G then corresponds to the a sum of quantities consumed $q_{i,G}$ weighted by the price-structure ($p^*_{i,G}$) for the commodity aggregate G as follows

$$V_G = \sum_{i \in G} (\frac{q_{i,G} p^*_{i,G}}{q_G}) \tag{7}$$

Following Nelson (1991), we reject the use of sum of physical quantities $q_G = \sum_{i \in G} q_i$ itself as Q_G (as used by Deaton (1988) - see Equations 2 and 5) in favour of the above relative-price-weighted sum of expenditure per physical unit (within the commodity G)[16].

Let's consider an example to illustrate how the measure of quality would relate with the total expenditure E_G in the group G and the group aggregate price P_G (see Nelson (1991) for a more detailed theoretical discussion). Let's say we observe the consumption on goat and beef within a meatsproteins commodity with prices observed as 20£, 10£ (resp.) and the quantities consumed by the household are 1.5 kg and 2 kg (resp.). One approach is to the treat the physical sum of quantities i.e. 3.5 kg as the quantity of the composite good "meatsproteins". However, it is more difficult to argue that the households optimise the weight of the composite good - rather than comparing the disparate quantities of goods (see Nelson (1991) for details of this argument). Since quality is to be priced in the market, a quality-adjusted quantity is the more appropriate formulation where we consider a price-structured weighted quantity as the quality-adjusted quantity and express the pair i.e. $\{(p_{goat}, q_{goat}), (p_{beef}, q_{beef})\}$= $\{(20, 1.5), (10, 2)\}$ as $(10, 5 (= 2 \times 1.5 + 1 \times 2))$, $(0, 1.43 = \frac{5}{1.5+2})$ or $\{(P_{meats}, Q_{meats})$,$(0, V_{meats})\}$ = $\{(10, 5), (0, 1.43)\}$. Here, P_G (or P_{meats}) is simply the minimum of $20, 10$ i.e. the prices of goat and beef respectively - corresponding to the price-structure p^*_G is (2,1) for {goat, beef}. In other words, consuming 1.5 kg of goat ($q_{goat} = 1.5$) is equivalent to consuming 3 units of commodity: meats-proteins ($Q_{meats} = 2 \times 1.5$) with quality of 2 ($Q_{meats} = \frac{2 \times 1.5}{1.5} = 2$) since the price of goat is twice that of base good: beef.

[16] Nelson (1991) argues that the composite good quantity Q_G can be equivalent to the sum of physical quantities q_G (i.e. $Q_G = q_G$) only if the quality effects are absent. With $U_G = \frac{E_G}{q_G}$ as the unit quantity consumed this is implied due to $Q_G = q_G \Rightarrow \frac{E_G}{P_G} = \frac{E_G}{U_G} \Rightarrow P_G = U_G$.

Good	*Prices*	*Quantity*		P_{meats}	Q_{meats} and V_{meats}
Goat	p_{goat} =20£	1.5	$\rightarrow$	10	$Q_{meats} = 5$ $(= 2 \cdot 1.5 + 1 \cdot 2)$
Beef	p_{beef} =10£	2.0			V_{meats} =1.43 $(= \frac{5}{1.5+2})$

Table 3: Quality Measurement in Illus. 1 (prices not representative of observed prices)

Comparing the $V_{meats} = 1.43$ above with another case where household consumes 0.5 kg of goat and 3 kg of beef so that the prices and quantities are $\{(20, 0.5), (10, 3)\}$ respectively for goat and beef, we have the same expenditure as before since $E_G = P_G Q_G = \sum_G p_i q_i = 40$. However, as shown in the table below, the quantity Q_G and quality V_G now corresponds to $(10, 4(= 2 \times 0.5 + 1 \times 3))$ and $(0, 1.14 = \frac{4}{3.5})$ respectively. The quality is lower for the latter household even though the sum of physical quantities - rather than quality-adjusted Q_G - is the same.

Good	*Prices*	*Quantity*		P_{meats}	Q_{meats} and V_{meats}
Goat	p_{goat} =20£	0.5	$\rightarrow$	10	$Q_{meats} = 4$ $(= 2 \cdot 0.5 + 1 \cdot 3)$
Beef	p_{beef}=10£	3.0			V_{meats} =1.14 $(= \frac{4}{3.5})$

Table 4: Quality Measurement in Illus. 2 (prices not representative of observed prices)

3.3 Econometric Method

The goal of the comparison of quality metrics across commodity groups defined in Section 3.2 is to measure how the demand for the diversity-based quality is distributed across the population and varies across prices, household needs, wealth and other household characteristics in the cross-section.

In the "Unrestricted method" of AIDS system of equations (see McKelvey (2011) and Andalon & Gibson (2017); Gibson & Kim (2019)), each composite commodity group - unless it consists of just one good/item - corresponds to both a budget equation and a quality metric dependent variable. The income and price elasticities are calculated with the total-expenditure x and base-price P_G using the AIDS implementation for food categories defined in Table 1. As described earlier, the base-prices correspond to every category in the classification defined in Table 1 (based on prices shown in Figure 1). We use two formulations with the total household expenditure logarithm used as the main explanatory in the first formulation and the logarithm of the household assets value as the explanatory variable in the second formulation. An indicator variable is also used as control for energy - specifying whether the household uses electricity or not.

With each of the two explanatory variables, we use both the quality-metric $ln\ V_G$ and the budget share w_G as dependent variables (for a food commodity G) in the AIDS system of equations. Thus with intercepts $\rho_{1,G}$, $\rho_{2,G}$ for budget-share and quality dependent variables equations (respectively) for given commodity group G among n commodity groups and coefficients $\rho_{1,Gk}, \rho_{2,Gk}$ for s demographic characteristics $\{d_k\}_{k\in[1,s]}$, $\beta_{G,1}, \beta_{G,2}$, $ln(x)$ as logarithm of total expenditure and coefficient $\gamma_{1,Gj}$, $\gamma_{2,Gj}$ for the base-prices corresponding to n commodity groups $\{P_j\}_{j\in[1,n]}$, we have the following system of equations (for each commodity group G)

$$w_G = \rho_{1,G} + \sum_{k=1}^{s} \rho_{1,Gk} d_k + \sum_{j=1}^{n} \gamma_{1,Gj} ln(P_j) + \beta_{G,1} ln(x) + \epsilon_{G,1} \tag{8}$$

$$ln\ V_G = \rho_{2,G} + \sum_{k=1}^{s} \rho_{2,Gk} d_k + \sum_{j=1}^{n} \gamma_{2,Gj} ln(P_j) + \beta_{G,2} ln(x) + \epsilon_{G,2} \tag{9}$$

Equivalently, with $ln(A)$ as the explanatory variable, we have the following system of equations

$$w_G = \rho'_{1,G} + \sum_{k=1}^{s} \rho'_{1,Gk} d_k + \sum_{j=1}^{n} \gamma'_{1,Gj} ln(P_j) + \beta'_{G,1} ln(A) + \epsilon'_{G,1} \tag{10}$$

$$ln\ V_G = \rho'_{2,G} + \sum_{k=1}^{s} \rho'_{2,Gk} d_k + \sum_{j=1}^{n} \gamma'_{2,Gj} ln(P_j) + \beta'_{G,2} ln(A) + \epsilon'_{G,2} \tag{11}$$

Once again, the intercepts $\rho'_{1,G}$, $\rho'_{2,G}$ corresponding to a commodity group G (of which there are n in number) are for budget-share w_G and quality metric $ln\ V_G$ dependent variable equations (respectively) while the coefficients $\rho'_{1,Gk}, \rho'_{2,Gk}$ are defined for s demographic characteristics :$\{d_k\}_{k\in[1,s]}$. Similarly, $\beta'_{G,1}, \beta'_{G,2}$ are coefficients of $ln(A)$ - the logarithm of total assets value and the coefficients $\gamma'_{1,Gj}$, $\gamma'_{2,Gj}$ are for the base-prices corresponding to n commodity groups $\{P_j\}_{j\in[1,n]}$. Notice that the s demographic variables in Equations 8 and 9 include the indicator variables related to access to electricity as well. Further, since the price for quality is not required, the price-coefficients in the $ln\ V$ equations are not subject to any restrictions - unlike the budget-share estimation equations where the constraints of symmetry are applied. More specifically, the symmetry conditions are imposed with $\gamma_{1,Gj} = \gamma_{1,jG}$ for all j, G in the equations for budget-share equations (and equivalently

$\gamma'_{1,Gj} = \gamma'_{1,jG}$ for all j, G).

The homogeneity and adding-up restrictions mean that the sum of all expenditure shares in the AIDS model is unity - thus leading to the residuals variance-covariance matrix becoming singular (Barten (1969); Anderson & Blundell (1982); Fujii *et al.* (1985); Asche (1996); Li *et al.* (2004)). As a solution to this well-known estimation problem, it is common to delete one of the equations to estimate and recover its coefficients through the adding-up restrictions (Paris & Caracciolo (2014); Li *et al.* (2004)). Notice that the adding-up restrictions require that $\sum_G^n \rho_{1,G} = 1$, $\sum_G^n \beta_{G,1} = 0$ and $\sum_G^n \gamma_{1,Gj} = 1$ (for all j) while the homogeneity restrictions require that and $\sum_j^n \gamma_{1,Gj} = 0$ (for all G). Thus one of the commodity group (chicken) - which does not correspond to a quality is ignored from the estimation. The coefficients in the budget-share equation for chicken can be recovered as $\rho_{chicken} = 1 - \sum_{G \neq chicken}^n \rho_{1,G}$ and $\gamma_{1,chicken,j} = - \sum_{G \neq chicken}^n \gamma_{1,Gj}$ respectively.

In order to describe an exact equation set to be estimated, we consider the commodity $G = meatsproteins$ along with the demographic variables d_h (number of household members), d_τ (age of the household-head), d_χ (urban residence) and d_ξ (electricity-access). There are two equations for budget-share and quality of the meats-proteins commodity (which we name `qmeatsproteins` and `qVmeatsproteins` respectively - for reference purposes) :

$$
\begin{gathered}
qmeatsproteins : \\
w_{meatsproteins} = \rho_{1,meatsproteins} + \rho_{1,meatsproteins,h} d_h + \rho_{1,meatsproteins,\tau} d_\tau \\
+ \rho_{1,meatsproteins,\chi} d_\chi + \rho_{1,meatsproteins,\xi} d_\xi + \gamma_{1,meatsproteins,fat} ln(P_{fat}) \\
+ \gamma_{1,meatsproteins,meatsproteins} ln(P_{meatsproteins}) + \gamma_{1,meatsproteins,cereals} ln(P_{cereals}) \\
+ \gamma_{1,meatsproteins,veg} ln(P_{veg}) + \gamma_{1,meatsproteins,milk} ln(P_{milk}) \\
+ \gamma_{1,meatsproteins,starches} ln(P_{starches}) + \gamma_{1,meatsproteins,complements} ln(P_{complements}) \\
+ \gamma_{1,meatsproteins,tubers} ln(P_{tubers}) + \gamma_{1,meatsproteins,fruits} ln(P_{fruits}) \\
+ \gamma_{1,meatsproteins,fish} ln(P_{fish}) + \beta_{meatsproteins,1} ln(x) + \epsilon_{meatsproteins,1}
\end{gathered}
$$

$qVmeatsproteins$:

$$
\begin{aligned}
ln\ V_{meatsproteins} &= \rho_{2,meatsproteins} + \rho_{2,meatsproteins,h} d_h + \rho_{2,meatsproteins,\tau} d_\tau \\
&+ \rho_{2,meatsproteins,\chi} d_\chi + \rho_{2,meatsproteins,\xi} d_\xi + \gamma_{2,meatsproteins,fat} ln(P_{fat}) \\
&+ \gamma_{2,meatsproteins,meatsproteins} ln(P_{meatsproteins}) + \gamma_{2,meatsproteins,cereals} ln(P_{cereals}) \\
&+ \gamma_{2,meatsproteins,veg} ln(P_{veg}) + \gamma_{2,meatsproteins,milk} ln(P_{milk}) \\
&+ \gamma_{2,meatsproteins,starches} ln(P_{starches}) + \gamma_{2,meatsproteins,complements} ln(P_{complements}) \\
&+ \gamma_{2,meatsproteins,tubers} ln(P_{tubers}) + \gamma_{2,meatsproteins,fruits} ln(P_{fruits}) \\
&+ \gamma_{2,meatsproteins,fish} ln(P_{fish}) + \beta_{meatsproteins,2} ln(x) + \epsilon_{meatsproteins,2}
\end{aligned}
$$

For symmetry, the following restrictions are applied. Notice that $\gamma_{1,fat,meatsproteins}$ corresponds to the equation for fat (`qfat`).

$$
\begin{aligned}
\gamma_{1,meatsproteins,fat} &= \gamma_{1,fat,meatsproteins} \\
\gamma_{1,meatsproteins,cereals} &= \gamma_{1,cereals,meatsproteins} \\
\gamma_{1,meatsproteins,veg} &= \gamma_{1,veg,meatsproteins} \\
\gamma_{1,meatsproteins,milk} &= \gamma_{1,milk,meatsproteins} \\
\gamma_{1,meatsproteins,starches} &= \gamma_{1,starches,meatsproteins} \\
\gamma_{1,meatsproteins,complements} &= \gamma_{1,tubers,complements} \\
\gamma_{1,meatsproteins,tubers} &= \gamma_{1,tubers,meatsproteins} \\
\gamma_{1,meatsproteins,fruits} &= \gamma_{1,fruits,meatsproteins} \\
\gamma_{1,meatsproteins,fish} &= \gamma_{1,fish,meatsproteins}
\end{aligned}
$$

These conditions are repeated in the estimation for every other $G \in \{fat, cereals, veg, milk, meatsproteins, starches, complements, tubers, fruits, fish\}$ i.e. 10 commodities in total. The system of equation is thus used to observe the variation of measures of quality across the total expenditure and household characteristics in Tanzania. The entire set of equations consists of two equations for each commodity (10) - where one equation (per commodity) has budget-share as the dependent variable and another equation has quality-metric as the dependent variable. These $10 \times 2 = 20$ equations with respective constraints are listed in Appendix IV. The AIDS estimation for the system of equations that accommodates the constraints uses a 3SLS method (instead of SUR - which requires at least one regressor not used in other equations).

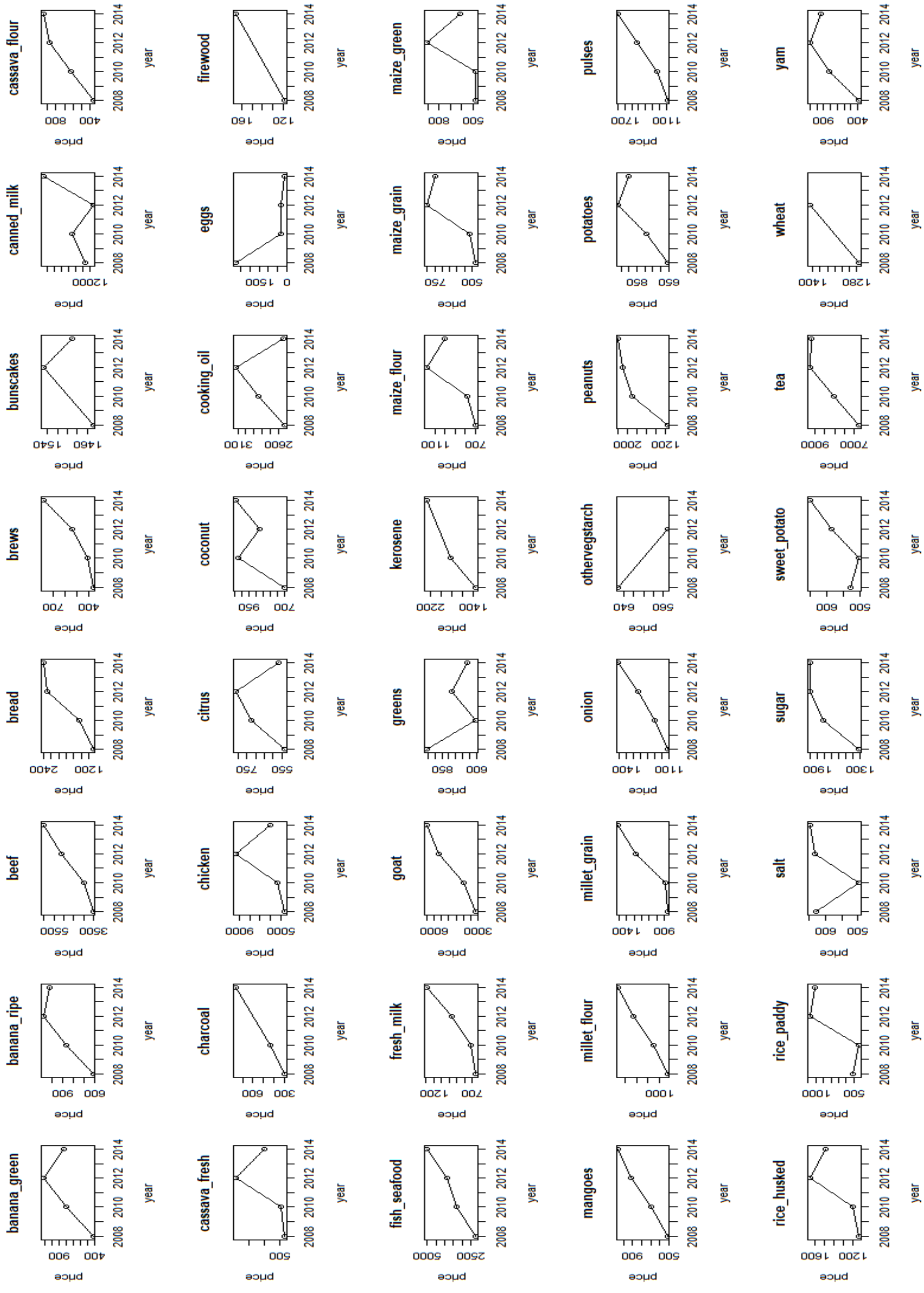

Figure 1: Market Prices recorded in 2008, 2010, 2012 and 2014 surveys

4 Data

The data used for our analysis has been obtained from the Living Standard Measurement Study (LSMS) - conducted by the World Bank - for the year 2014 - which is the last wave in the survey. The survey has been designed to assist in the understanding of links between asset ownership, community access (to market, schools), food prices and agriculture activities. The data in the surveys from multiple countries is largely uniform in its data-model (fields) and is often geo-referenced with a sufficiently wide-coverage in the country to allow a study of spatial variation in the observed variables. The years used for the analyses are the most recent years in the survey for Tanzania (2014) i.e. the last wave available in the survey at the time of writing this chapter. The price-data which we used in the classification described in Section 3.1 is based on prices for waves (years) 2008, 2010, 2012 and 2014.

The LSMS survey records past expenditure with diary and recall methods. The diary method is used for food items while other purchases are recorded as weekly, monthly and yearly recalls. The expenditures on food are recorded with a greater level of detail than other expenditures. The demographic variables from survey that we use in our a cross-sectional analysis are based on the current locality and the number of members in the family.

The consumption microdata for the year (2014) - used for budget shares and quality measures - is combined from across the recall and weekly diaries - merging the weekly data with yearly data by multiplying the past week's consumption into the number of weeks in the year. The details of this process are described in Appendix I. Once combined, the market prices for the goods consumed by a household are matched with the reported consumed quantities of the food items [17].

The prices relevant for a household are marked as those that are available as market prices in the district where the household is located. Since the market-observed prices in the survey are recorded at every district level or at finer levels, we match these prices with every household in the survey based on the district the household is located in. This is necessitated also because not all wards and enumerated-areas(EAs) within every district in the survey have prices recorded for all relevant food items. Further, as price observations at the district level are recorded in different quantities (grams, kilograms for weight and litres, mls for fluids etc.), we infer the price at the district level using a regression over price records for the good in the district. This is only a means to standardise the prices in a standard unit such as a kilogram or a litre from the prices that are recorded in several units. Since the price per unit of any item declines with the increase in quantity purchase, the price data from across different recorded quantities are assimilated using a regression to obtain the price corresponding to a standard unit-quantity of an good (kg, litres etc.). A simple quadratic expression $\frac{m}{q} = \beta\frac{1}{q^2} + c$ to used to approximate the inverse proportionality of price-per-unit

[17] The absence of a good in the recall record for a household as the good is not to be interpreted as evidence of non-usage of the good. With the case of electricity, for example, the field for "main lighting fuel" is more reliable for the test of electricity usage than the last expenditure on electricity.

with the quantity purchase. Thus, observed marked-prices m are regressed against the quantities q they're recorded in where β is the coefficient and c is a constant . The price of any arbitrary quantity $\underline{q}$ of a good is thus simply $\frac{\beta}{\underline{q}^2} + c$ and for the price of unit-quantity that we use for base-prices and relative price structures, the price is simply $\beta + c$ (for $\underline{q} = 1$).

asset	*type*
bike	transport
motorbike	transport
car	transport
sewingmachine	household
bed	household
watch	household
chair	household
table	household
cupboard	household
sofa	household
sports_hobby	household
mobile	electric
waterheater	electric
camera	electric
phone	electric
musicplayer	electric
videoplayer	electric
musicsystem	electric
ac_fan	electric
waterpump	electric
tv	electric
dishtv	electric
computer	electric
refrigerator	electric
land	household
housing	household

Table 5: Long-term assets in the LSMS

The values of assets owned by the household that we use as a measure for wealth are obtained from the record of durable goods in the survey. The durable goods in the LSMS data range from short-term durable items such as mobile phones to the expensive and long-term assets such as land or housing. Of these, we are interested only in the transferable long-term owned assets (see Table 5). The exclusion of short-term assets or the items that are not transferred over a generation is based on consideration of intergenerational wealth whose relevance is sought as an SES measure. The empirical studies often prefer the data on ownership of assets (Filmer & Pritchett (1999, 2001)) for SES effects since the inter-generational transfers of wealth are what make a break in the inequality gap (i.e. mobility through reduction of wealth differences) difficult (Obasuyi & Rasiah (2019)). Another reason why the income data has not been used directly in the current study is that it is available only for around 30% of the households that we have the diary data for.

The assets transferred over a generation that we use for SES measures can be readily verified by inspecting households in the data that are split when a young member of the unsplit family starts a new household - treating the assets except land and house that are more expensive than the bed (furniture) as those that contribute to the long-term asset-values. The details of the records of asset-ownership in the LSMS data include the number n_t of durable goods owned by the household, the reported cost C_t at which the durable good was purchased and the reported price Π_t which the household expects by selling the durable good in the current market at the time of survey. We use the reported price Π_t of the durable goods - rather than reported cost C_t - to infer the asset-values in the area surrounding the household for two reasons. First, Π_t is not susceptible to the errors associated with the recall of the purchase value which varies over years in the panel data for the household and item. Second, Π_t also encapsulates the perceived depreciation of the durable good over time - making it more appropriate for a comparison against non-durable consumption at a given time t. The total cost of the assets of a household is thus obtained simply as a product of the number of assets n_t reported by the household and the price Π_t.

	All	Rural	Urban
Mean (SD) Household size	4.97 (2.91)	5.39 (3.06)	4.12 (2.39)
Mean (SD) age of household head	44.87 (16.05)	46.46 (16.56)	42.01 (14.69)
Mean (SD) number of rooms per household	3.28 (2.06)	3.56 (2.14)	2.79 (1.81)
Mean (SD) Total Expenditure (Tanzanian Shillings)	2004450 (2004450)	1495100 (1236870)	3017537 (2102633)
Percentage with household head educated secondary or higher	21.31	14.64	33.30
Percentage of household heads employed in Agriculture	55.63	66.37	10.74
Total Number of Households	4068	2707	1361

Table 6: Descriptive statistics for LSMS Tanzania 2014

5 Empirical Analysis

5.1 Descriptive Statistics

The summary statistics from the LSMS microdata for 2014 are presented in the Table 6. The average household in Tanzania has nearly 5 members and the average age of the family-

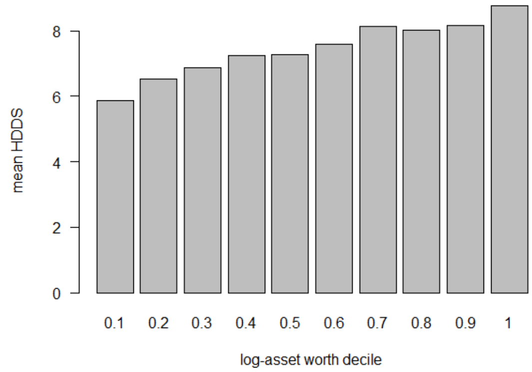

Figure 2: Diversity Score changes by log asset deciles

head is 45 years. A significantly higher number of household heads in the rural areas are employed in agriculture.

While the food diversity scores do vary significantly across Tanzania (see Figure 2), they do not indicate an extreme segmentation based on assets as is reported for many economies in the region (Nti (2011); Hailu & Woldemichael (2019)). It is worth noting that FAO standards do not prescribe what's considered a low dietary diversity status. It is common for studies to therefore consider empirically validated thresholds for the analysis of diversity. McDonald *et al.* (2015) , for example, set this threshold to 3. Considering the threshold diversity score of 3, the diversity scores in Tanzania might not appear too low (see Figure 2).

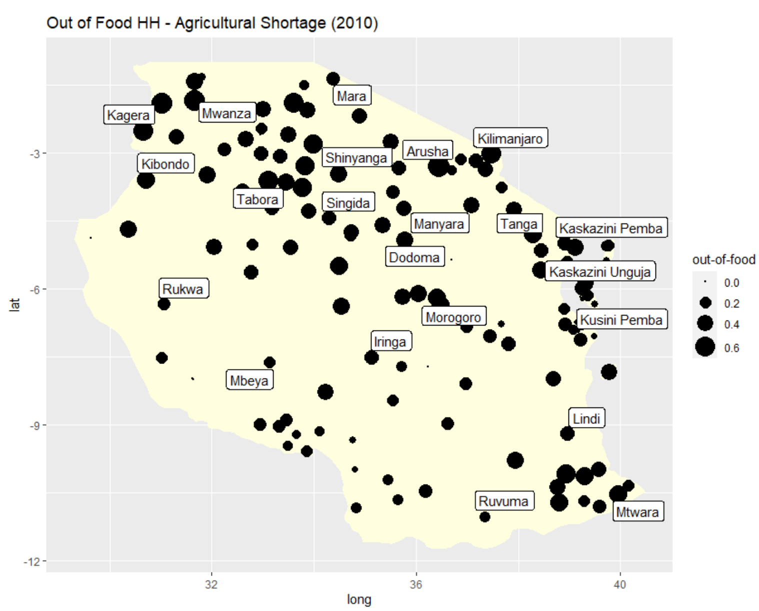

Figure 3: Fraction of households having run of food due to agricultural inputs in the past year (2010)

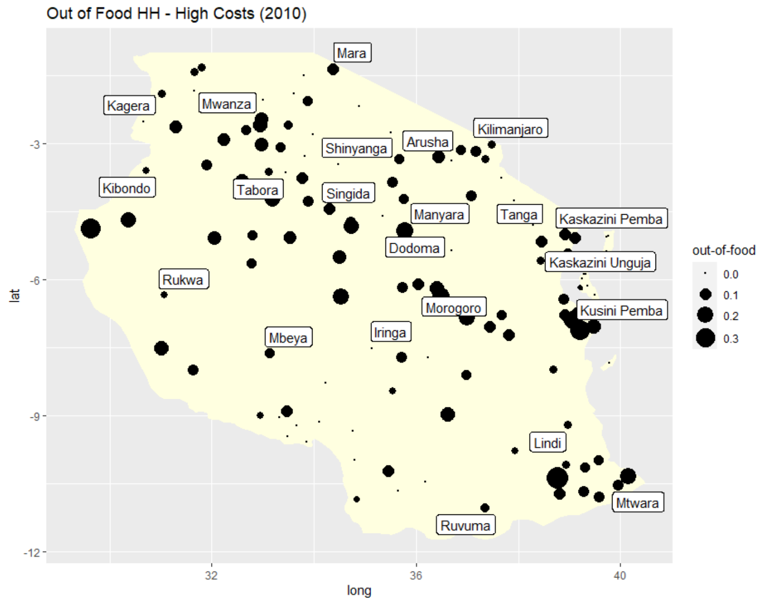

Figure 4: Fraction of households having run of food due to costs in the past year (2010)

While diversity in food may not be related with food insecurity in Tanzania, the spatial distribution of food insecurity provides us an overview of regional disparities in the country. Here, we use the directly observed food deprivation in the survey to compare the fraction of households having run out of food (either due to lack of agricultural inputs or high prices) in the past year across urban and rural areas (see Figures 3 and 4). While the figures do suggest a significant proportion of households running out of food in urban areas (due to high costs), the overall hunger instances remain proportionately lower in the urban areas (when compared to the households having run out of food due to agricultural reasons- see Figure 4). While the food insecurity does not seem significantly stronger in either urban or rural areas, the extremity of urban-rural or regional differences seems evident from a comparison of assets and occupations. As a non-parametric view of occupations[18] and value of assets-owned show (Figure 5), the higher-paid occupations seems severely to urban - particularly eastern coastal - areas in Tanzania.

5.2 Results

The key goal of our empirical analysis is to test whether the SES measures - the asset-ownership and household expenditure measures in particular - significantly influence the degree to which the household may spend on quality in diverse food-categories in Tanzania or not. The disaggregated view of quality into commodities based on FAO categories allows us to relate the choice for quality in high-level commodity groups with the wealth effects - while also controlling with local prices in an AIDS framework. The effect of

[18]The variable `occupation_rank` shown in the figure is defined as an ordered variable indicating an income-based rank inferred from the occupation of the head-household using the available income data (see Table Appendix III for mapping of occupations to occupation-ranks).

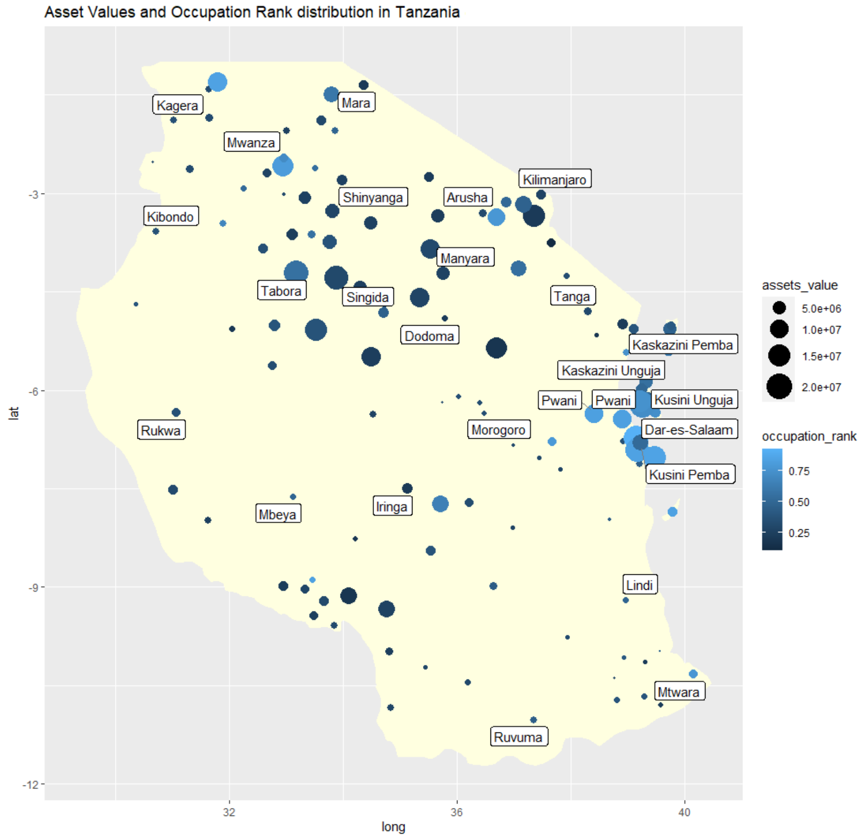

Figure 5: Occupations and consumer-owned assets in Tanzania

SES measures - both total assets or total expenditure - is significant on food quality - particularly for meats-proteins commodity. We also find that access to higher food quality is higher in localities with access to electricity.

Variable	Description
`ln_tot_exp`	logarithm of per-head total expenditure x_t per household
`lp-`	base-prices for various commodities
`hsize`	number of members in a household
`age`	age of the household-head
`logA`	logarithm of sum of reported market-price of assets owned by the household
`isurban`	indicator variable specifying if the region is Dar-es-Salaam, Mbeya, Mwanza or Magharibi Unguja(Zanzibar)
`has_electric`	indicator variable specifying if the household uses electricity or not

Table 7: Control Variables

The estimation results from the AIDS formulation - which we have specified in Equations 8 and 9 - are presented in Tables 9 and 10. The logarithm of the total expenditure ln_tot_exp is used as the main explanatory variable in the results presented in Table 9 . In an alternative formulation for which the results presented in Table 10, the logarithm of total household owned (long-term) assets logA is used as the main explanatory variable. An important set of controls are the prices corresponding to the food commodities - which are listed in Table 1. As described in Section 3.3, the AIDS formulation in Equations 8 and 9 use the logarithm of base-prices of food categories (commodities) as price-controls. These are represented as the variables starting with the prefix lp- (e.g. lpdensefoods, lpnonfresh, lpprotein etc.) in the results presented in Tables 9 and 10. Recall that the base-price P_G for every commodity G in the Equation 6 is simply the minimum price of the goods within the commodity group that is derived from the locally observed market prices (at the district level) rather than the unit-values (estimated by averaging expenditure over a locality) for goods within a commodity. Every composite commodity in the AIDS regression (see Equations 8 and 9) thus corresponds to an lp- variable. It is worth remarking that the prices of other items in the commodity are incorporated in the price-structure that is considered in the measurement of quality. Other important controls used for results in Tables 9 and 10 are listed in Table 17.

Of the controls in Table 17, the indicator variable has_electric - specifies whether the household uses electricity (used in both Tables 9 and 10) and is inferred from the field for source of energy for lighting in the survey. Two further household characteristics which we explore the effects of are hsize (number of household members) and age (age of the household-head). Whether the households reside in urban areas or not are considered with a indicator variable isurban (indicator variable for densely populated urban areas).

Variable	Description
qcereals	budget share for the entire commodity: cereals
qVcereals	quality metric for the entire commodity: cereals
qcomplements	budget share for the entire commodity: complements
qVcomplements	quality metric for the entire commodity: complements
qfat	budget share for the entire commodity: fat
qVfat	quality metric for the entire commodity: fat
qfish	budget share for the entire commodity: fish
qVfish	quality metric for the entire commodity: fish
qfruits	budget share for the entire commodity: fruits
qVfruits	quality metric for the entire commodity: fruits
qmeatsproteins	budget share for the entire commodity: meats-proteins
qVmeatsproteins	quality metric for the entire commodity: meats-proteins
qmilk	budget share for the entire commodity: milk
qVmilk	quality metric for the entire commodity: milk
qstarches	budget share for the entire commodity: starches
qVstarches	quality metric for the entire commodity: starches
qtubers	budget share for the entire commodity: tubers
qVtubers	quality metric for the entire commodity: tubers
qveg	budget share for the entire commodity: vegetables
qVveg	quality metric for the entire commodity: vegetables

Table 8: Dependent Variables

The dependent variables of the AIDS regressions in the columns of Tables 9 and 10- starting either with `q-` or with `qV` - indicate the budget-share and quality metric respectively. The columns starting with `q-` indicate the budget shares that are used as the dependent variables in AIDS regressions (see Equation 8) while the columns starting with `qV-` indicate the logarithm of the quality metric as the dependent variable (i.e. $ln\ V$ in the Equation 9). The list of all dependent variables are presented in Table 8. Recall that the classification of items - which is based on prices-correlation - results in the commodities and constituents good listed in Table 1. The total number of equations (the Equations 8 and 9 specified in Section 3.3) for the estimation is therefore $10 \times 2 = 20$ (see Appendix IV for the entire list of estimation equations). The estimation uses a three-stage least-squares method for systems of equations (see Zellner & Theil (1992)) for the Equations 8 and 9 and with symmetry constraints specified in Section 3.3.

Discussion

The results obtained from the AIDS regression shown in Tables 9 and 10 suggest a relevance of ownership of assets - as well as access to electricity - on the demand for quality in food. While there is a some heteroskedasticity in the results (tested for with Breush-Pagan statistic), the effects of household expenditure and total assets owned appear significant for quality.

In Table 9, the effect of `ln_tot_exp` is positive on quality across all food commodities i.e. the income-elasticities are positive for quality within food categories (commodities). This does not seem surprising since the income-elasticities for quality are expected to be positive so long as a higher total expenditure `ln_tot_exp` is spent on the more expensive variants (goods) within a food category (commodity). The negative income elasticities for budget-share of some food commodities are also predictable - if we consider that certain goods are preferred for higher (price-based) quality and therefore lower quantity (budget share). Of particular attention is how the budget shares show a decline with total expenditure logarithm for commodities `fat` and `meatsproteins` (see coefficients of `ln_tot_exp` under `qfat` and `qmeatsproteins` in Table 9) . More specifically, the increase in food expenditure is associated with less quantity (at the cost of higher quality) of `fats` and `meatsproteins` - while quality consumed for both fats and meats-proteins rises with higher total expenditure logarithm (see coefficients of `ln_tot_exp` under `qVfat` and `qVmeatsproteins` in Table 9). With cereals, on the other hand, we see that the budget shares rise with higher total expenditure logarithm (see coefficient of `ln_tot_exp` under `qcereals` in Table 9) while the cereals-quality also increases with higher total expenditure logarithm (see coefficient of `ln_tot_exp` under `qVcereals` in Table 9). The demand for quality (price-based) for meat is unlike that for cereals in the sense that higher-income households increase both price-based quality and quantity (budget-shares) for cereals whereas they seem increase quality without increasing quantity (budget shares) for meats.

Looking at the effect of access to electricity (`has_electric`) in Table 9, we see a higher quality across food categories - an effect similar to that of total expenditure logarithm `ln_tot_exp` (except for fats where quality is not significantly higher for consumers with access to electricity). It could be argued that having access to electricity is endogenous with higher prosperity. Thus it may simply be that those with higher income are the one with access to electricity and have a better access to quality through ownership of electric appliances. However, the correlation of having access to electricity with prosperity is more likely through being in the urban area rather through income. This is because the indicator variable `has_electric` used for access to electricity is based only on the usage of electricity as the primary source of lighting at home. The basic usage of electricity hardly reflects the income of the household - and is more strongly correlated with being in an area (more often urban) where electricity is available (particularly given the sparse distribution of electricity in Tanzania). Since availability of refrigeration facilities in a market may improve the availability of fruits and meats in a wider area, the positive externality through being in richer areas - one that includes access to electricity - is more likely to be the cause for higher quality in food categories.

The effects of hsize on quality are also worth noting - as larger families consume higher quality (particularly in protein and fruits-veg) but lower their budget-share for consumption. This suggests a pressure to maintain high quality in larger families with children.

A key advantage of using the proposed framework of quality is that it allows us to examine the effect of prices of commodities on quality. Looking at the effect of (base-)prices (variables lp-) in both Tables 9 and 10, we see with lpmeatsproteins - for example - that the high base-price of meats-proteins (the cheapest meat-protein available in the district) corresponds to higher quality in fruits and veg. Thus, the households in districts where base-price of meatsproteins (price of cheapest meat-protein) is high also avail higher quality of fruits and veg - an indication of how meat consumption may be associated with higher income in Tanzania.

The results in Table 9 also suggest certain substitutions in quality across some food commodities. For example, with a rise in prices of cereals (lpcereals), the quality in meats-proteins (see coefficient of lpcereals under qVmeatsproteins in Table 9) increases but the quality in starches (see coefficient of lpcereals under qVstarches in Table 9) and vegetables (see coefficient of lpcereals under qVveg in Table 9) declines - indicating that the consumers tend to increase quality in meat-consumption while reducing the quality for starches and veg. In other words, with higher prices of (cheapest) meat, the consumer is more likely to increase quality elsewhere (e.g. in fruits and vegetables) - indicating once again how meat consumption rises with higher income.

On similar lines, we see that the quality in starches seems to drop with rise in prices of fruits (see coefficient of lpfruits under qVstarches in Table 9) whereas the quality in fruits does not rise with the base-price of starches (see coefficient of lpstarches under qVfruits in Table 9). In other words, when (cheapest) fruit is more expensive, starch quality is also lower for consumers whereas (cheapest) starch being more expensive does not raise the quality of fruits for consumers. It is more often thus that the consumers spend higher on quality in starches when the fruits become expensive (rather than spending higher on quality in fruits when starch becomes more expensive). A similar relation is not seen between tubers and starches whose consumption of quality seem to move together.

The observation from the budget shares that the expenditure on veg and meatsproteins is higher - particularly for meatsproteins - in urban areas can also be verified with a simple calculation of total expenditure divided by the commodity base-price. Estimating the effective quantity of meatsproteins consumed as the meatsproteins expenditure divided by its base-price, the urban areas seem to consume about 1.61 times more meatsproteins and spend 1.63 times more (comparing just expenditure) - not as much for the expenditure on chicken or fish. With effective quantity of veg, the urban areas consume about 1.1 times more meatsproteins and spend also about 1.1 times more than the rural areas. Looking at the expenditures in urban and rural areas for cereals, we see that unlike with meatsproteins, the differences in expenditure (or in effective quantity) for cereals across urban and rural areas and are not wide. The expenditures also suggest that while the consumption of veg rises with total expenditure logarithm ln_tot_exp , it does not rise as much as meatsproteins in urban areas and does not differ a lot from the expenditures in rural areas.

In Table 10 - where total assets logarithm logA is used as the main explanatory variable instead of total expenditure ln_tot_exp - the coefficient of total assets logarithm is positive for meatsproteins (dependent variable: qmeatsproteins) - suggesting that those with lower assets do consume less meatsproteins overall. In other words, the lower quantity of meatsproteins for those with low-assets-ownership does not mean a higher quality in meatsproteins (compare signs under qmeatsproteins of the coefficients for logA and ln_tot_exp in Tables 9 and 10). The quality consumed for meats-proteins does rise with higher total assets logarithm as well. Comparing with cereals, on the other hand, we see that the budget shares are lower for those with higher total assets - even though the quality consumed is higher.

The access to electricity (has_electric) indicates a higher quality across food categories in Table 10 as well. The budget shares rise for fruits and milk in Table 10 whereas they fall for fat (qfat) and meatsproteins (qmeatsproteins) - even though the quality metrics rise (both qVfat and qVmeatsproteins) for the consumers having electricity. This may be due to refrigeration storage facilities available in certain localities. The consumption of fish (budget shares qfish) is not affected by the has_electric variable as much as meatsproteins - suggesting a higher local consumption for fish (likely less dependent on refrigeration facilities overall). For fruits and milk on the other hand, both the quality consumed and budget-share are higher for consumers with access to electricity (see Table 10).

In both Tables 9 and 10, we see that the effect of isurban (apart from the base-price P_G) on quality is significant on quality across all food categories. This could be an indication of higher income occupations concentrated in the eastern coast and centre of Tanzania. More specifically, quality for meatsproteins (qVmeatsproteins) is slightly lower in urban areas (compare coefficients of isurban under qVmeatsproteins and qVfruits in both Tables 9 and 10) and is better with access to electricity. In other words, those with no access to electricity in the urban areas are less likely to spend higher on quality of meats-proteins compared to the consumers in rural areas. The effects of both total expenditure and assets-ownership are significant in the quality of consumption for food. The access to electricity in urban environment creates clear differences in lifestyle choices as well as dependence on higher budgets - an effect that remains significant for access to quality in nutrition. In summary, even though there may be some positive externality with being in the urban areas, the differences in quality of consumption associated with high assets possession remain significant.

Robustness Checks

As a test of the robustness of results, we calculate the food-quality using the market-provided prices and instead of the expenditure reported by the household. More specifically, in the results shown in Tables 9 and 10, we have used diary-costs on goods as reported by the household - costs that are recorded by the LSMS for the goods that were consumed from purchases in the last week. If a household didn't purchase anything in the past week, there would only be quantities consumed (not costs) that would be reported for the household in the diary. Since we have the market-prices available, another way to calculate costs, budget-shares and quality would be to infer costs as the multiple of market-prices from the quantities consumed in the past week (which is reported for all households regardless of whether they had purchased something in the last week or not). Recalculating quality and budget shares still shows us the same economic and statistical significance (results available on request) of electricity and household assets in quality of food categories (commodities).

Table 9: reg3 results with electricity usage indicator control (2014)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	qcereals	qcomplements	qfat	qfish	qfruits	qmeatsproteins	qmilk	qstarches	qtubers	qVcereals	qVcomplements	qveg	qVfat	qVfish	qVfruits	qVmeatsproteins	qVmilk	qVstarches	qVtubers	qVveg
isurban	-0.0317***	-0.0170***	0.0002	0.0197***	0.0094*	0.0118	-0.0041*	0.0074**	-0.0039	-0.1542**	0.0360	0.0055*	-0.8281	0.0484*	0.1402**	-0.4567***	-0.0581***	0.0190	0.0577	0.1297***
	(0.000)	(0.000)	(0.964)	(0.000)	(0.020)	(0.120)	(0.043)	(0.007)	(0.260)	(0.004)	(0.104)	(0.021)	(0.283)	(0.011)	(0.003)	(0.000)	(0.000)	(0.764)	(0.121)	(0.000)
has_electric	-0.0641***	-0.0095*	0.0019	-0.0050	0.0253***	0.0296***	0.0066**	0.0175***	-0.0041	0.0828	0.0294	-0.0008	-1.4587	0.0367	0.2107***	0.4544***	0.0939***	0.5391***	0.1254**	0.1341***
	(0.000)	(0.029)	(0.653)	(0.398)	(0.000)	(0.000)	(0.002)	(0.000)	(0.278)	(0.136)	(0.206)	(0.767)	(0.071)	(0.069)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
hh_age	0.0002	0.0002	-0.0003**	0.0004*	-0.0002*	0.0002	-0.0000	-0.0001	-0.0002*	0.0023	0.0008	0.0000	-0.0081	-0.0005	-0.0027*	0.0044**	-0.0003	-0.0019	-0.0024*	-0.0013**
	(0.407)	(0.057)	(0.009)	(0.015)	(0.020)	(0.274)	(0.560)	(0.301)	(0.044)	(0.100)	(0.180)	(0.883)	(0.688)	(0.321)	(0.028)	(0.003)	(0.403)	(0.253)	(0.015)	(0.004)
hsize	-0.0035**	0.0042***	0.0026***	0.0038***	-0.0018**	-0.0003	-0.0014***	-0.0009*	-0.0004	-0.0887***	-0.0310***	-0.0009*	0.2308*	0.0000	-0.0484***	-0.0574***	-0.0141***	-0.0294**	-0.0228***	-0.0208***
	(0.004)	(0.000)	(0.000)	(0.000)	(0.003)	(0.808)	(0.000)	(0.029)	(0.478)	(0.000)	(0.000)	(0.011)	(0.049)	(0.994)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
ln_tot_exp	0.0641***	-0.0091***	-0.0326***	-0.0052*	0.0095***	-0.0532***	0.0042***	0.0112***	0.0049**	0.6292***	0.2089***	-0.0002	0.6893*	0.1220***	0.3857***	0.5941***	0.0799***	0.4104***	0.1870***	0.1455***
	(0.000)	(0.000)	(0.000)	(0.025)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.855)	(0.032)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lpcereals	-0.0060	0.0001	-0.0014	0.0031	0.0166***	-0.0166***	-0.0011	0.0023	0.0049**	-1.5037***	0.0516**	-0.0018	0.6404	0.0194	0.0237	0.3641***	-0.0228*	-0.1978***	-0.0431	-0.0503***
	(0.253)	(0.970)	(0.397)	(0.187)	(0.000)	(0.000)	(0.252)	(0.133)	(0.002)	(0.000)	(0.001)	(0.217)	(0.247)	(0.100)	(0.477)	(0.000)	(0.012)	(0.000)	(0.088)	(0.000)
lpcomplements	0.0001	0.0019	0.0003	-0.0012	0.0016	0.0060	-0.0005	0.0015	-0.0066***	1.5261***	-0.0461	-0.0031	4.4315**	-0.0882**	0.0245	1.7650***	0.0163	0.4861***	0.0484	-0.1422***
	(0.970)	(0.805)	(0.768)	(0.429)	(0.615)	(0.273)	(0.522)	(0.263)	(0.000)	(0.000)	(0.260)	(0.058)	(0.002)	(0.001)	(0.767)	(0.000)	(0.419)	(0.000)	(0.440)	(0.000)
lpfat	-0.0014	0.0003	0.0002	0.0013	-0.0020*	0.0032	-0.0008	-0.0019**	0.0013	-0.0110	-0.0236***	-0.0002	-8.8267***	0.0064	0.0098	-0.0016	-0.0028	-0.1016***	0.0115	-0.0025
	(0.397)	(0.768)	(0.850)	(0.202)	(0.044)	(0.075)	(0.077)	(0.003)	(0.065)	(0.419)	(0.000)	(0.714)	(0.000)	(0.156)	(0.426)	(0.916)	(0.423)	(0.000)	(0.224)	(0.590)
lpfish	0.0031	-0.0012	0.0013	0.0052*	-0.0027	-0.0041	-0.0023***	-0.0015	0.0030**	0.0100	-0.0214*	-0.0007	-0.4615	0.0413***	0.0326	-0.0128	-0.0078	0.0209	0.0306*	0.0004
	(0.187)	(0.429)	(0.202)	(0.013)	(0.059)	(0.110)	(0.000)	(0.104)	(0.003)	(0.606)	(0.011)	(0.382)	(0.111)	(0.000)	(0.063)	(0.542)	(0.116)	(0.374)	(0.023)	(0.946)
lpfruits	0.0166***	0.0016	-0.0020*	-0.0027	0.0079*	-0.0243***	0.0015*	0.0023*	0.0005	0.0458	-0.0046	-0.0013	-0.9906	-0.0084	-0.3593***	-0.0227	-0.0027	-0.1496**	-0.0263	-0.0169
	(0.000)	(0.615)	(0.044)	(0.059)	(0.010)	(0.000)	(0.028)	(0.043)	(0.632)	(0.259)	(0.795)	(0.301)	(0.112)	(0.498)	(0.000)	(0.601)	(0.773)	(0.002)	(0.343)	(0.195)
lpmeatsproteins	-0.0166***	0.0060	0.0032	-0.0041	-0.0243***	0.0382***	0.0017	-0.0054**	-0.0044*	-0.0368	0.0432	0.0058**	8.0136***	0.0343	0.1864**	-2.2568***	0.0109	-0.0440	-0.0364	0.1751***
	(0.000)	(0.273)	(0.075)	(0.110)	(0.000)	(0.000)	(0.153)	(0.003)	(0.012)	(0.593)	(0.153)	(0.002)	(0.000)	(0.104)	(0.003)	(0.000)	(0.486)	(0.597)	(0.438)	(0.000)
lpmilk	-0.0011	-0.0005	-0.0008	-0.0023***	0.0015*	0.0017	0.0019***	0.0001	-0.0014**	0.0094	-0.0048	0.0009*	-0.2357	-0.0076*	0.0283**	-0.0062	0.0176***	0.0107	0.0017	0.0032
	(0.252)	(0.522)	(0.077)	(0.000)	(0.028)	(0.153)	(0.000)	(0.752)	(0.001)	(0.333)	(0.257)	(0.023)	(0.109)	(0.016)	(0.001)	(0.554)	(0.000)	(0.369)	(0.806)	(0.330)
lpstarches	0.0023	0.0015	-0.0019**	-0.0015	0.0023*	-0.0054**	0.0001	0.0032**	-0.0002	0.0228	0.0239**	-0.0003	-0.2865	0.0002	0.0124	0.0015	-0.0043	-0.0307	-0.0022	-0.0020
	(0.133)	(0.263)	(0.003)	(0.104)	(0.043)	(0.003)	(0.752)	(0.001)	(0.699)	(0.173)	(0.001)	(0.598)	(0.260)	(0.962)	(0.415)	(0.936)	(0.293)	(0.145)	(0.852)	(0.715)
lptubers	0.0049**	-0.0066***	0.0013	0.0030**	0.0005	-0.0044*	-0.0014**	-0.0002	0.0037***	-0.0097	0.0020	-0.0007	-0.6671**	0.0180***	-0.0171	0.0468**	-0.0108**	-0.0172	0.0179	0.0015
	(0.002)	(0.000)	(0.065)	(0.003)	(0.632)	(0.012)	(0.001)	(0.699)	(0.000)	(0.479)	(0.730)	(0.234)	(0.001)	(0.000)	(0.169)	(0.002)	(0.002)	(0.303)	(0.073)	(0.753)
lpveg	-0.0018***	-0.0031***	-0.0002***	-0.0007***	-0.0013	0.0058***	0.0009*	-0.0003***	-0.0007	-0.0530***	-0.0202***	0.0014**	-1.6173	-0.0154***	0.0586***	0.1228***	0.0062***	0.0231***	-0.0021***	0.0337***
	(0.217)	(0.058)	(0.714)	(0.382)	(0.301)	(0.002)	(0.023)	(0.598)	(0.234)	(0.011)	(0.028)	(0.157)	(0.000)	(0.017)	(0.002)	(0.000)	(0.205)	(0.365)	(0.886)	(0.000)
_cons	-0.6042***	0.1824***	0.5310***	0.1178***	-0.0430	0.9945***	-0.0289*	-0.1060***	-0.0190	-8.3633***	-1.7428***	0.0398**	-2.3817	-1.0892***	-4.0316***	-6.9911***	-0.8506***	-5.2349***	-2.0281***	-1.2673***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.068)	(0.000)	(0.012)	(0.000)	(0.347)	(0.000)	(0.000)	(0.004)	(0.623)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

p-values in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: reg3 results with total assets (logarithm) and electricity usage indicator control (2014)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	qcereals	qcomplements	qfat	qfish	qfruits	qmeatsproteins	qmilk	qstarches	qtubers	qVcereals	qVcomplements	qveg	qVfat	qVfish	qVfruits	qVmeatsproteins	qVmilk	qVstarches	qVtubers	qVveg
isurban	-0.0134	-0.0197***	-0.0062	0.0194***	0.0104**	-0.0028	-0.0040*	0.0079**	-0.0024	-0.0367	0.0658**	0.0058*	-0.7816	0.0705***	0.2010***	-0.3775***	-0.0484**	0.0675	0.0893*	0.1544***
	(0.111)	(0.000)	(0.133)	(0.000)	(0.009)	(0.724)	(0.044)	(0.004)	(0.484)	(0.526)	(0.005)	(0.015)	(0.310)	(0.000)	(0.000)	(0.000)	(0.001)	(0.295)	(0.018)	(0.000)
has_electric	-0.0047	-0.0210***	-0.0211***	-0.0043	0.0298***	-0.0172*	0.0078***	0.0217***	0.0018	0.4745***	0.1259***	0.0003	-1.3344	0.1183***	0.4277***	0.7374***	0.1332***	0.7203***	0.2375***	0.2203***
	(0.594)	(0.000)	(0.000)	(0.457)	(0.000)	(0.034)	(0.000)	(0.000)	(0.635)	(0.000)	(0.000)	(0.911)	(0.094)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
logA	-0.0077***	0.0042***	-0.0016	-0.0043***	0.0021*	0.0045**	0.0014**	0.0031***	-0.0019*	0.0633***	0.0464***	-0.0010*	0.2649	0.0042	0.0521***	0.1156***	0.0146***	0.0958***	0.0191*	0.0156***
	(0.000)	(0.000)	(0.084)	(0.000)	(0.013)	(0.008)	(0.001)	(0.000)	(0.015)	(0.000)	(0.000)	(0.049)	(0.105)	(0.316)	(0.000)	(0.000)	(0.000)	(0.000)	(0.018)	(0.000)
hh_age	-0.0001	0.0002	-0.0000	0.0005**	-0.0004**	0.0005*	-0.0001	-0.0002**	-0.0002	-0.0036*	-0.0018**	0.0000	-0.0196	-0.0015**	-0.0067***	-0.0027	-0.0012**	-0.0071***	-0.0042***	-0.0027***
	(0.775)	(0.123)	(0.910)	(0.001)	(0.001)	(0.026)	(0.077)	(0.002)	(0.062)	(0.019)	(0.003)	(0.584)	(0.339)	(0.006)	(0.000)	(0.096)	(0.002)	(0.000)	(0.000)	(0.000)
hsize	0.0036**	0.0024***	0.0003	0.0045***	-0.0016*	-0.0058***	-0.0014***	-0.0008	0.0005	-0.0519***	-0.0249***	-0.0007	0.2275	0.0094**	-0.0289***	-0.0355***	-0.0109***	-0.0187	-0.0117	-0.0124***
	(0.008)	(0.000)	(0.673)	(0.000)	(0.015)	(0.000)	(0.000)	(0.091)	(0.387)	(0.000)	(0.000)	(0.071)	(0.061)	(0.003)	(0.000)	(0.000)	(0.000)	(0.067)	(0.052)	(0.000)
lpcereals	0.0015	-0.0017	-0.0082***	0.0024	0.0189***	-0.0221***	0.0001	0.0056***	0.0057***	-1.4272***	0.0747***	-0.0021	0.6073	0.0339**	0.0758*	0.4352***	-0.0096	-0.1343**	-0.0203	-0.0341**
	(0.788)	(0.560)	(0.000)	(0.324)	(0.000)	(0.000)	(0.913)	(0.000)	(0.000)	(0.000)	(0.000)	(0.163)	(0.272)	(0.006)	(0.028)	(0.000)	(0.299)	(0.003)	(0.430)	(0.008)
lpcomplements	-0.0017	0.0030	0.0017	-0.0008	0.0001	0.0076	-0.0009	0.0004	-0.0066***	1.3209***	-0.1476**	-0.0028	3.5007*	-0.1468***	-0.1352	1.4214***	-0.0148	0.3250**	-0.0329	-0.2106***
	(0.560)	(0.692)	(0.124)	(0.587)	(0.962)	(0.165)	(0.262)	(0.756)	(0.000)	(0.000)	(0.001)	(0.079)	(0.013)	(0.000)	(0.112)	(0.000)	(0.472)	(0.004)	(0.603)	(0.000)
lpfat	-0.0082***	0.0017	0.0038***	0.0013	-0.0030**	0.0088***	-0.0013**	-0.0033***	0.0005	-0.0690***	-0.0407***	-0.0003	-8.8596***	-0.0059	-0.0261*	-0.0518**	-0.0109**	-0.1391***	-0.0064	-0.0160**
	(0.000)	(0.124)	(0.000)	(0.197)	(0.002)	(0.000)	(0.002)	(0.000)	(0.484)	(0.000)	(0.000)	(0.589)	(0.000)	(0.204)	(0.040)	(0.001)	(0.002)	(0.000)	(0.500)	(0.001)
lpfish	0.0024	-0.0008	0.0013	0.0047*	-0.0024	-0.0034	-0.0023***	-0.0013	0.0027**	0.0141	-0.0179*	-0.0009	-0.4367	0.0412***	0.0364*	-0.0039	-0.0072	0.0279	0.0314*	0.0011
	(0.324)	(0.587)	(0.197)	(0.023)	(0.086)	(0.191)	(0.000)	(0.158)	(0.006)	(0.497)	(0.042)	(0.296)	(0.132)	(0.000)	(0.045)	(0.864)	(0.157)	(0.245)	(0.022)	(0.868)
lpfruits	0.0189***	0.0001	-0.0030**	-0.0024	0.0082**	-0.0260***	0.0017*	0.0028*	0.0008	0.0937*	0.0149	-0.0012	-0.8222	0.0065	-0.3217***	0.0516	0.0053	-0.1163*	-0.0070	-0.0003
	(0.000)	(0.962)	(0.002)	(0.086)	(0.008)	(0.000)	(0.012)	(0.013)	(0.409)	(0.027)	(0.423)	(0.357)	(0.188)	(0.615)	(0.000)	(0.281)	(0.578)	(0.020)	(0.805)	(0.983)
lpmeatsproteins	-0.0221***	0.0076	0.0088***	-0.0034	-0.0260***	0.0423***	0.0005	-0.0086***	-0.0051**	0.0170	0.0843**	0.0060**	8.6268***	0.0567*	0.2325***	-2.1152***	0.0163	-0.0114	-0.0076	0.2018***
	(0.000)	(0.165)	(0.000)	(0.191)	(0.000)	(0.000)	(0.689)	(0.000)	(0.004)	(0.813)	(0.008)	(0.002)	(0.000)	(0.010)	(0.000)	(0.000)	(0.310)	(0.893)	(0.872)	(0.000)
lpmilk	0.0001	-0.0009	-0.0013**	-0.0023***	0.0017*	0.0005	0.0020***	0.0005	-0.0012**	0.0279**	0.0021	0.0009*	-0.1894	-0.0029	0.0411***	0.0164	0.0204***	0.0241*	0.0082	0.0084*
	(0.913)	(0.262)	(0.002)	(0.000)	(0.012)	(0.689)	(0.000)	(0.256)	(0.003)	(0.007)	(0.629)	(0.021)	(0.198)	(0.379)	(0.000)	(0.152)	(0.000)	(0.045)	(0.231)	(0.015)
lpstarches	0.0056***	0.0004	-0.0033***	-0.0013	0.0028*	-0.0086***	0.0005	0.0040***	0.0002	0.0770***	0.0452***	-0.0002	-0.1288	0.0148**	0.0509**	0.0721***	0.0040	0.0087	0.0177	0.0142*
	(0.000)	(0.756)	(0.000)	(0.158)	(0.013)	(0.000)	(0.256)	(0.000)	(0.788)	(0.000)	(0.000)	(0.704)	(0.610)	(0.007)	(0.001)	(0.000)	(0.325)	(0.681)	(0.126)	(0.015)
lptubers	0.0057***	-0.0066***	0.0005	0.0027**	0.0008	-0.0051**	-0.0012**	0.0002	0.0037***	0.0020	0.0065	-0.0008	-0.6590**	0.0197***	-0.0094	0.0583***	-0.0090*	-0.0069	0.0209*	0.0037
	(0.000)	(0.000)	(0.484)	(0.006)	(0.409)	(0.004)	(0.003)	(0.788)	(0.000)	(0.892)	(0.292)	(0.184)	(0.001)	(0.000)	(0.463)	(0.000)	(0.011)	(0.684)	(0.040)	(0.452)
lpveg	-0.0021***	-0.0028	-0.0003***	-0.0009***	-0.0012***	0.0060***	0.0009	-0.0002	-0.0008***	-0.0564**	-0.0215***	0.0013***	-1.6391	-0.0172***	0.0558***	0.1160	0.0056	0.0223**	-0.0040*	0.0317***
	(0.163)	(0.079)	(0.589)	(0.296)	(0.357)	(0.002)	(0.021)	(0.704)	(0.184)	(0.010)	(0.026)	(0.188)	(0.000)	(0.011)	(0.005)	(0.000)	(0.264)	(0.391)	(0.784)	(0.000)
_cons	0.3323***	0.0112	0.1167***	0.0995***	0.0596***	0.2383***	0.0104	0.0083	0.0677***	-0.5637**	0.5892***	0.0489***	4.6900	0.5407***	0.6369***	-0.1000	0.0720	-0.7448**	0.3107*	0.5505***
	(0.000)	(0.441)	(0.000)	(0.000)	(0.000)	(0.000)	(0.080)	(0.323)	(0.000)	(0.004)	(0.000)	(0.000)	(0.084)	(0.000)	(0.000)	(0.636)	(0.136)	(0.001)	(0.017)	(0.000)

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Conclusions

The availability of market-prices and the details on household characteristics as well as owned assets allow us to understand the factors that may cause the differences in the consumer baskets and influence consumption of quality. Given the disparate consumer baskets for the urban and rural households as well as the disparity in household incomes, the differences in expenditure on quality is hardly surprising - but differences in quality for meat and fresh goods esp for urban households with access to electricity indicates a peculiar environmental difference in areas where urban amenities are available. Whether we use the income measure based on the total expenditure or the measure of intergenerational wealth, the relatively affluent households appear to avail significantly higher quality and diversity in food - particular in the meats-proteins category. Further, the apparent demand for higher quality of meats-proteins - seems a consequence of increasing urbanisation and availability of appliances (as well as storage facilities in urban areas) - a trend that may not be aligned with improvements in nutritional diversity.

These results also fit in with the observation on the role of positive externality made by the studies on subjective welfare in Tanzania. More specifically, while poor relative incomes are meant to be strongly related with the general happiness and future outlook of a consumer, the evidence from the LSMS data suggests that the positive externalities from being in a richer area significantly influence the consumer's happiness levels recorded in the survey (Atsebi & i Carbonell (2019)). The improvements in food quality show a particular channel of how positive externalities from being in richer areas might influence the quality of life and the subjective welfare of the resident consumers. Whether consumption of quality is viewed as part of aspirational consumption or not, there seems little doubt that it is on a path to rise with improvements in household incomes.

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APPENDIX I

Data Preparation Steps

Following steps were performed towards the combining of LSMS data on Tanzania. The files referred to are for year 2010:

1. Read weekly diary data from Section K (a table of goods with the quantities consumed and cost associated with the item for every household).

    (a) All goods that had no cost associated with them were ignored (not included in total consumption)

    (b) Gift quantities were ignored for consumption (median ratio of gift to total diary consumption was zero - only 132/3828 households had this ratio 1% or higher)

    (c) Weekly diary data was multiplied by 52 (to estimate annual consumption)

        i. Weekly recall goods were also multiplied by 52 (to estimate annual consumption)

    (d) Monthly recall goods were multiplied by 12 (to estimate annual consumption) - except for repair related cost which we only multiplied by 2 (assuming that repair frequency is ~6 months for all goods to be repaired)

    (e) All expenditure from (c)-(d) above were summed up as total expenditure

2. Read Assets from Section N (for year: 2010) and calculated asset scores

3. Obtained Personal Data from Section A,B,C and J files

    (a) Section C_CB was read to obtain market facilitycode and gauge the accessibility of a market in every district. The closest accessible market could be either within the district or outside the district at a given distance. If a market was within the district or less than 10 kms away it was deemed “accessible”. Urban/rural classifications based on population density could be inserted at this stage (population density in not available in LSMS).

    (b) Read section B and C files

    (c) Calculated age of member by subtracting YOB (year-of-birth) from 2010 (survey year)

    (d) Read section J for housing data (total house rent, number of primary/secondary rooms)

4. Obtained income data from Section E (currently ignored for analysis for it being sparse). Here, the recorded pay frequency was in hours, days, weeks, months, fortnights, months, quarter, half year or year - while the mandatory fields corresponding to all of these units were i) number of hours worked per week ii) number of weeks worked per month and iii) number of months worked in an year .

   (a) When pay was on a per-hour basis, the number of hours worked per week (provided) was multiplied with the number of weeks worked per month (provided). This product was then multiplied with the number of months worked per year (provided) to estimate the annual income.
   (b) When pay was per-day, a 10 hour working day was assumed to obtain the effective number of work-days per week (based on the number of hours worked per week). This was then multiplied with the number of weeks worked per month in the year and then further multiplied with the number of months worked in an year to obtain the estimated annual income.
   (c) When pay was per week, the number of weeks worked per month was multiplied with the number of months worked per year.
   (d) When pay was in fortnights, then twice the number of months worked in an year was used to calculate the total income received over the year.
   (e) When pay was per-month, then the multiplication factor was just the number of months worked per year
   (f) When pay was per-quarter, then the effective number of quarters were inferred from the number of months worked per year (number_of_months/3) and multiplied with the number of months worked per year to obtain the estimated annual income.
   (g) For self-employed income, the work-months in an year was similarly used to compute total income from self-employment in the year
   (h) All members less than 5 year old were ignored from the income data
   (i) For wage workers:

      i. summed up wages into column yearly pay
      ii. summed up values under "other forms of payment"
      iii. sum up values as secondary of payment (for wage-workers)
      iv. only primary job was used to identify the employer type of the individual
      v. added other wages from secondary job by summing up yearly-income from all sources into the yearly income

5. Ignored bad data and extreme outliers

   (a) Ignored 5 households with exceedingly high expenditure on marriage (more than reported annual income)

(b) Ignored households in the income table but with zero income (number of households with income data thus ignored were under 2%)

(c) Ignored data with more than 30 times the median cost (ensuring that no more than 3% of the data is ignored)

(d) Ignore goods that are consumed by 10 or less households (goods - mortgage, rice_paddy, nut_products, wild_birds, packaged_fish, miscdrinkpowder, readymade_tea_coffee and winespirits were thus ignored in the analyses)

6. Merged all data

   (a) Set education expense of houses with education expenses= NA as zero

   (b) Summed up educational expense and total house rent from personal data into total expenditure (both weren't a part of diary data)

   (c) Obtained personids of the house-heads and the following variables for household-head: education-level, age, years in community, language, occupation

   (d) Obtained visible expenditure by summing up expenditure on visible goods

   (e) Merged all data into one table

While we extrapolate weekly diary to annual expense in Step 1, we must also consider that with a large size of families (40% of households have size 5 or higher), it may be common to stock goods for consumption. The LSMS survey records the quantities for food goods - even if they were not purchased in the past week. But for other non-food goods (such as soap, skin creams whose quantities are not recorded in the survey) are likely to be purchased in bulk in large families as well. Since the frequency of purchases would be lower when the quantity of bulk purchases increases- this may cause us to overestimate consumption. To verify that this not a significant issue, we first test if such stocking (quantities purchased) may be uniform in all region in the country. We then test the significance of household factors that may affect long-term storage (e.g. household size or distance from market) of the purchased item. Observing the quantity purchased on the item e, the total expenditure on all goods x and the distance from the market d, we use a difference-in-means analysis to confirm the low effect of travel-costs on the ratio $log(\frac{e}{x})$ and conclude that stockpiling is not significant. It turns out that the number of family members is a far more significant factor for large purchases.

For non-food categories, where the data is less detailed, some further adjustments were made for the classification of non-durable consumption into the wide categories of energy and household consumption. For example, repairs and maintenance costs - which are provided in the weekly diary - were not simply extrapolated to annual consumption (multiplication of a factor of 12) - but instead an assumption on the average life of the item being repaired or maintained was considered to perform the extrapolation to the annual expenditure.

APPENDIX II

Cross-sectional AIDS with adjustment for non-consumption

The use of Hick's commodity theorem for classification of items implies that a substitution between two goods is possible only if they belong to the same commodity group. The functional criteria of separability combined with the Hick's commodity theorem restriction is however a view adopted by the researcher rather than a claim on household's behaviour (see Nelson (1991) for substantiation of this argument). To provide a comparison with a disaggregated approach, we provide the provide the results from item-wised view of elasticities suggested by Heien & Wessells (1990).

Model

The first-stage of the Heien-Wells (HW) method is the following probit where the dependent variable Y_{ih} is an indicator variable denoting whether the household h consumes the item i from n goods or not. Given s demographic variables d_{jh} for $j \in [1, s]$, prices p_{kh} for $k \in [1, n]$ and household-income m_h, the inverse mills is calculated for the following:

$$Y_{ih} = f(p_{1h}, p_{2h}, ..., p_{nh}, m_h, d_{1h}, d_{2h}, ...d_{sh}) \tag{12}$$

Notice that the inverse mills ratio R_{ih} is calculated for every household using the probit regression (Equation 12)

$$R_{ih} = \begin{cases} \frac{\phi(p_h, m_h, d_h)}{\Phi(p_h, m_h, d_h)} & q_{ih} > 0 \\ \frac{\phi(p_h, m_h, d_h)}{1-\Phi(p_h, m_h, d_h)} & q_{ih} = 0 \end{cases} \tag{13}$$

R_{ih} is then used as an instrument in the following estimation equation

$$w_i = \rho_{io} + \sum_{k=1}^{s} \rho_{ik} d_{kh} + \sum_{j=1}^{n} \gamma_{ij} ln(p_{jh}) + \beta_i ln(\frac{x_h}{P}) + \delta_i R_{ih} \tag{14}$$

Typically one uses the following formulation for $ln(P)$

$$ln(P) = \alpha_0 + \sum_{i=1}^{n} \alpha_i ln(p_i) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} ln(p_i) ln(p_j)$$

But a simpler linear-AIDS formulation $P = \sum_{i=1}^{n} w_i ln(p_{ih})$ is also often used (Stone's index). Notice that the inverse-mills instrument must also comply with the symmetry and homogeneity-restrictions and thus one must ensure that $\sum_{i=0}^{n} \delta_i R_{ih} = 0$ in addition to $\sum \alpha_i = 0$, $\sum_{i=1}^{n} \gamma_{ij} = 0 \forall j \in [1, n]$, $\sum_{j=1}^{n} \beta_i = 0$ and $\gamma_{ij} = \gamma_{ji}$. Heien & Wessells (1990) choose a more general approach for the instrument variable by adding an equation to the system with term $\delta_i R_{ih}$ replaced by $- \sum_{i=0}^{n-1} \delta_i R_{ih}$so that the additivity condition is always met.

Implementation and Results

The first step with the selection approach is a probit where the dependent variable is an indicator variable that is unity when the item is consumed and zero otherwise. The control variables used in the first-stage probit are the prices of the item and market-characteristics (region etc. - see Equation 12) . The inverse-mills ratio calculated from the probit (as explained with the Equation 13 - see Heien & Wessells (1990)) is then used as an instrument in the AIDS regressions(see Equation 14). Notice that the instrument is calculated for every household and every item - and is part of the additivity constraint that is used for estimation.

The constraints of symmetry, additivity and homogeneity are essential in facilitating a discussion of the effect of cross-elasticities on demand (measured as budget shares). The results thus obtained with a seemingly-unrelated regression (SUR) after imposing the constraints are presented in the Table 11, 12 and 13. The own-price and cross-price elasticities presented in the results provide us an overview of the demand across rare and commonly consumed goods.

The main control variables are `consu` (family size adjusted based on the age of the member), `educrank` (education rank interpreted from the highest education level of head of every household), `invmills` (inverse-mills ratio), `lntotexp` (log of the total expenditure) and `occupationrank` (occupation rank - an ordered variable derived from the occupation of the head of the household). The other control variables starting with lp- are logarithm of price corresponding to every commodity in the second-stage AIDS regression (see Equation 14). The columns in the table (names starting with q) indicate the budget shares that are used as the dependent variables in the second-stage regression (see Equation 14).

The above item-wise analysis suggests a split between the goods that are consumed in rural households (where the greens and fruits seem more abundant) against those consumed in urban households (where beef, charcoal and beer are more readily available). The elasticities against income and education show that the goods available in the industrialised regions of the Tanzania seem to have positive elasticities for income and education rank whereas the goods of agrarian production seem to matter less to the highly educated, middle-age populations huddled in the urban areas. Similarly, how households respond to changes in kerosene and electricity prices indicates the limited availability of industrial goods. A contrast between the goods that are influenced by electricity prices and those that are influenced by kerosene prices demonstrates this urban-rural split as well (demand for goods such as rice, beef is less sensitive to electricity than it is to kerosene). It isn't simply that the households with electricity are more likely to consume the more expensive goods (due to their higher incomes) but that a certain goods become less relevant in the urban settings or are simply unavailable in the rural settings.

Going further, the signs of the coefficients suggest that mangoes (less consumed) and rice (commonly consumed) to be substitutes while fish appears as a complement to cassava-flour ([qfish_seafood]lpcassava_flour <0 etc.) rice. Similarly, fresh milk is a complement to beef, beer, cassava_flour ([qcassava_flour]lpfresh_milk = -0.001) and greens - while it is a substitute to bread and mangoes respectively. The substitution and complementarity thus observed are hardly an indicator of the overall quality since the reported cross-price elasticities do not consider the functional separation. More specifically, one cannot make much out of the cross-elasticities of kerosene with respect to buns or cassava unless without imposing strict separability assumptions Deaton (1993) or model restrictions (such as more buns would means less cooking in the household etc.). An aggregated view of the basket is thus preferred given our interest in the choice of quality exercised by the household when faced with multiple varieties of several qualities and price.

Table 11: Estimation for all goods after the first-stage non-consumption probit (1/3)

	(1) qbeef	(2) qbeer	(3) qbread	(4) qbunscakes	(5) qcassavaflour	(6) qcassavafresh	(7) qcharcoal	(8) qcoconut
age	0.0005	0.0000	0.0001	-0.0002	-0.0001	0.0001	-0.0002	-0.0001
	(0.0000***)	(0.0020**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
cons	-0.3348	-0.0985	-0.0514	-0.0326	0.0639	-0.0334	-0.0831	-0.0495
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
consu	-0.0033	-0.0002	-0.0001	0.0005	0.0003	-0.0001	-0.0006	0.0000
	(0.0000***)	(0.0000***)	(0.0040**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.7610)
educrank	0.0174	0.0018	0.0230	-0.0686	-0.0127	-0.0073	-0.0249	-0.0169
	(0.0000***)	(0.0600)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
invmills	0.0001	0.0011	0.0003	-0.0032	0.0007	0.0013	-0.0005	-0.0007
	(0.9140)	(0.0000***)	(0.0560)	(0.0000***)	(0.0250*)	(0.0000***)	(0.1260)	(0.0010**)
lntotexp	0.0285	0.0065	0.0046	0.0073	-0.0044	0.0021	0.0114	0.0056
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbeef	-0.0548	-0.0074	0.0161	0.0080	0.0025	-0.0015	-0.0089	0.0337
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbeer	-0.0074	-0.0023	0.0024	-0.0021	0.0019	-0.0017	0.0034	-0.0027
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbread	0.0161	0.0024	0.0008	-0.0029	0.0071	-0.0028	0.0001	0.0042
	(0.0000***)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.7670)	(0.0000***)
lpbunscakes	0.0080	-0.0021	-0.0029	-0.0118	-0.0043	0.0016	0.0060	-0.0040
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcassavaflour	0.0025	0.0019	0.0071	-0.0043	0.0001	-0.0016	0.0062	0.0032
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.8650)	(0.0000***)	(0.0000***)	(0.0000***)
lpcassavafresh	-0.0015	-0.0017	-0.0028	0.0016	-0.0016	0.0008	-0.0021	-0.0036
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcharcoal	-0.0089	0.0034	0.0001	0.0060	0.0062	-0.0021	0.0227	0.0032
	(0.0000***)	(0.0000***)	(0.7670)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcoconut	0.0337	-0.0027	0.0042	-0.0040	0.0032	-0.0036	0.0032	-0.0078
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcookingoil	-0.0057	0.0009	-0.0010	0.0014	0.0005	0.0053	-0.0225	0.0055
	(0.0000***)	(0.0060**)	(0.0020**)	(0.0040**)	(0.1230)	(0.0000***)	(0.0000***)	(0.0000***)
lpdriedcannedfish	0.0038	-0.0016	-0.0023	0.0032	-0.0070	-0.0009	0.0015	-0.0007
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0010**)
lpelectricity	0.0006	0.0022	-0.0039	-0.0028	0.0059	-0.0007	0.0078	-0.0056
	(0.5150)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0240*)	(0.0000***)	(0.0000***)
lpfishseafood	0.0051	0.0041	0.0001	-0.0039	-0.0005	0.0031	0.0049	-0.0099
	(0.0000***)	(0.0000***)	(0.7470)	(0.0000***)	(0.0760)	(0.0000***)	(0.0000***)	(0.0000***)
lpfreshmilk	-0.0018	-0.0022	0.0043	0.0018	-0.0006	-0.0028	0.0111	0.0083
	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0070**)	(0.0000***)	(0.0000***)	(0.0000***)
lpgreens	-0.0060	0.0010	0.0016	-0.0027	0.0022	0.0004	-0.0069	0.0074
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)
lpkerosene	-0.0140	0.0029	-0.0056	0.0033	0.0054	-0.0013	-0.0027	0.0020
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpmangoes	-0.0036	-0.0017	0.0003	-0.0017	-0.0006	-0.0005	0.0038	0.0038
	(0.0000***)	(0.0000***)	(0.0260*)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lponion	-0.0052	-0.0037	0.0007	0.0042	0.0019	0.0028	0.0028	0.0008
	(0.0000***)	(0.0000***)	(0.0030**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0030**)
lppeanuts	-0.0032	-0.0005	-0.0025	-0.0027	-0.0008	0.0006	0.0013	-0.0004
	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0220*)
lppotatoes	0.0092	-0.0020	-0.0001	0.0009	0.0002	0.0001	-0.0030	0.0017
	(0.0000***)	(0.0000***)	(0.4210)	(0.0000***)	(0.2440)	(0.2530)	(0.0000***)	(0.0000***)
lppulses	0.0000	-0.0002	-0.0023	0.0020	-0.0073	-0.0005	0.0041	-0.0057
	(0.9880)	(0.5550)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0460*)	(0.0000***)	(0.0000***)
lpricehusked	0.0503	-0.0013	-0.0050	0.0004	-0.0092	-0.0008	-0.0139	-0.0080
	(0.0000***)	(0.0080**)	(0.0000***)	(0.5770)	(0.0000***)	(0.0390*)	(0.0000***)	(0.0000***)
lpsalt	-0.0081	0.0016	-0.0007	-0.0013	-0.0002	0.0013	-0.0022	-0.0009
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.1760)	(0.0000***)	(0.0000***)	(0.0000***)
lpsugar	-0.0003	0.0094	-0.0071	0.0073	-0.0045	0.0048	-0.0190	-0.0236
	(0.7210)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpsweetpotato	-0.0090	-0.0005	-0.0014	0.0002	-0.0004	-0.0001	0.0026	-0.0007
	(0.0000***)	(0.0020**)	(0.0000***)	(0.3670)	(0.0270*)	(0.3110)	(0.0000***)	(0.0000***)
occupationrank	-0.0015	-0.0003	0.0011	0.0011	-0.0005	0.0015	0.0139	0.0034
	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0020**)	(0.0000***)	(0.0000***)	(0.0000***)

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Estimation for all goods after the first-stage non-consumption probit (2/3)

	(1) qcookingoil	(2) qdriedcannedfish	(3) qelectricity	(4) qfishseafood	(5) qfreshmilk	(6) qgreens	(7) qkerosene	(8) qmangoes
age	-0.0002	-0.0002	0.0001	0.0001	0.0000	-0.0001	0.0004	-0.0001
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
cons	0.3757	0.1711	-0.1125	0.0766	-0.0623	0.0536	0.5433	-0.0182
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
consu	0.0014	0.0014	-0.0009	0.0003	-0.0004	-0.0004	0.0013	-0.0003
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
educrank	0.0120	-0.0022	0.0735	0.0331	0.0215	-0.0146	0.0243	0.0004
	(0.0000***)	(0.2630)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.4690)
invmills	-0.0053	-0.0001	0.0067	-0.0032	0.0019	-0.0009	0.0008	0.0011
	(0.0000***)	(0.7150)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0310*)	(0.0000***)
lntotexp	-0.0217	-0.0107	0.0008	-0.0027	0.0035	0.0007	-0.0335	0.0010
	(0.0000***)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbeef	-0.0057	0.0038	0.0006	0.0051	-0.0018	-0.0060	-0.0140	-0.0036
	(0.0000***)	(0.0000***)	(0.5150)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)
lpbeer	0.0009	-0.0016	0.0022	0.0041	-0.0022	0.0010	0.0029	-0.0017
	(0.0060**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbread	-0.0010	-0.0023	-0.0039	0.0001	0.0043	0.0016	-0.0056	0.0003
	(0.0020**)	(0.0000***)	(0.0000***)	(0.7470)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0260*)
lpbunscakes	0.0014	0.0032	-0.0028	-0.0039	0.0018	-0.0027	0.0033	-0.0017
	(0.0040**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcassavaflour	0.0005	-0.0070	0.0059	-0.0005	-0.0006	0.0022	0.0054	-0.0006
	(0.1230)	(0.0000***)	(0.0000***)	(0.0760)	(0.0070**)	(0.0000***)	(0.0000***)	(0.0000***)
lpcassavafresh	0.0053	-0.0009	-0.0007	0.0031	-0.0028	-0.0004	-0.0013	-0.0005
	(0.0000***)	(0.0000***)	(0.0240*)	(0.0000***)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)
lpcharcoal	-0.0225	0.0015	0.0078	0.0049	0.0111	-0.0069	-0.0027	0.0038
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcoconut	0.0055	-0.0007	-0.0056	-0.0099	0.0083	0.0074	0.0020	0.0038
	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcookingoil	0.0136	0.0019	-0.0085	0.0084	-0.0013	-0.0049	0.0005	-0.0043
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0030**)	(0.0000***)	(0.3900)	(0.0000***)
lpdriedcannedfish	0.0019	-0.0089	0.0075	-0.0111	0.0003	0.0049	0.0043	0.0024
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.1750)	(0.0000***)	(0.0000***)	(0.0000***)
lpelectricity	-0.0085	0.0075	0.0265	0.0054	0.0051	-0.0075	-0.0066	0.0064
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpfishseafood	0.0084	-0.0111	0.0054	-0.0181	0.0017	0.0017	0.0020	0.0003
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0930)
lpfreshmilk	-0.0013	0.0003	0.0051	0.0017	-0.0046	-0.0005	0.0043	0.0016
	(0.0030**)	(0.1750)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0160*)	(0.0000***)	(0.0000***)
lpgreens	-0.0049	0.0049	-0.0075	0.0017	-0.0005	0.0004	-0.0007	-0.0005
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0160*)	(0.0900)	(0.0300*)	(0.0000***)
lpkerosene	0.0005	0.0043	-0.0066	0.0020	0.0043	-0.0007	-0.0041	-0.0028
	(0.3900)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0300*)	(0.0000***)	(0.0000***)
lpmangoes	-0.0043	0.0024	0.0064	0.0003	0.0016	-0.0005	-0.0028	0.0018
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0930)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lponion	-0.0112	0.0034	0.0037	0.0028	-0.0043	-0.0021	0.0001	-0.0015
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.8780)	(0.0000***)
lppeanuts	-0.0005	-0.0010	0.0062	-0.0001	-0.0039	0.0023	-0.0008	0.0005
	(0.1200)	(0.0000***)	(0.0000***)	(0.5280)	(0.0000***)	(0.0000***)	(0.0010**)	(0.0000***)
lppotatoes	-0.0019	0.0016	-0.0061	0.0024	0.0009	0.0015	0.0005	-0.0007
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0290*)	(0.0000***)
lppulses	-0.0067	-0.0026	0.0098	0.0011	-0.0029	-0.0047	0.0015	-0.0023
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0240*)	(0.0000***)	(0.0000***)	(0.0150*)	(0.0000***)
lpricehusked	0.0102	0.0028	-0.0093	-0.0029	0.0017	0.0078	0.0108	0.0046
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0080**)	(0.0000***)	(0.0000***)	(0.0000***)
lpsalt	0.0015	-0.0009	-0.0010	0.0028	-0.0017	-0.0023	-0.0013	-0.0004
	(0.0000***)	(0.0000***)	(0.0230*)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpsugar	0.0213	0.0002	-0.0347	0.0006	-0.0124	0.0053	-0.0038	-0.0054
	(0.0000***)	(0.6450)	(0.0000***)	(0.2340)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpsweetpotato	-0.0025	-0.0009	-0.0006	0.0003	-0.0021	0.0022	0.0062	0.0005
	(0.0000***)	(0.0000***)	(0.1750)	(0.1180)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
occupationrank	-0.0070	-0.0044	0.0037	-0.0033	0.0016	0.0007	0.0030	0.0006
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Estimation for all goods after the first-stage non-consumption probit (3/3)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	qonion	qpeanuts	qpotatoes	qpulses	qricehusked	qsalt	qsugar	qsweetpotato
age	-0.0001	0.0000	-0.0001	0.0001	-0.0003	0.0001	0.0002	-0.0001
	(0.0000***)	(0.0450*)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
cons	0.3803	-0.0119	-0.0409	0.0248	-0.4139	0.2239	0.1990	0.0138
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
consu	0.0002	-0.0001	-0.0003	0.0012	-0.0006	0.0009	0.0015	-0.0001
	(0.0010**)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
educrank	-0.0108	-0.0039	-0.0007	-0.0161	-0.0210	0.0177	0.0007	-0.0080
	(0.0000***)	(0.0000***)	(0.3210)	(0.0000***)	(0.0000***)	(0.0000***)	(0.7030)	(0.0000***)
invmills	-0.0075	0.0011	0.0005	-0.0030	-0.0065	0.0001	-0.0042	0.0011
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.4090)	(0.0000***)	(0.0000***)
lntotexp	-0.0195	0.0002	0.0045	-0.0017	0.0356	-0.0151	-0.0040	0.0009
	(0.0000***)	(0.0690)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbeef	-0.0052	-0.0032	0.0092	0.0000	0.0503	-0.0081	-0.0003	-0.0090
	(0.0000***)	(0.0000***)	(0.0000***)	(0.9880)	(0.0000***)	(0.0000***)	(0.7210)	(0.0000***)
lpbeer	-0.0037	-0.0005	-0.0020	-0.0002	-0.0013	0.0016	0.0094	-0.0005
	(0.0000***)	(0.0010**)	(0.0000***)	(0.5550)	(0.0080**)	(0.0000***)	(0.0000***)	(0.0020**)
lpbread	0.0007	-0.0025	-0.0001	-0.0023	-0.0050	-0.0007	-0.0071	-0.0014
	(0.0030**)	(0.0000***)	(0.4210)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpbunscakes	0.0042	-0.0027	0.0009	0.0020	0.0004	-0.0013	0.0073	0.0002
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.5770)	(0.0000***)	(0.0000***)	(0.3670)
lpcassavaflour	0.0019	-0.0008	0.0002	-0.0073	-0.0092	-0.0002	-0.0045	-0.0004
	(0.0000***)	(0.0000***)	(0.2440)	(0.0000***)	(0.0000***)	(0.1760)	(0.0000***)	(0.0270*)
lpcassavafresh	0.0028	0.0006	0.0001	-0.0005	-0.0008	0.0013	0.0048	-0.0001
	(0.0000***)	(0.0000***)	(0.2530)	(0.0460*)	(0.0390*)	(0.0000***)	(0.0000***)	(0.3110)
lpcharcoal	0.0028	0.0013	-0.0030	0.0041	-0.0139	-0.0022	-0.0190	0.0026
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcoconut	0.0008	-0.0004	0.0017	-0.0057	-0.0080	-0.0009	-0.0236	-0.0007
	(0.0030**)	(0.0220*)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpcookingoil	-0.0112	-0.0005	-0.0019	-0.0067	0.0102	0.0015	0.0213	-0.0025
	(0.0000***)	(0.1200)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpdriedcannedfish	0.0034	-0.0010	0.0016	-0.0026	0.0028	-0.0009	0.0002	-0.0009
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.6450)	(0.0000***)
lpelectricity	0.0037	0.0062	-0.0061	0.0098	-0.0093	-0.0010	-0.0347	-0.0006
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0230*)	(0.0000***)	(0.1750)
lpfishseafood	0.0028	-0.0001	0.0024	0.0011	-0.0029	0.0028	0.0006	0.0003
	(0.0000***)	(0.5280)	(0.0000***)	(0.0240*)	(0.0000***)	(0.0000***)	(0.2340)	(0.1180)
lpfreshmilk	-0.0043	-0.0039	0.0009	-0.0029	0.0017	-0.0017	-0.0124	-0.0021
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0080**)	(0.0000***)	(0.0000***)	(0.0000***)
lpgreens	-0.0021	0.0023	0.0015	-0.0047	0.0078	-0.0023	0.0053	0.0022
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpkerosene	0.0001	-0.0008	0.0005	0.0015	0.0108	-0.0013	-0.0038	0.0062
	(0.8780)	(0.0010**)	(0.0290*)	(0.0150*)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpmangoes	-0.0015	0.0005	-0.0007	-0.0023	0.0046	-0.0004	-0.0054	0.0005
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lponion	0.0027	-0.0009	0.0005	0.0041	0.0070	-0.0002	-0.0101	0.0016
	(0.0000***)	(0.0000***)	(0.0070**)	(0.0000***)	(0.0000***)	(0.2450)	(0.0000***)	(0.0000***)
lppeanuts	-0.0009	-0.0026	-0.0004	0.0002	-0.0033	0.0016	0.0095	0.0013
	(0.0000***)	(0.0000***)	(0.0280*)	(0.6520)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lppotatoes	0.0005	-0.0004	-0.0016	0.0011	0.0023	-0.0011	-0.0039	-0.0021
	(0.0070**)	(0.0280*)	(0.0000***)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lppulses	0.0041	0.0002	0.0011	0.0108	0.0112	-0.0018	-0.0056	-0.0034
	(0.0000***)	(0.6520)	(0.0010**)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpricehusked	0.0070	-0.0033	0.0023	0.0112	-0.0654	0.0070	-0.0005	0.0034
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.6630)	(0.0000***)
lpsalt	-0.0002	0.0016	-0.0011	-0.0018	0.0070	0.0011	0.0053	0.0021
	(0.2450)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
lpsugar	-0.0101	0.0095	-0.0039	-0.0056	-0.0005	0.0053	0.0625	0.0047
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.6630)	(0.0000***)	(0.0000***)	(0.0000***)
lpsweetpotato	0.0016	0.0013	-0.0021	-0.0034	0.0034	0.0021	0.0047	-0.0014
	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)	(0.0000***)
occupationrank	-0.0023	-0.0009	0.0000	-0.0035	0.0000	0.0003	-0.0076	-0.0003
	(0.0000***)	(0.0000***)	(0.5270)	(0.0000***)	(0.9600)	(0.0000***)	(0.0000***)	(0.0010**)

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

APPENDIX III

It is common for the empirical studies in sub-Saharan Africa to use the income data only indirectly. There are two mains reasons for this. First, the income-data is much more sparse than for occupation or education (only about a quarter of households, for example, have income data available in the LSMS survey for Tanzania). Second, the predominance of informal sectors further subjects the income data to significant measurement errors.

While the income data may not be of direct utility to its sparsity, it is useful in providing an overview of occupational differences in Tanzania. As the household occupation-data is more widely available than the income data, we use a mapping of incomes on to the list of occupational (ordered) ranks by sorting the occupations based on income. More specifically, the occupations are sorted based on the average income received and categorised in broad ranks ranging form 0 to 3 (non-paying occupations are unemployed status is set to 0 and a higher-rank corresponds to a higher-income occupation). The occupation ranks thus assigned are shown in Table 27. The variation in education levels is also given a similar treatment and used as education ranks for comparison. In other words, an ordered variable corresponding to the varied education levels is inferred as occupation-rank based on income received by the highest-education level recorded for individuals in the data. The mappings from education-levels to education ranks are listed in Table 25.

Table 14: Occupations as ranks in Tanzania

code	occupation area	occupation rank	median income	number of entries
14	Student	0	NA	43
13	Job Seeker	0	NA	7
12	Paid Family Work	0	NA	7
16	Unemployed	0	NA	40
11	Unpaid Family Work	0	NA	23
17	Unemployed (too young)	0	NA	0
1	Livestock/Agriculture	1	400000.00	1097
2	Fishing	1	1660800.00	19
3	Mining	1	666666.67	8
4	Tourism	1	46666.67	1
7	Private Sector	2	3000000.00	873
9	Non-Agricultural (w Employer)	2	2662400.00	2
10	Non-Agricultural (w/o Employer)	2	2116800.00	2
8	Non-Government/Religious Org	3	2440000.00	36
5	Government	3	7168000.00	329
6	Parastatal	3	10736000.00	18

Table 15: Education levels as ranks in Tanzania

	education code	education rank
PP	1	1
ADULT	2	2
D1	11	2
D2	12	2
D3	13	2
D4	14	2
D5	15	2
D6	16	2
D7	17	2
D8	18	3
OSC	19	3
MS COURSE	20	3
F1	21	3
F2	22	3
F3	23	3
F4	24	3
O COURSE	25	4
F5	31	4
F6	32	4
A COURSE	33	4
DIPLOMA	34	4
U1	41	4
U2	42	4
U3	43	4
U4	44	4
U5&	45	4

APPENDIX IV

For each of the 10 relevant commodities $\{meatsproteins,\ fat,\ cereals\ ,\ veg,\ milk,\ starches,\ complements,\ tubers,\ fruits,\ fish\}$, we have one equation each with budget share as the dependent variable (indicated with equation starting with q such as $qmeatsproteins, qfat$ etc.) and another (for each commodity) with the quality-metric as dependent variable (indicated with equation starting with qV such as $qVmeatsproteins, qVfat$ etc.). The entire list is as follows.

$qmeatsproteins:$

$$
\begin{gathered}
w_{meatsproteins} = \rho_{1,meatsproteins,\chi}d_{\chi} + \rho_{1,meatsproteins,\xi}d_{\xi} + \gamma_{1,meatsproteins,fat}ln(P_{fat}) \\
+ \gamma_{1,meatsproteins,meatsproteins}ln(P_{meatsproteins}) + \gamma_{1,meatsproteins,cereals}ln(P_{cereals}) \\
+ \gamma_{1,meatsproteins,veg}ln(P_{veg}) + \gamma_{1,meatsproteins,milk}ln(P_{milk}) \\
+ \gamma_{1,meatsproteins,starches}ln(P_{starches}) + \gamma_{1,meatsproteins,complements}ln(P_{complements}) \\
+ \gamma_{1,meatsproteins,tubers}ln(P_{tubers}) + \gamma_{1,meatsproteins,fruits}ln(P_{fruits}) \\
+ \gamma_{1,meatsproteins,fish}ln(P_{fish}) + \beta_{meatsproteins,1}ln(x) + \epsilon_{meatsproteins,1}
\end{gathered}
$$

$qVmeatsproteins:$

$$
\begin{gathered}
ln\ V_{meatsproteins} = \rho_{1,meatsproteins,\chi}d_{\chi} + \rho_{1,meatsproteins,\xi}d_{\xi} + \gamma_{1,meatsproteins,fat}ln(P_{fat}) \\
+ \gamma_{1,meatsproteins,meatsproteins}ln(P_{meatsproteins}) + \gamma_{1,meatsproteins,cereals}ln(P_{cereals}) \\
+ \gamma_{1,meatsproteins,veg}ln(P_{veg}) + \gamma_{1,meatsproteins,milk}ln(P_{milk}) \\
+ \gamma_{1,meatsproteins,starches}ln(P_{starches}) + \gamma_{1,meatsproteins,complements}ln(P_{complements}) \\
+ \gamma_{1,meatsproteins,tubers}ln(P_{tubers}) + \gamma_{1,meatsproteins,fruits}ln(P_{fruits}) \\
+ \gamma_{1,meatsproteins,fish}ln(P_{fish}) + \beta_{meatsproteins,1}ln(x) + \epsilon_{meatsproteins,1}
\end{gathered}
$$

$qfat:$

$$
\begin{gathered}
w_{fat} = \rho_{1,fat,\chi}d_{\chi} + \rho_{1,fat,\xi}d_{\xi} + \gamma_{1,fat,fat}ln(P_{fat}) \\
+ \gamma_{1,fat,fat}ln(P_{fat}) + \gamma_{1,fat,cereals}ln(P_{cereals}) \\
+ \gamma_{1,fat,veg}ln(P_{veg}) + \gamma_{1,fat,milk}ln(P_{milk}) \\
+ \gamma_{1,fat,starches}ln(P_{starches}) + \gamma_{1,fat,complements}ln(P_{complements}) \\
+ \gamma_{1,fat,tubers}ln(P_{tubers}) + \gamma_{1,fat,fruits}ln(P_{fruits}) \\
+ \gamma_{1,fat,fish}ln(P_{fish}) + \beta_{fat,1}ln(x) + \epsilon_{fat,1}
\end{gathered}
$$

$qVfat:$

$$
\begin{aligned}
ln\, V_{fat} = \rho_{1,fat,\chi}d_{\chi} + \rho_{1,fat,\xi}d_{\xi} + \gamma_{1,fat,fat}ln(P_{fat}) \\
+ \gamma_{1,fat,fat}ln(P_{fat}) + \gamma_{1,fat,cereals}ln(P_{cereals}) \\
+ \gamma_{1,fat,veg}ln(P_{veg}) + \gamma_{1,fat,milk}ln(P_{milk}) \\
+ \gamma_{1,fat,starches}ln(P_{starches}) + \gamma_{1,fat,complements}ln(P_{complements}) \\
+ \gamma_{1,fat,tubers}ln(P_{tubers}) + \gamma_{1,fat,fruits}ln(P_{fruits}) \\
+ \gamma_{1,fat,fish}ln(P_{fish}) + \beta_{fat,1}ln(x) + \epsilon_{fat,1}
\end{aligned}
$$

$qcereals:$

$$
\begin{aligned}
w_{cereals} = \rho_{1,cereals,\chi}d_{\chi} + \rho_{1,cereals,\xi}d_{\xi} + \gamma_{1,cereals,fat}ln(P_{fat}) \\
+ \gamma_{1,cereals,cereals}ln(P_{cereals}) + \gamma_{1,cereals,cereals}ln(P_{cereals}) \\
+ \gamma_{1,cereals,veg}ln(P_{veg}) + \gamma_{1,cereals,milk}ln(P_{milk}) \\
+ \gamma_{1,cereals,starches}ln(P_{starches}) + \gamma_{1,cereals,complements}ln(P_{complements}) \\
+ \gamma_{1,cereals,tubers}ln(P_{tubers}) + \gamma_{1,cereals,fruits}ln(P_{fruits}) \\
+ \gamma_{1,cereals,fish}ln(P_{fish}) + \beta_{cereals,1}ln(x) + \epsilon_{cereals,1}
\end{aligned}
$$

$qVcereals:$

$$
\begin{aligned}
ln\, V_{cereals} = \rho_{1,cereals,\chi}d_{\chi} + \rho_{1,cereals,\xi}d_{\xi} + \gamma_{1,cereals,fat}ln(P_{fat}) \\
+ \gamma_{1,cereals,cereals}ln(P_{cereals}) + \gamma_{1,cereals,cereals}ln(P_{cereals}) \\
+ \gamma_{1,cereals,veg}ln(P_{veg}) + \gamma_{1,cereals,milk}ln(P_{milk}) \\
+ \gamma_{1,cereals,starches}ln(P_{starches}) + \gamma_{1,cereals,complements}ln(P_{complements}) \\
+ \gamma_{1,cereals,tubers}ln(P_{tubers}) + \gamma_{1,cereals,fruits}ln(P_{fruits}) \\
+ \gamma_{1,cereals,fish}ln(P_{fish}) + \beta_{cereals,1}ln(x) + \epsilon_{cereals,1}
\end{aligned}
$$

$qveg:$

$$
\begin{aligned}
w_{veg} = \rho_{1,veg,\chi}d_{\chi} + \rho_{1,veg,\xi}d_{\xi} + \gamma_{1,veg,fat}ln(P_{fat}) \\
+ \gamma_{1,veg,veg}ln(P_{veg}) + \gamma_{1,veg,cereals}ln(P_{cereals}) \\
+ \gamma_{1,veg,veg}ln(P_{veg}) + \gamma_{1,veg,milk}ln(P_{milk}) \\
+ \gamma_{1,veg,starches}ln(P_{starches}) + \gamma_{1,veg,complements}ln(P_{complements}) \\
+ \gamma_{1,veg,tubers}ln(P_{tubers}) + \gamma_{1,veg,fruits}ln(P_{fruits}) \\
+ \gamma_{1,veg,fish}ln(P_{fish}) + \beta_{veg,1}ln(x) + \epsilon_{veg,1}
\end{aligned}
$$

$qVveg:$

$$\begin{aligned} ln\ V_{veg} = \rho_{1,veg,\chi}d_{\chi} + \rho_{1,veg,\xi}d_{\xi} + \gamma_{1,veg,fat}ln(P_{fat}) \\ + \gamma_{1,veg,veg}ln(P_{veg}) + \gamma_{1,veg,cereals}ln(P_{cereals}) \\ + \gamma_{1,veg,veg}ln(P_{veg}) + \gamma_{1,veg,milk}ln(P_{milk}) \\ + \gamma_{1,veg,starches}ln(P_{starches}) + \gamma_{1,veg,complements}ln(P_{complements}) \\ + \gamma_{1,veg,tubers}ln(P_{tubers}) + \gamma_{1,veg,fruits}ln(P_{fruits}) \\ + \gamma_{1,veg,fish}ln(P_{fish}) + \beta_{veg,1}ln(x) + \epsilon_{veg,1} \end{aligned}$$

$qmilk:$

$$\begin{aligned} w_{milk} = \rho_{1,milk,\chi}d_{\chi} + \rho_{1,milk,\xi}d_{\xi} + \gamma_{1,milk,fat}ln(P_{fat}) \\ + \gamma_{1,milk,milk}ln(P_{milk}) + \gamma_{1,milk,cereals}ln(P_{cereals}) \\ + \gamma_{1,milk,veg}ln(P_{veg}) + \gamma_{1,milk,milk}ln(P_{milk}) \\ + \gamma_{1,milk,starches}ln(P_{starches}) + \gamma_{1,milk,complements}ln(P_{complements}) \\ + \gamma_{1,milk,tubers}ln(P_{tubers}) + \gamma_{1,milk,fruits}ln(P_{fruits}) \\ + \gamma_{1,milk,fish}ln(P_{fish}) + \beta_{milk,1}ln(x) + \epsilon_{milk,1} \end{aligned}$$

$qVmilk:$

$$\begin{aligned} ln\ V_{milk} = \rho_{1,milk,\chi}d_{\chi} + \rho_{1,milk,\xi}d_{\xi} + \gamma_{1,milk,fat}ln(P_{fat}) \\ + \gamma_{1,milk,milk}ln(P_{milk}) + \gamma_{1,milk,cereals}ln(P_{cereals}) \\ + \gamma_{1,milk,veg}ln(P_{veg}) + \gamma_{1,milk,milk}ln(P_{milk}) \\ + \gamma_{1,milk,starches}ln(P_{starches}) + \gamma_{1,milk,complements}ln(P_{complements}) \\ + \gamma_{1,milk,tubers}ln(P_{tubers}) + \gamma_{1,milk,fruits}ln(P_{fruits}) \\ + \gamma_{1,milk,fish}ln(P_{fish}) + \beta_{milk,1}ln(x) + \epsilon_{milk,1} \end{aligned}$$

$qstarches:$

$$\begin{aligned} w_{starches} = \rho_{1,starches,\chi}d_{\chi} + \rho_{1,starches,\xi}d_{\xi} + \gamma_{1,starches,fat}ln(P_{fat}) \\ + \gamma_{1,starches,starches}ln(P_{starches}) + \gamma_{1,starches,cereals}ln(P_{cereals}) \\ + \gamma_{1,starches,veg}ln(P_{veg}) + \gamma_{1,starches,milk}ln(P_{milk}) \\ + \gamma_{1,starches,starches}ln(P_{starches}) + \gamma_{1,starches,complements}ln(P_{complements}) \\ + \gamma_{1,starches,tubers}ln(P_{tubers}) + \gamma_{1,starches,fruits}ln(P_{fruits}) \\ + \gamma_{1,starches,fish}ln(P_{fish}) + \beta_{starches,1}ln(x) + \epsilon_{starches,1} \end{aligned}$$

$qVstarches:$

$$\begin{aligned}ln\,V_{starches} = \rho_{1,starches,\chi}d_{\chi} + \rho_{1,starches,\xi}d_{\xi} + \gamma_{1,starches,fat}ln(P_{fat})\\ + \gamma_{1,starches,starches}ln(P_{starches}) + \gamma_{1,starches,cereals}ln(P_{cereals})\\ + \gamma_{1,starches,veg}ln(P_{veg}) + \gamma_{1,starches,milk}ln(P_{milk})\\ + \gamma_{1,starches,starches}ln(P_{starches}) + \gamma_{1,starches,complements}ln(P_{complements})\\ + \gamma_{1,starches,tubers}ln(P_{tubers}) + \gamma_{1,starches,fruits}ln(P_{fruits})\\ + \gamma_{1,starches,fish}ln(P_{fish}) + \beta_{starches,1}ln(x) + \epsilon_{starches,1}\end{aligned}$$

$qcomplements:$

$$\begin{aligned}w_{complements} = \rho_{1,complements,\chi}d_{\chi} + \rho_{1,complements,\xi}d_{\xi} + \gamma_{1,complements,fat}ln(P_{fat})\\ + \gamma_{1,complements,complements}ln(P_{complements}) + \gamma_{1,complements,cereals}ln(P_{cereals})\\ + \gamma_{1,complements,veg}ln(P_{veg}) + \gamma_{1,complements,milk}ln(P_{milk})\\ + \gamma_{1,complements,starches}ln(P_{starches}) + \gamma_{1,complements,complements}ln(P_{complements})\\ + \gamma_{1,complements,tubers}ln(P_{tubers}) + \gamma_{1,complements,fruits}ln(P_{fruits})\\ + \gamma_{1,complements,fish}ln(P_{fish}) + \beta_{complements,1}ln(x) + \epsilon_{complements,1}\end{aligned}$$

$qVcomplements:$

$$\begin{aligned}ln\,V_{complements} = \rho_{1,complements,\chi}d_{\chi} + \rho_{1,complements,\xi}d_{\xi} + \gamma_{1,complements,fat}ln(P_{fat})\\ + \gamma_{1,complements,complements}ln(P_{complements}) + \gamma_{1,complements,cereals}ln(P_{cereals})\\ + \gamma_{1,complements,veg}ln(P_{veg}) + \gamma_{1,complements,milk}ln(P_{milk})\\ + \gamma_{1,complements,starches}ln(P_{starches}) + \gamma_{1,complements,complements}ln(P_{complements})\\ + \gamma_{1,complements,tubers}ln(P_{tubers}) + \gamma_{1,complements,fruits}ln(P_{fruits})\\ + \gamma_{1,complements,fish}ln(P_{fish}) + \beta_{complements,1}ln(x) + \epsilon_{complements,1}\end{aligned}$$

$qtubers:$

$$\begin{aligned}w_{tubers} = \rho_{1,tubers,\chi}d_{\chi} + \rho_{1,tubers,\xi}d_{\xi} + \gamma_{1,tubers,fat}ln(P_{fat})\\ + \gamma_{1,tubers,tubers}ln(P_{tubers}) + \gamma_{1,tubers,cereals}ln(P_{cereals})\\ + \gamma_{1,tubers,veg}ln(P_{veg}) + \gamma_{1,tubers,milk}ln(P_{milk})\\ + \gamma_{1,tubers,starches}ln(P_{starches}) + \gamma_{1,tubers,complements}ln(P_{complements})\\ + \gamma_{1,tubers,tubers}ln(P_{tubers}) + \gamma_{1,tubers,fruits}ln(P_{fruits})\\ + \gamma_{1,tubers,fish}ln(P_{fish}) + \beta_{tubers,1}ln(x) + \epsilon_{tubers,1}\end{aligned}$$

$qVtubers:$

$$\begin{aligned}ln\,V_{tubers} = \rho_{1,tubers,\chi}d_\chi + \rho_{1,tubers,\xi}d_\xi + \gamma_{1,tubers,fat}ln(P_{fat})\\
+ \gamma_{1,tubers,tubers}ln(P_{tubers}) + \gamma_{1,tubers,cereals}ln(P_{cereals})\\
+ \gamma_{1,tubers,veg}ln(P_{veg}) + \gamma_{1,tubers,milk}ln(P_{milk})\\
+ \gamma_{1,tubers,starches}ln(P_{starches}) + \gamma_{1,tubers,complements}ln(P_{complements})\\
+ \gamma_{1,tubers,tubers}ln(P_{tubers}) + \gamma_{1,tubers,fruits}ln(P_{fruits})\\
+ \gamma_{1,tubers,fish}ln(P_{fish}) + \beta_{tubers,1}ln(x) + \epsilon_{tubers,1}\end{aligned}$$

$qfruits:$

$$\begin{aligned}w_{fruits} = \rho_{1,fruits,\chi}d_\chi + \rho_{1,fruits,\xi}d_\xi + \gamma_{1,fruits,fat}ln(P_{fat})\\
+ \gamma_{1,fruits,fruits}ln(P_{fruits}) + \gamma_{1,fruits,cereals}ln(P_{cereals})\\
+ \gamma_{1,fruits,veg}ln(P_{veg}) + \gamma_{1,fruits,milk}ln(P_{milk})\\
+ \gamma_{1,fruits,starches}ln(P_{starches}) + \gamma_{1,fruits,complements}ln(P_{complements})\\
+ \gamma_{1,fruits,tubers}ln(P_{tubers}) + \gamma_{1,fruits,fruits}ln(P_{fruits})\\
+ \gamma_{1,fruits,fish}ln(P_{fish}) + \beta_{fruits,1}ln(x) + \epsilon_{fruits,1}\end{aligned}$$

$qVfruits:$

$$\begin{aligned}ln\,V_{fruits} = \rho_{1,fruits,\chi}d_\chi + \rho_{1,fruits,\xi}d_\xi + \gamma_{1,fruits,fat}ln(P_{fat})\\
+ \gamma_{1,fruits,fruits}ln(P_{fruits}) + \gamma_{1,fruits,cereals}ln(P_{cereals})\\
+ \gamma_{1,fruits,veg}ln(P_{veg}) + \gamma_{1,fruits,milk}ln(P_{milk})\\
+ \gamma_{1,fruits,starches}ln(P_{starches}) + \gamma_{1,fruits,complements}ln(P_{complements})\\
+ \gamma_{1,fruits,tubers}ln(P_{tubers}) + \gamma_{1,fruits,fruits}ln(P_{fruits})\\
+ \gamma_{1,fruits,fish}ln(P_{fish}) + \beta_{fruits,1}ln(x) + \epsilon_{fruits,1}\end{aligned}$$

$qfish:$

$$\begin{aligned}w_{fish} = \rho_{1,fish,\chi}d_\chi + \rho_{1,fish,\xi}d_\xi + \gamma_{1,fish,fat}ln(P_{fat})\\
+ \gamma_{1,fish,fish}ln(P_{fish}) + \gamma_{1,fish,cereals}ln(P_{cereals})\\
+ \gamma_{1,fish,veg}ln(P_{veg}) + \gamma_{1,fish,milk}ln(P_{milk})\\
+ \gamma_{1,fish,starches}ln(P_{starches}) + \gamma_{1,fish,complements}ln(P_{complements})\\
+ \gamma_{1,fish,tubers}ln(P_{tubers}) + \gamma_{1,fish,fruits}ln(P_{fruits})\\
+ \gamma_{1,fish,fish}ln(P_{fish}) + \beta_{fish,1}ln(x) + \epsilon_{fish,1}\end{aligned}$$

$qVfish$:

$$
\begin{aligned}
ln\, V_{fish} = \rho_{1,fish,\chi}d_\chi + \rho_{1,fish,\xi}d_\xi + \gamma_{1,fish,fat}ln(P_{fat})\\
+ \gamma_{1,fish,fish}ln(P_{fish}) + \gamma_{1,fish,cereals}ln(P_{cereals})\\
+ \gamma_{1,fish,veg}ln(P_{veg}) + \gamma_{1,fish,milk}ln(P_{milk})\\
+ \gamma_{1,fish,starches}ln(P_{starches}) + \gamma_{1,fish,complements}ln(P_{complements})\\
+ \gamma_{1,fish,tubers}ln(P_{tubers}) + \gamma_{1,fish,fruits}ln(P_{fruits})\\
+ \gamma_{1,fish,fish}ln(P_{fish}) + \beta_{fish,1}ln(x) + \epsilon_{fish,1}
\end{aligned}
$$

The symmetry restrictions corresponding the ten commodities are as follows.

$$
\begin{aligned}
\gamma_{1,meatsproteins,fat} &= \gamma_{1,fat,meatsproteins}\\
\gamma_{1,meatsproteins,cereals} &= \gamma_{1,cereals,meatsproteins}\\
\gamma_{1,meatsproteins,veg} &= \gamma_{1,veg,meatsproteins}\\
\gamma_{1,meatsproteins,milk} &= \gamma_{1,milk,meatsproteins}\\
\gamma_{1,meatsproteins,starches} &= \gamma_{1,starches,meatsproteins}\\
\gamma_{1,meatsproteins,complements} &= \gamma_{1,complements,meatsproteins}\\
\gamma_{1,meatsproteins,tubers} &= \gamma_{1,tubers,meatsproteins}\\
\gamma_{1,meatsproteins,fruits} &= \gamma_{1,fruits,meatsproteins}\\
\gamma_{1,meatsproteins,fish} &= \gamma_{1,fish,meatsproteins}
\end{aligned}
$$

$$
\begin{aligned}
\gamma_{1,fat,cereals} &= \gamma_{1,cereals,fat}\\
\gamma_{1,fat,veg} &= \gamma_{1,veg,fat}\\
\gamma_{1,fat,milk} &= \gamma_{1,milk,fat}\\
\gamma_{1,fat,starches} &= \gamma_{1,starches,fat}\\
\gamma_{1,fat,complements} &= \gamma_{1,complements,fat}\\
\gamma_{1,fat,tubers} &= \gamma_{1,tubers,fat}\\
\gamma_{1,fat,fruits} &= \gamma_{1,fruits,fat}\\
\gamma_{1,fat,fish} &= \gamma_{1,fish,fat}
\end{aligned}
$$

$$\gamma_{1,cereals,veg} = \gamma_{1,veg,cereals}$$

$$\gamma_{1,cereals,milk} = \gamma_{1,milk,cereals}$$

$$\gamma_{1,cereals,starches} = \gamma_{1,starches,cereals}$$

$$\gamma_{1,cereals,complements} = \gamma_{1,complements,cereals}$$

$$\gamma_{1,cereals,tubers} = \gamma_{1,tubers,cereals}$$

$$\gamma_{1,cereals,fruits} = \gamma_{1,fruits,cereals}$$

$$\gamma_{1,cereals,fish} = \gamma_{1,fish,cereals}$$

$$\gamma_{1,veg,milk} = \gamma_{1,milk,veg}$$

$$\gamma_{1,veg,starches} = \gamma_{1,starches,veg}$$

$$\gamma_{1,veg,complements} = \gamma_{1,complements,veg}$$

$$\gamma_{1,veg,tubers} = \gamma_{1,tubers,veg}$$

$$\gamma_{1,veg,fruits} = \gamma_{1,fruits,veg}$$

$$\gamma_{1,veg,fish} = \gamma_{1,fish,veg}$$

$$\gamma_{1,milk,starches} = \gamma_{1,starches,milk}$$

$$\gamma_{1,milk,complements} = \gamma_{1,complements,milk}$$

$$\gamma_{1,milk,tubers} = \gamma_{1,tubers,milk}$$

$$\gamma_{1,milk,fruits} = \gamma_{1,fruits,milk}$$

$$\gamma_{1,milk,fish} = \gamma_{1,fish,milk}$$

$$\gamma_{1,starches,complements} = \gamma_{1,complements,starches}$$

$$\gamma_{1,starches,tubers} = \gamma_{1,tubers,starches}$$

$$\gamma_{1,starches,fruits} = \gamma_{1,fruits,starches}$$

$$\gamma_{1,starches,fish} = \gamma_{1,fish,starches}$$

$$\gamma_{1,complements,tubers} = \gamma_{1,tubers,complements}$$

$$\gamma_{1,complements,fruits} = \gamma_{1,fruits,complements}$$

$$\gamma_{1,complements,fish} = \gamma_{1,fish,complements}$$

$$\gamma_{1,tubers,fruits} = \gamma_{1,fruits,tubers}$$

$$\gamma_{1,tubers,fish} = \gamma_{1,fish,tubers}$$

$$\gamma_{1,fruits,fish} = \gamma_{1,fish,fruits}$$

Part II

Urbanisation Levels and Wealth Effects on Education in sub-Saharan Africa

Abstract

The economies in sub-Saharan Africa show significant wealth effects that often limit wider access to higher education in the region. To examine the extent of such limits on education expenses, we survey the wealth effects on education expenses in Tanzania and Nigeria across differing levels of urbanisation and access to secondary education in the two economies. We find that despite varied contexts of education in the two economies, the role of wealth effects is weakened as urbanisation rises in sub-Saharan Africa and that the availability of secondary-education can have a stronger effect than wealth effects on education expenses in the region.

1 Introduction

The participation rates for secondary and higher education remain one of the lowest for the economies of sub-Saharan Africa (SSA). Education remains inaccessible to the vast majority and inadequate in providing mobility to those with low-income who do acquire it (Dabalen *et al.* (2001); Oketch (2016); Ndyali (2016); Minnis (2006)). The low participation in education has been attributed both to an insufficient focus on non-formal education (Minnis (2006)) and the barriers imposed by inadequate wealth (Glewwe & Jacoby (2004); Ilie & Rose (2018)). In the presented chapter, we examine if education expenses are limited by wealth differences and whether the changes brought about by urbanisation in SSA may act to reduce or worsen the effect of long-term wealth (i.e. wealth effects) on education expenditures or not. Comparing the role of urbanisation across Tanzania and Nigeria - economies which we select due to significant differences in levels of urbanisation and degree of dependence on agrarian production - we find that the significance of household wealth on education declines with higher urbanisation in the region while the role of availability of education remains strong.

The wealth effects on education - i.e. the extent to which the household wealth contributes to education expenses - are commonly observed through various mechanisms (Glewwe & Jacoby (2004); Ilie & Rose (2018)). Other than through costs (such as transportation) imposed on households when public education access is poorer, the household wealth also influences access to education due to information symmetries that may help in future job-searches, better representations in the nascent political institutions of developing economies or certain social characteristics that align with higher local (relative) household wealth (Behrman & Knowles (1999)). As higher intergenerational wealth may help fund higher levels of education, the wealth inequalities can become educational inequalities by creating a poverty trap for the lower-income households (Glewwe & Jacoby (2004); Behrman & Knowles (1999)) - a concern that has been important for policy in SSA due to the predominance of large informal sector in the region and the higher consequent income volatility which deprioritises education expenditures for poorer households (K'akumu & Olima (2007); Owusu & Agyei-Mensah (2011); Minnis (2006))[19]. The empirical literature often suggests a stronger role of wealth effects than physical access for education expenses in the literature (Glewwe & Jacoby (2004); Behrman & Knowles (1999)).

While we measure wealth effects as the annual total household expenditure, the effects of urbanisation - whose effects we wish to detail in the current chapter - are interpreted as that of wealth-concentration in the immediate area surrounding the household. The goal of the particular notion of urbanisation as a measure of concentration of wealth is to take into consideration the spatial variation in the SSA while standardising the measurement of

[19]Such effects evidently get worse at higher levels of education since the foregone labour income through time spent in education becomes costlier for households with low possessions or wealth.

urbanisation across different economies. More specifically, the measure of urbanisation as concentration of wealth relies on the market value of assets[20] owned by the household. While several empirical studies use urban-rural effects to explain disparities in education expenditures in SSA (Ebaidalla (2018); Donkoh & Amikuzuno (2011)) as well as in other developing economies (Bayar & İlhan (2016); Knight & Shi (1996); Acar *et al.* (2016)), recent studies highlight the need to consider spatial distribution of resources and employment opportunities in the SSA - instead of the broad or implicit urban-rural classifications that are often used in surveys (Abay *et al.* (2021); Wiggins & Proctor (2001)). These concerns motivate the use of wealth-concentration as the primary measure of urbanisation in the current study.

The urban-rural disparities can influence the participation in education through various mechanisms. Setting aside the physical access to education - i.e. the higher availability of education opportunities in urban areas which we consider as a separate control - the two fundamental mechanisms we intend to focus on through a measure of urbanisation are the relative abundance of opportunities for higher income employment and the social environment of the urban areas. The better opportunities of employment and wealth overall make education more affordable so that the households in rural areas - where incomes are invariably lower and education somewhat of a luxury- end up underinvesting in education. The social environment of urban areas is also often different - leading to a stronger need for finding education-dependent employment in urban areas. Both of the factors constitute the positive externalities from being in a rich locality (district) that are encompassed in the measure of urbanisation - a measure driven by the concentration of richness in terms of assets. More specifically, the study measures urbanisation with the average assets values in the household vicinity - while explicitly accounting for other social factors pertaining to the household (religious identity etc.) and controlling for availabililty of education opportunities.

The wealth concentration interpretation of urbanisation also assists us in empirically distinguishing the effects of urbanisation from household wealth effects. This is foremost because the asset values used in the wealth concentration and the total budget expenditure used in the permanent income (Modigliani & Brumberg (1954); Friedman (1957)) are measured independently in the survey - avoiding the need to rely on any community-level fields (characteristics of village, ward etc. assigned in the survey) for assessment of urbanisation-levels. To compare this assessment with a more conventional approach using urban-rural indicators, we also provide estimation results with an alternative formulation where a ruralness-score of the district based on urban-rural distinction in the survey is used

[20]The term "assets" signifies the goods that are owned by the household. These constitute items that are more often referred to as durable goods in the consumption literature from the developed economies. There seem at least two reasons why the developing economics literature more often refers to the durable household possessions as assets. First, the financial assets are far less relevant in the developing economies. Second, the durable goods such as bicycles or stoves - however insignificant - are far more important for consumption behaviour in the developing world.

as a measure of urbanisation and household-wealth is measured using the assets owned. The primary wealth-concentration interpretation of urbanisation - which interprets urbanisation as concentration of long-term asset ownership in a 6-km area [21] - provides a continuous (rather than categorical) variable for urbanisation levels. The wealth effects - measured as effects of household wealth on its education expenditures (Glewwe & Jacoby (2004)) - are then contrasted against the urbanisation effects (which include the positive externality from being in a wealthy area). With wealth effects and urbanisation effects thus compared after controlling for physical access and social factors, we find that the wealth effects for education to be more severe in less urbanised areas.

The physical access to education - a factor that directly influences education expenditure - is an important control in the above analysis. Given the focus on secondary education in development policy as well as literature in the last decades (Fuller (1976); Tilak (2002, 2007); Heyneman (2003, 1980b)), we focus on the accessibility of secondary education in the two economies. Controlling for physical access is relevant also because poor education access might make wealth effects appear stronger (due to higher transportation costs etc.). The control in fact often plays a critical role in determining whether a given amount of funds is more appropriately used to build accessible schools or to support and economise education instead. More specifically, if physical access for education is what prevents the attainment of education, then building more schools becomes of higher priority. On the other hand, if wealth effects are stronger in the economy, then affordability of education becomes an important issue - even if returns to education were a cause of concern. Whether returns to education are enough to increase education participation for lower-income households or not - also often hinges on there being less significant wealth effects and sufficient physical access to education in an economy (Glewwe & Jacoby (2004)). The results we obtain with urbanisation levels are particularly significant since the wealth effects are more often reported to be stronger than the effects of physical access in empirical studies from the region (Obasuyi & Rasiah (2019); Filmer & Pritchett (1999, 2001); Minnis (2006); Behrman & Knowles (1999); Glewwe & Jacoby (2004); Kambon & Busby (2000)).

The social environment of a household is another important control that one cannot ignore as the factors influencing participation in education. While the effects of discernible factors such as segregation or exclusion based on social identities education have been often highlighted in SSA (K'akumu & Olima (2007); Owusu & Agyei-Mensah (2011)), the specific role of social factors that may encourage or support education present a more challenging task to the empirical studies. Early attempts to explain the role of social factors have advanced the notion of social capital (Bourdieu (2018)) - which encompasses habits, preferences and behaviour cultivated in richer environments that affect future educational mobility. The empirical studies pertaining to social capital - however emphasise more often

[21] This 6-km scale in the district where the household residence is located - is based on the geographical distances between districts and the average distance to the education facility recorded in the consumption survey.

on certain environmental factors - such as the feedback for improvement of students, the subjective evaluations of students or other measures of social interactions (Manski (2000))- rather than any claimed role of a “higher-culture” (Yan *et al.* (2021); Yamamoto & Brinton (2010); Byun (2007)) that purportedly may influence participation or success in education. As empirical measures for social capital have neither been considered universal nor equivalent to physical in the empirical literature (Sobel (2002)), we prefer to focus on specific social factors at the household level in the current study.

These social factors encompass the acquisition of skills from parents or from the social environment (networks) valued in the employment markets and higher levels of education. The parental educational levels - which are widely observed to have a significant effect on education attainment in the developing economies (Tansel (1997)) - are the first important social factor. It is also possible to argue - from a certain human capital perspective (Wu *et al.* (2008); Behrman & Knowles (1999); Glewwe & Jacoby (2004); Spaull (2013))- that the effect of parental education levels is not unlike the effect of wealth (which has a strong effect on educational expenditures) since both accumulations are transferred to further generations (Becker & Tomes (1979)) - therefore making it a relevant control to consider. The other relevant social factor that may favour participation in education is the main occupation in the household. More particularly, the agrarian or non-agrarian nature of the household occupation in a largely agrarian economy may indicate a non-transactional advantage for individuals through the social networks they acquire. Other household characteristics of social significance that influence participation in education vary across the economies. In Tanzania, for example, the speakers of English language seem to be generally more educated and have higher incomes. The ability to speak English could indicate an exposure to education in ways that the poorer or rural households may not be exposed. The religious identities also have some implications for participation in education in countries such as Nigeria (Cooray & Potrafke (2011); Alesina *et al.* (2019)).

An essential claim of the human capital theory (Tilak (2002)) - which the empirical literature on determinants of education expenditure often relies on - is that the educational investments must change over the life cycle of consumers. The current chapter takes advantage of the reporting of household expenditures on education at individual level in the surveys for both the countries and considers how the education expenditure may vary with the age of the children in the household. The variables for childrens’ ages are important for our comparison also because the education expenditures for a population where the majority joins the workforce after attaining primary education would be very different from one where the employment opportunities are higher for educated individuals. Since large households have higher basic needs than smaller households, we also consider the number of children as another relevant control that is closely related with lifecycle concerns. It is worth highlighting that while one may expect the household expenses on education to decline with the rise in number children due to a higher cost pressures, studies often find that education enrollments to rise instead of decline with the number of children in some sub-Saharan African countries (Chernichovsky (1985); Maralani (2008))[22].

It is worth emphasising how a particular sense of urbanisation also helps us separate the effects of wealth concentration from the social factors identified above. The measure of wealth-concentration as inter-generational long-term assets quantifies urban-rural disparities and allows us to assess the extent to which a higher wealth concentration may provide a more supportive environment for education participation after accounting for the effects of wealth, occupation in the household, the physical access in the region (the district boundary in the surrounding 6-km distance) and other factors of social significance. The particular interpretation of urbanisation is based on suggestions to consider spatial distribution of assets in the recent literature - which has emphasised the network of occupations and contractual relationships surrounding the ownership of land or natural resources in SSA (Kosec *et al.* (2018); Chamberlin *et al.* (2020); Reardon (1997)) and highlighted inadequacies of the conventional urban-rural dichotomy based on categorical variables from community surveys that may not consider the spatial distribution of wealth and markets in SSA (Abay *et al.* (2021); Wiggins & Proctor (2001))[23].

As mentioned earlier, the two economies in SSA that we have selected for our comparison of education expenditure have different levels of economic development and a different degree of dependence on agrarian output. More particularly, Nigeria relies more heavily on energy exports while Tanzania's economy is more reliant on its agricultural output - a difference that is critical for the varied level of urbanisation in the two economies. While the educational attainments in the populations of the two countries are evidently shaped by the idiosyncrasies of the policy and distinct social factors, the varying levels of urbanisation in the two economies allow us to explore the challenges that improvement of employment opportunities and economic development may bring towards access to education in the region. More particularly, if wealth effects matter less in the urbanised areas i.e. if education is more egalitarian for residents in the urban areas (after controlling for physical access), then the policy may not need to focus on wealth effects and direct the attention to improving access elsewhere instead. On other hand, if wealth effects are significant despite higher economic development in urbanised regions, then more attention is needed for improvement of access to education for lower-income households.

To summarise, household wealth and urbanisation levels are the main explanatory variables in our comparison of educational expenditures while physical access to education, the social or demographic factors and the household characteristics serve as important

[22] A caveat in such observations is the use of enrollment data - which has been criticised in favour of educational expenditure on the basis for former measuring "flows" rather than "stocks" relevant to education (Thomas *et al.* (1999); Obasuyi & Rasiah (2019)).

[23] Notice that apart from taking spatial considerations across wider geographical scales into account, the wealth concentration measure also avoids the population density based approaches due to issues arising of densely populated rural areas in SSA economies (Henderson *et al.* (2013); Chamberlin *et al.* (2020); Abay *et al.* (2021)).

controls[24]. The first explanatory variable i.e. the wealth or the permanent income of the household uses the logarithm of household's total annual expenditure. The use of total expenditure as permanent income is common in studies on consumption and relies on standard consumption theory (Modigliani & Brumberg (1954); Friedman (1957)). The urbanisation levels correspond to a wealth-concentration measure that is used as the second explanatory variable (see Section 5.3 for details). As mentioned earlier, the wealth-concentration measure is simply the average asset-ownership levels in the households' vicinity. The physical access to education - is measured with the number of secondary schools in every district so that a higher score of `secondary_schools` for a district implies more secondary schools in the district. Further robustness checks are conducted by redefining the wealth concentration measures which vary the boundaries of households vicinity and examine the significance of wealth-concentration in the household's neighborhood of similar occupations (agrarian/non-agrarian) and education ranks (primary,secondary).

In the alternative formulation - which we provide for a comparison with a more conventional approach using urban-rural demarcations from the survey - the total value of long-term assets owned by the household i.e. the measure of household wealth is used as the first explanatory variable and a "ruralness" score based on urban-rural indicators from the survey is used as the second explanatory variable. The use of wealth-indices based on the stock of durable goods (excluding short-term durable goods that are not transferred over a generation) is also common in the studies from health and household economics (Howe *et al.* (2008, 2010); McKenzie (2005); Booysen *et al.* (2008))[25].

The main finding from the current study is that a higher urbanisation is correlated with lower severity of wealth effects in the region considering the two economies. While the higher urbanisation may itself depend on the country's governmental efficiency, natural resources or fiscal condition, it does seem to reduce the wealth effects on education. Despite the peculiarities of inequality in SSA such as high land-labour ratios and sparse distribution of economic resources (Anderson & McKay (2004)), therefore, the weakening of wealth effects with rising urbanisation points in a promising direction - through rise in employment opportunities - and marks past success in education improvements in the region. The study also finds that the segregation of education opportunities and the disparities in future employment opportunities across the country are more evident in Tanzania where the differences between urban and rural prosperity seem more extreme. The other side of the

[24]Since urban households evidently have higher wealth, a comparison of urbanisation and wealth effects is not without concerns of a correlation between household wealth and urbanisation. However, as the study is concerned only with the relative importance of urbanisation and permanent income measures in the two countries - rather than the elasticities of expenditure, these issues are less relevant to the comparison of household educational expenditure.

[25]Instead of using income-data, the empirical studies for education more often rely on the data on ownership of assets (Filmer & Pritchett (1999, 2001)) - since the inter-generational transfers of wealth are what make a break in the inequality gap (i.e. mobility through reduction of wealth differences) difficult (Obasuyi & Rasiah (2019)).

seemingly desirable effects of urbanisation, therefore, is that the need to improve to education participation in less urbanised areas remains a significant challenge for policy. The recommendations for addressing non-formal education and improving basic education for rural populations may therefore be an important concern for an education policy when urbanisation is not readily achievable for the economy.

The current chapter contributes to the literature on determinants of education in two different ways. First, it demonstrates that despite the challenges of urban overpopulation, the effect of urbanisation may be a desirable one for the education levels of the population and the lifestyle improvements in urban areas. This may support the conventional view that despite the evident problems with rise in inequality, the urbanisation may play a key role in economic growth through rise in employment opportunities and income from higher paid occupations (Kuznets (2019)). More particularly, the weakening in severity of wealth effects with the rise in urbanisation could indicate the pathways to future improvements in income equality and reduction in education inequalities through developments of the industrial sector and rise in demand for education. The second contribution of the chapter is the delineation of links between levels of economic activity and education levels - which we perform considering the spatial concentration of wealth and education across the two economies. While most of the literature we have surveyed has focused on the urban-rural dichotomy from community, the current study relies on the spatial distribution of wealth to examine the specific link between wealth-concentration, occupational levels and education expenses in the region.

In the sections that follow, the Section 2 surveys the literature on education expenditures, Section 3 details the method used in empirical analysis, Section 4 describes the data used for Nigeria and Tanzania in the study and Sections 5, 6 discuss the results from the empirical analyses.

2 Literature Survey

> There is no well educated literate population that is poor, [and] there is no illiterate population that is other than poor.
>
> *Beyond contentment*, John Kenneth Galbraith, (1994)

While education may not be considered a basic necessity in all poverty-measurement surveys, it is seldom disputed that a lack of education contributes to poverty. Even in the developing economies, the poorest individuals tend to have a strong demand for education (Tilak (2002); Gertler & Glewwe (1990)). The literature goes as far to suggest that when education is not state-funded in the developing economies, there might be a compulsion - rather than a mere willingness - to pay for education among the poor (Tilak (2002); Tilak *et al.* (2002)). With a high demand for educated workforce in an industrialising economy, there seems little disagreement in policy therefore - whether from a human capital perspective (Barro (1991, 1999)) or the capability perspective (Sen (1992, 1978); Nussbaum (2003)) - that economic growth bears a strong relationship with educational attainment.

An important consideration for education attainment in the population is that while higher education provides needed skills for higher incomes, the expenditure on education is often limited by the wealth one possesses. The differences in education elasticities based on income have in fact been emphasised in the literature early on since the mid-last century (Benson (1961); Hashimoto & Heath (1995)). The empirical studies from the SSA also report significant wealth effects on education (Glewwe & Jacoby (2004)) . Inspecting the enrollments data, for example, Chernichovsky (1985) note that the children from households that have large cattle stocks face less reductions in enrollment, because higher wealth may allow the households to take care of the cattle and prevent the childrens' withdrawals from schools[26]. Using a benefit incidence analysis to test if the education is pro-rich, Ilie & Rose (2018) show that the poor young people receive only 5% of funds allocated to tertiary education compared with 54% for the rich.

While the wealth-effects remain significant in SSA, much of the discussion on the high graduate unemployment and low higher-education participation has focused on the poor returns to education in the region. On one hand, the literature attributes these problems to the prevalent mismanagement in public education (Languille (2019)) and on the other it highlights a misplaced focus on formal education in the informal economy settings (Minnis (2006)). Instead of focusing on the returns-to-education, we argue that the poor returns may not offer a complete view of lower participation in education. One reason is that the education needs or perceived value of education may not be adequately captured with a returns-to-education approach. As Heyneman (2003) point out, the returns-to-education approaches tend to ignore the positive externalities from education[27]. The other reason is simply that the role of physical and wealth may be far more dominant than the issue of poor returns-to-education in an economy.

The positive externalities from education - which one may use to argue that the returns-to-education perspective is an incomplete one - are less of an issue in the context of SSA. Many empirical studies in fact report several instances of waste in rent-seeking activities after graduation in the SSA (Oketch (2016); Minnis (2006); Dabalen *et al.* (2001)).

[26]One caveat with the use of education enrollment data is that they are often not considered rigorous for empirical assessments - as they ignore the difference in educational levels and measure "flow" rather than "stock" with respect to educational inequalities (Obasuyi & Rasiah (2019); Thomas *et al.* (1999)).

[27]In a debate on whether the policy should favour free basic education to all (at the point of use) over the investments in higher education or not, Heyneman (2003, 1980a) argue that the positive externalities from education are simply not factored in the productivity measures used in the returns-to-education approach proposed by Psacharopoulos & Patrinos (2004). Heyneman (1980b) elaborate that the individuals benefit culturally and physically from education and that such changes are ignored when using a returns-of-education approach. It would seem also that not only does formal education help workers pick up more skills on their own (Fuller (1976)), the skills from secondary or higher education are often necessary in the labour market (Tilak (2007)).

The case for positive externalities from education is weakened further due to the low economic growth experienced by the countries in the last decades - a slide that may have suppressed the value of secondary or higher education in the region. While there should be little doubt on that the concerns for return-to-education are important, they do need to be viewed in the context of wealth effects and availability of education facilities. More specifically, it is possible that the demand for education is suppressed due to inadequate income (relatively high prices of education) in the economy or a sparse distribution of education opportunities rather than due to lower pay from post-education employment opportunities alone (Glewwe & Jacoby (2004)). Therefore, if education expenditures are better explained with physical access, then the policy may need to focus on building more accessible schools whereas if wealth-effects are more significant, then there is a need to make education more affordable for the lower-income households.

In the context of SSA, the empirical studies have generally found that the physical access is less significant than the wealth effects (Filmer & Pritchett (1999); Kambon & Busby (2000); Obasuyi & Rasiah (2019)). There is some evidence that the effects of physical access do become stronger at higher (secondary and tertiary) levels of education (Ngware *et al.* (2006)). The effect of urban-rural differences - which may be correlated with difference in both physical access and wealth concentration - has also been widely reported to be significant in SSA (Ilie & Rose (2018); Castro-Leal *et al.* (1999); Glewwe & Jacoby (2004); Bossuroy & Cogneau (2013)). Both urbanisation-levels and wealth (aside from the physical access to education used as a control) - are thus important concerns in the current study that motivate our exploration of the decline in wealth effects with rise of urbanisation.

Another way to interpret the effect of a standardised wealth-concentration-based measure of urban-rural differences is to contrast local vs wider wealth disparities that prevent access to education. In other words, the wealth-concentration interpretation of urbanisation helps us explore whether the effects of a wealthier locality have a stronger influence on education than household income (indicate by total expenditure) or not. As Porzio *et al.* (2021) report, for example, the changes in social environment of the urbanised areas may create a more competitive setting over time and across the wider populations.The specific wealth-concentration sense permits a clearer view of the role of social factors as well - since the urban-rural labels of the survey could encapsulate social divisions - such as ethnic or socioeconomic differentiations in the society being surveyed.

The effects of social factors on education - particularly the link between cultural capital and education - has been of interest in the sociological literature since the beginning of the post-war era (Bourdieu (2018)). While this early research had viewed education as a certain high-culture participation that enhances the social capital of a household, the later refinements have focused on the specific role of social networks and parental acquisitions or skills (Byun (2007); Yamamoto & Brinton (2010); De Graaf *et al.* (2000); Yan *et al.* (2021); Katsillis & Rubinson (1990); Alesina *et al.* (2019); Bossuroy & Cogneau (2013)). De Graaf *et al.* (2000) find - for example - that it is the reading habits among the richer households rather than high-culture-participation that affects school performance in Netherlands. More importantly, as De Graaf *et al.* (2000) argue, it is possible to explain a significant part of parental social background with explicit measures of resources accessible to the students. In another study, Gould *et al.* (2020) point out that higher educated parents invariably spend more time with children - a social factor that contributes to how parental education levels influence the next generation. In fact, the high-culture participation does not always influence educational performance positively either. As Byun (2007) find, the high-culture participation affects educational performance negatively in South Korea as it takes time off from study. In most cases, the cultural factors thus seem to matter in education only through economic factors that are relevant for participation in education. Recent literature is thus more often concerned with a “network social capital” - focusing on the role of social networks in consumer decisions instead (Mouw (2006); Manski (2000)). The scope of social effects in the current study is therefore limited to that of urbanisation and other household (religious identity, language spoken) or paternal characteristics (paternal education-level, occupation etc.).

In summary, we note several factors - such as the pro-rich nature of education, an insufficient focus on informal economy, mismanagement in public expenditure on education and poor returns after graduation - that may simultaneously contribute to education expenses and the low education participation in SSA. The disparate local environments in the SSA imply that generic or partial solutions to improvements of education opportunities are unlikely to be successful if one ignores local income disparities. For instance, the dual-model (Oketch (2016); Court (2001)) for universities[28]- which serves as a middle path between public and privately funded education systems - may have addressed the demands for free-education but it does little to improve access to higher education for poorer students without the extension of credit (lending) facilities. Such effects of household wealth are expected to captured with the consideration of income and positive externalities from richer environments on education expenditure in the current chapter.

It is worth admitting that despite the notable progress made towards education attainment in SSA, there are evident limits to what education alone can achieve. In fact, the structural problems which the region faces have rather definite implications for the education expenses in SSA. Therefore, while local wealth disparities are important, a broad outlook towards education expenses in the region must also take into account the wider macro-economic context of the economies in the region. A few distinguishing aspects of the economies in the SSA are worth stating in this regard. The high-land labour ratios - a recurrent theme in the studies on SSA (Anderson & McKay (2004)) - often characterise the strains on growth while also contributing to the varied inequality and migration-pressures in

[28]In the universities that follow the dual modelOketch (2016); Court (2001), the university attendees are a mix of privately funded and state-funded students.

the region (Kosec *et al.* (2018)). The high susceptibility of the region to volatilities in commodity prices is another issue that affects household budgets significantly (Deaton (1999)). The presence of a large informal sector facing such uncertainties further constrains the funding for "non-necessities" such as education. Finally, the political powers availed by the lower-income workforce - which an underdeveloped and commodity reliant industrial sector (Kaplinsky & Morris (2016)) has struggled to absorb (Geda (2019); Arbache & Page (2009); Clementi *et al.* (2019); Minnis (2006)) - also remain relatively little in the region.

As many such factors are shared by both Nigeria and Tanzania, we have focused only on the contexts that differentiate the two economies in the current chapter. In particular, we note that Nigeria has had more investments in commodities sector (oil and petroleum) than Tanzania - which remains a relatively agrarian economy. Additionally, the policy of education has also been different in the two economies - with Tanzania having a history of restrictions of secondary education at a time when other countries in the region were expanding their education sector (Söderbom *et al.* (2006); Appleton *et al.* (1999); Buchert (1992)). These differences as well as the disparities in wealth, urbanisation and access to secondary education are reflected in the levels of educational attainment that we detail in the subsequent sections.

3 Econometric Method

The goal of our empirical analysis is to find out if with rise in urbanisation, the wealth effects better explain the disparity in education expenses rather than urbanisation levels in the two economies. As mentioned earlier, we rely primarily on a wealth-concentration measure of urbanisation levels - while providing results from a formulation based on urban-rural indicators for comparison. In the main formulation, the logarithm of total expenditure is used as the main explanatory variable while the wealth concentration measure - the second explanatory variable - is calculated as the average assets in the consumer's district (for smaller districts, the average over multiple districts within a 6-km boundary is taken). In the alternative formulation using urban-rural indicators, the two explanatory variables are the wealth based on durable goods from the survey and an ruralness score based on urban-rural indicators themselves. The measures for wealth-concentration (as well as the first explanatory variable in the alternative formulation) rely on the market-value of durable goods (including land, housing) that are reported in the survey (see Section 4 for details). It is worth highlighting that the durable goods are considered as part of the consumer wealth only if they are transferable over generations. The ownership of goods that won't last more than a lifetime enter as consumption for the household rather than as assets contributing to the intergenerational wealth.

In a simple econometric model, the representative household balances i) her non-durable consumption (excluding education) with ii) increasing expenditure on education for the children. The non-durable consumption that the household may spend on excludes the expenses on maintenance of owned assets. The educational expenses and non-durable consumption excluding assets-related-costs thus form the consumer budget in the model. In this model for cross-sectional comparison of education expenses, we do not consider the substitution with savings towards durable goods. Other than our focus on cross-sectional effects, another reason why we avoid panel methods in the current study is a severe measurement error with time-varying household asset values in the survey (see Section 4 for details of asset values recorded in the consumption microdata). More specifically, the variation in time of ownership of assets is not accurate enough for us to measure the changing value of household assets possessions - due to the inconsistent recalls of the number of assets over time for the same household.

It is worth highlighting that the econometric analysis is limited for households having one or more children. In other words, only households with at least one member with their age less than 18 are considered in the analysis. Since the households with lower working age are likely to have less accumulations as well as needs, the average paternal age in the household is also used as a control in the comparison. The number of children (household-size), the educational level of the parents, the accessibility of schools in the district and the social characteristics of the household such as religion and language spoken are other important controls used in the analyses. Notice that for the paternal educational levels, we use an educational rank that is standardised by differentiating between primary, secondary and higher educational levels (see Section 4 for details).

Given the recent industrialisation in the sub-Saharan Africa, the dichotomy of agrarian and non-agrarian occupations is of particular importance to our analyses and is used as a control in the analysis. However, we are also aware of not mixing up the peri-urban with the rest of the rural settings in the economy (Wiggins & Proctor (2001)) and thus focus on the comparison of the educational expenses across wealth concentration levels in our analysis.

The analysis uses two formulations with the budget-share of education expenses and logarithm of education expenditure as dependent variables. Such an approach - using both budget-share and logarithm of education expenditure as dependent variables - is similar to the empirical method used by Acar *et al.* (2016) - where the budget shares offer a better view of the household-level demand while the logarithm of expenditure facilitate an appropriate comparison of wide-differences in educational expenses across the economy.

The first regression uses the budget share of education expenses w_{educ} as the dependent variable

$$w_{educ} = \rho + \alpha_{educ} \cdot r + \beta_{educ} \cdot log(x_i) + \gamma_{educ} \cdot log(p_{ne}) + \delta_{educ} \cdot s + \epsilon_{ne} \qquad (15)$$

The main explanatory variables used in the empirical analysis are the the logarithm of the total annual expenditure $log(x_i)$ (for a household i in a given year) and the urbanisation level (the wealth concentration r). The demographic and social identity variables ρ (e.g. age of the children, the family size and other variables listed in Table 17) , the access to education s, the indicator variable specifying if there are households members with an age appropriate for primary, secondary or tertiary education and the prices p_{ne} associated with non-durable expenditure in the region (calculated as unit-value i.e. the average non-durable expenditure excluding asset-related costs in the district) are all used as controls in the analysis. In above Equation 15, ρ is the intercept, α_{educ} is the coefficient for urbanisation level, β_{educ} is the coefficient for $log(x_i)$, γ_{educ} is the coefficient for logarithm of prices p_{ne} and δ_{educ} is the set of coefficients for physical access s. The variables used in the results are listed in Table 17.

In the alternative formulation provided for a comparison with the analysis based on urban-rural indicators, we use the the logarithm of total assets owned ($log(A)$) and a ruralness score based on urban-rural indicators as the explanatory variables. The second regression thus uses the logarithm of educational expenses $log(x_{educ})$ as the dependent variable against the same set of control variables (instead of w_{educ} in Equation 15)

$$log(x_{educ}) = \rho + \alpha_{educ} \cdot r + \beta_{educ} \cdot log(x_i) + \gamma_{educ} \cdot log(p_{ne}) + \delta_{educ} \cdot s + \epsilon_{ne} \qquad (16)$$

While the appearance of educational expenses both in the dependent variable and in the logarithm of the total expenditure $log(x)$ (used as the explanatory variable) may cause some endogeneity, it does not interfere with the comparison of relative effects of r and $log(x)$ in the model. The estimation results from the comparison of education expenditure for Tanzania and Nigeria - which uses a tobit (due to zero expenditure on education for a significant number of households) - are presented in Section 5.3 after a discussion of the descriptive statistics in Section 5.2.

4 Data

The educational expenses and the non-asset related expenditures are obtained from the Living Standard Measurement Study (LSMS) which is conducted by the World Bank. The survey is unique in its and aims to improves the understanding of links between asset ownership, community access (to market, schools), food prices and agriculture activities. The data in the surveys from multiple countries is largely uniform in its data-model (fields) and is often geo-referenced with a sufficiently wide-coverage in the country to allow a study of spatial variation in the observed variables. The years used for the cross-section analyses are the most recent years in the survey for Tanzania (2014) and Nigeria (2015) - i.e. the last waves available in the survey at the time of writing this chapter.

As described earlier, one of the interpretation of urbanisation is the wealth concentration - which is measured as the log-averages of the values of durable goods (calculated as per the specifications in Table 22). The durable goods owned by every consumer available in the surveys range from the short-term durable goods such as mobile phones to the expensive and long-term assets such as land or houses. Given our interest in the wealth that excludes consumption that is not inherited, we focus on durable goods that can be transferred over a generation. For both Tanzania and Nigeria, we therefore include items as long-term assets only if they are costlier than furniture - which is the cheapest asset to be transferred between the generations in households. That the assets costlier than furniture are transferred over a generation is readily verified in the data by inspecting households that are split when a young member of the unsplit family starts a new household.

The details of the records of durable goods in the LSMS data include the number n_t of durable goods owned by the household, the reported cost C_t at which the durable good was purchased and the reported price P_t which the household expects by selling the durable good in the current market at the time of survey. We use the reported price P_t of the durable goods to infer the goods-values in the area surrounding the consumer - partly because P_t is not susceptible to errors associated with recall of the purchase value (which often varies for the same item over years in the panel data for a household). Further, P_t encapsulates the perceived depreciation of the durable good over time - a feature that makes it more appropriate for a comparison against non-durable consumption at a given year t. The total cost of the durable goods owned by the household is thus obtained simply as a product of the number of assets n_t reported by the consumer with price P_t. These costs are used both for the wealth-concentration measures and the assets-measure. As explained earlier, the permanent-income measure uses the logarithm of total expenditure at the household level.

At the time of writing this chapter, the precise geographic-location of every household (or the ward she belongs) to is not available to us in the LSMS data for Tanzania. As a result, we have relied only on the geo-coding of districts for the wider level consumer vicinity based on Euclidean distance. Partly to avoid the absence of rural-urban fields corresponding to the wards in year 2014 for Tanzania, we do not use the rural field for analysis at the wider-district level aggregation and use a variable indicating how rural the consumer's vicinity is by counting the number of rural wards in the 6 km vicinity (or the district boundary).

The physical access to education is measured using the distance to the nearest secondary school. More specifically, a score `secondary_schools` for each district represents the number of wards that have a secondary school within the 6-km area. A district with a higher score has more wards that have a secondary school in close vicinity (within 6-km vicinity). This measure takes care of the issue that there are many wards (and enumerated-areas within) having consumer entries for assets and consumption that the school-availability (primary as well as secondary) is not recorded for. The aggregation over districts takes care of this issues there are no district with consumer entries for assets and consumption that we don't have the total number (score) of secondary-schools for. This score evidently also factors in the high-population density in urban areas since densely populated districts would have more wards within the same geographical distance as a less populated district.

The next important control is the occupation of the households which is directly available for every individual in the survey. Whether an occupational sector is agriculture-related or not determined is based on the main occupation of household head (HH). The number of children in the household, the ages of the children (and other members) are directly observed in the data. Since the typical household unit in Tanzania and Nigeria may not be a nuclear family, the paternal educational level - which is another important control in the study - cannot simply be the education level of the household head(HH). This is because unlike for nuclear families, the individuals on whom the household's reported education expenses are spent, could be the grandchildren (rather than children) of the joint-family household-head. To avoid letting the household's paternal education level point to the generation before the parents of children for certain joint-family households - where the HH has his/her grandchildren attending school - while letting the same variable point to the parents of children in school for nuclear-families (where HH has his/her children attending school), we rely on a more uniform measure for a household's highest education rank `highesteduc` as the highest education in the generation of the parents of the children in household in the survey [29].

To provide a uniform treatment to educational levels across both Tanzania and Nigeria, we use 4 education categories - setting the education rank to 1 for all pre-primary levels, to rank 2 for until the completion of primary education, to rank 3 for up to the secondary education level and to 4 for all higher education levels (higher-secondary, university etc.). These mappings are provided in Tables 25 and 26 (see Appendix). For instance, the primary school leaving exam is taken at D7 in Tanzania and corresponds to the education rank 2 ; all standards above D7 and before O course (Diploma) correspond to the education rank 3 and all education levels at or above O course correspond to education rank 4 for Tanzania. Similarly, the levels above P6 - which is the highest primary education level in Nigeria - implies an education rank 3 (corresponding to P6 in Tanzania) and all education levels at or above the technical training level (treated equivalent to Diploma level in Tanzania) are correspond to education rank 4. As access to private education may be significant in the urban-areas, we also use a control for private-education that is available in the survey.

The languages spoken (`has_english` in Tanzania) and the religious-identity for household members (`religion` in Nigeria) - used as controls - are recorded at the individual's level in the survey data for the countries and are directly used as controls in the survey. To control for the price of consumption in the household's district, we also use the non-durable consumption averages `log_mean_cost_ne` (excluding the costs associated with ownership of assets in the survey). The measurement `log_mean_cost_ne` of price is akin to the price-deflator (unit-value) methods used in the demand literature (Deaton (1988); Tafere *et al.* (2010)). The rationale for excluding costs associated with assets is that the costs of maintaining assets (fees, repair costs, usage costs etc.) are not levied on those who don't own

[29]Notice that only relations with the household head are reported in the survey. Thus, there is no direct way of locating the parent of a child except through the relation with the household-head.

the related assets and should not be included in the general price of non-durable consumption.

Dependent Variable	Variable Name	Description
w_{educ}	`w_educ`	budget share of the educational expenses
$log(x_{educ})$	`log_educ`	logarithm of the educational expenses

Table 16: Dependent Variables

Controls / Explanatory Variables	Variable Name	Description	Ind/Ref Level
$log(x_t)$	`ln_tot_exp`	logarithm of the sum of total expenditure by the household	Individual
$log(A_t)$	`ln_tot_assets`	logarithm of the sum of total durable goods owned by the household	Individual
r	`assetdensity`	logarithm of mean asset-ownership level in the 6-km radius area around the household district	Area
r_Γ	`assetdensity_educ`	logarithm of mean asset-ownership level of consumers in the 6-km radius area having primary education level (or higher than primary) if the household has a primary (or higher than primary) education level	Area
r_Ω	`assetdensity_agri`	logarithm of mean asset-ownership level among the consumers of having the same value of the indicator variable denoting agrarian /non-agrarian occupation (i.e. the variable Ω) in the 6-km radius area around the household district	Area
p_{ne}	`log_mean_cost_ne`	logarithm of the mean non-durable expenditure - excluding asset costs in the area surrounding the consumer	Area
γ	`rural_wards`	the percentage of rural wards/eas in the district of consumer's residence	Area
s	`secondary_schools`	the number of wards in a district with an accessible secondary school (within 6-km)	Area
π	`educpriv`	factor variable indicating if any of the child attends a privately owned educational institution	Individual
μ_1	`is_primaryage`	factor variable indicating if there is a family member in the household of age between the mean primary school attendance ages (i.e. between 7 and 13 inclusive)	Individual
μ_2	`is_secondaryage`	factor variable indicating if there is a family member in the household of age between the mean secondary school attendance ages (i.e. between 15 and 23 inclusive)	Individual
μ_3	`is_tertiaryage`	factor variable indicating if there is a family member in the household of age between the mean secondary school attendance ages (i.e. between 23 and 31 inclusive)	Individual
Ω	`agri`	factor variable indicating whether the household head's occupation is agrarian or not	Individual
Γ^*	`highesteduc`	highest education rank in the paternal generation of the children considered in the household	Individual
h	`numchild`	number of children ($\leq$ 18 years age) in the household	Individual
χ	`religion`	the religion which most members in the household subscribe to	Individual
ξ	`has_english`	ability to speak or write English	Individual

Table 17: Control Variables

5 Empirical Analysis and Results

5.1 The context for Education in Tanzania and Nigeria

Despite similarities in geographic areas, age-distribution of populations, public infrastructure and use of English as the primary administrative language, the economies of the two countries on Eastern and Western coasts of Africa exhibit quite a few structural differences - owing primarily to levels of industrialisation and endowments in natural resources. Tanzania is spread over nearly 885,800 sq km of land while Nigeria sprawls over 910,768 sq km of total land. The age-distribution of the populations and the dependency ratio are similar in the two economies while the population growth rate remains under 3%. As of 2020, Nigeria had a population of 206.1 million and Tanzania's population was 59.7 million (source: World Bank). The differences in public infrastructure do not appear to be extremely wide - since Tanzania has a total of 145,203 km length of roadways while Nigeria has 195,000 km (based on a 2022 estimate). With nearly 43% of land in Tanzania being agricultural and over 37% of the land being forest land (based on a 2018 estimate), urban residents are more numerous in Nigeria - where agricultural land is nearly 78% of the total land and leaves only 9.5% of forest land. Only 36.7% of the population is urban in Tanzania whereas urban residents constitute 53.5% of the population in Nigeria (2022 estimates). The differences in urbanisation levels across the two economies seem stable - since the rate of urbanisation is nearly the same in the two economies.

The higher urbanisation in Nigeria is not without severe disparities in living standards. The infant-mortality in Nigeria (56.68 /1000) - for example - is in fact nearly double that of Tanzania (30.87/1000) and the per-capita availability of physicians remains lower in Nigeria (0.38/1000) relative to Tanzania (0.7/1000). The overall literacy is slightly better in Tanzania as well - with 77.9% population considered literate (above 15 years of age having the ability to read or write in any language) compared to 62% in Nigeria. Even though the countries have similar school life expectancy (9 years), the youth unemployment (between ages 15-24) is at a staggering 18.3% in Nigeria compared to 3.9% in Tanzania. The overall poverty also seems more widespread in Nigeria - with 40.1% below the poverty line (estimate) compared to 26.4% of the population living below the poverty line in Tanzania (2017 estimate). This is despite higher income inequality in Tanzania which has a Gini-coefficient for household income of 40.5 (2017 estimate) compared to 35.1 for Nigeria (2018 estimate).

A brief overview of the two economies using data from OECD (Organisation for Economic Cooperation and Development) suggests that of the two economies, a higher percent of the GDP comes from agricultural production in Tanzania. The per-capita GDP 2020 for Nigeria (2396.04 USD) is much higher than that of Tanzania (976.16 USD) (source World Bank). The GDP from manufacturing, mining and construction is nearly double for Nigeria (8749.61 million USD in 2022) compared to Tanzania (4221.41 million USD in 2021). Nigeria's GDP from agriculture is 9311.36 million USD and Tanzania's is 4313.47 million USD.

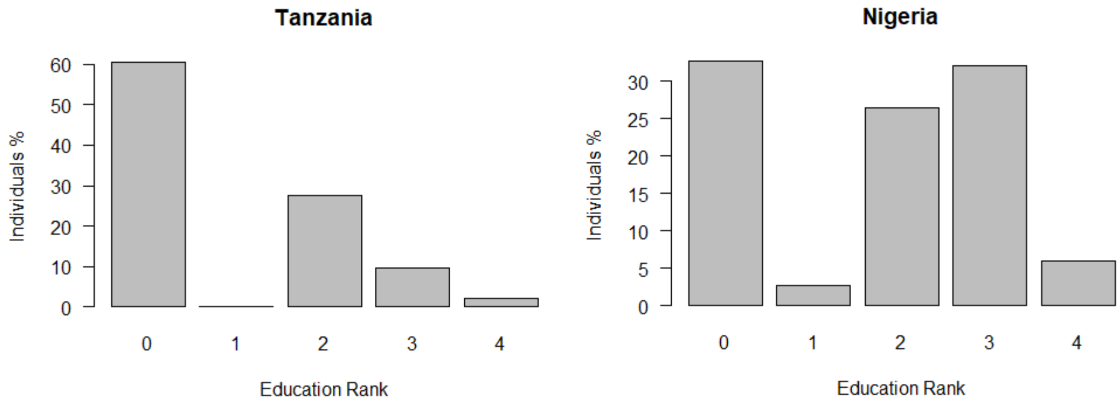

Figure 6: Education ranks for populations in Tanzania Nigeria (see Tables 25 and 26 for rank classification)

The structural differences seem to be due to a higher reliance on energy exports for Nigeria - which, as of 2020, exports \$35.9 billion crude-gas and imports \$7.75 billion of refined Petroleum apart from cars (\$3.03 billion) and wheat (\$2 billion). On the other hand, Tanzania's major exports are Gold and other minerals (\$3 billion) followed by agricultural products (0.594\$ billion). The major imports of Tanzania are refined copper and petroleum (\$2.2B). Among the two economies, Nigeria relies less on the agrarian exports and more on the energy-related infrastructure - likely accounting for higher average education levels in Nigeria (see Figure 6).

Of the political systems in the two countries, Tanzania has shown a higher propensity to state control as nearly all land resources in Tanzania are government-owned. Tanzania is also more uniform ethnically - as about 95% of Tanzanian nationals identify as Bantu. On the other hand, the ethnic composition is more varied in Nigeria with Hausa (30%), Yoruba (15.5%) and Igbo (15.2%) as prominent ethnic groups. The policy of education has also seen different directions in the two economies. At a time when other countries in the region were expanding their education sector, the secondary education opportunities had faced some restrictions in Tanzania (Söderbom *et al.* (2006); Appleton *et al.* (1999); Buchert (1992)). The private education seems to have flourished with relatively fewer limits in Nigeria. The effects of all of these factors towards education expense should become clearer in further subsections.

5.2 Descriptive Statistics for Education Expenses

Considering the overall distribution of education expenses, we see that the urban residents spend much higher on education than the rural residents in both the economies. The urban residents spend 2.34 times more than rural residents in Nigeria whereas they spend 2.8 times more in Tanzania. The secondary education appears to get much costlier in Tanzania since the mean education expenditure for tertiary education (rank 3) is almost double that of the

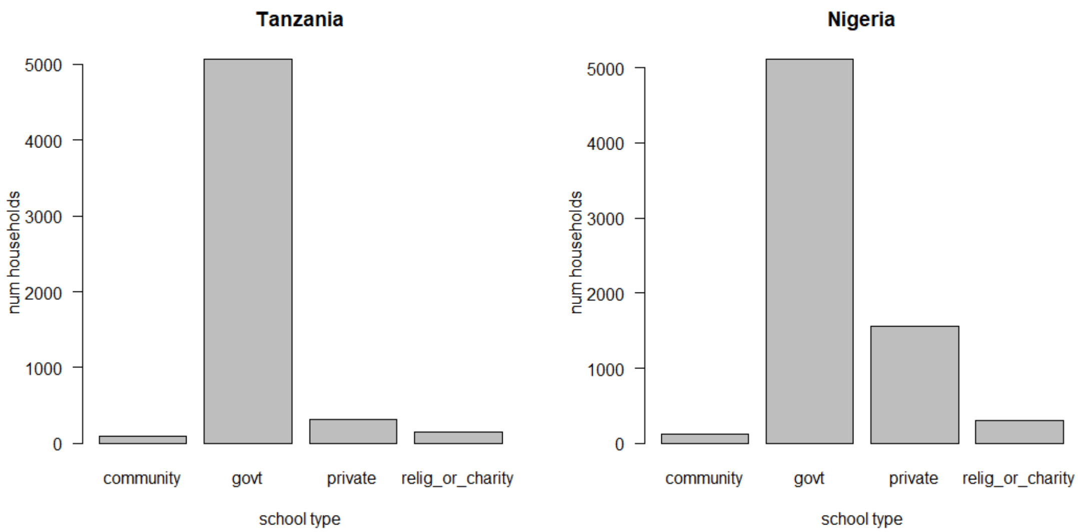

Figure 7: School types for non-adult population in Tanzania and Nigeria

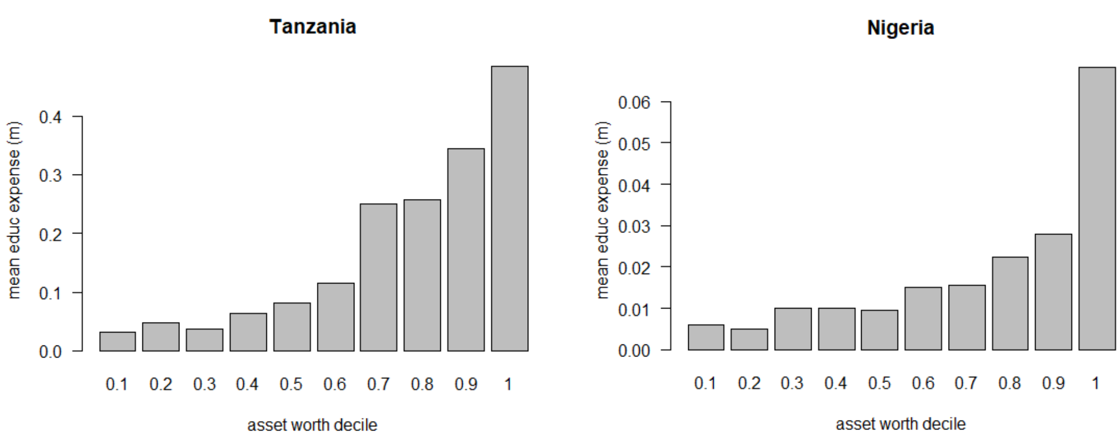

Figure 8: Educational expenses averages over deciles of asset worth in in Tanzania and Nigeria

expenditure on secondary education (rank 2) in Tanzania. In Nigeria, these expenditures rise by about 54%. The educational expenses do not seem to rise much with asset disparities in Nigeria - whereas they seem to be more unequally distributed in Tanzania (see Figure 8)[30]. Comparing education levels of the household heads, we see that the average-education rank of the household heads in Tanzania (1.8) is lower than that in Nigeria(1.9). We also see that the role of private education is much higher in Nigeria (see Figure 7).

	Tanzania			*Nigeria*		
Variable	$mean_{tnz}$	$median_{tnz}$	$stdev_{tnz}$	$mean_{ngr}$	$median_{ngr}$	$stdev_{ngr}$
w_educ	0.04	0.01	0.08	0.04	0	0.1
log_educ	7.77	10.49	5.46	3.97	0	4.94
ln_tot_exp	14.39	14.48	0.83	12.42	12.45	0.72
ln_tot_assets	12.96	12.76	1.93	10.93	11	1.35
assetdensity	14.9	14.8	1.13	11.43	11.42	0.74
assetdensity_educ	14.71	14.62	1.4	11.42	11.49	0.83
assetdensity_agri	14.79	14.82	1.23	11.36	11.39	0.84
log_mean_cost_ne	12.9	12.97	0.53	10.85	10.86	0.53
rural_wards	0.66	0.78	0.33	0.71	1	0.41
secondary_schools	4.56	2	7.59	1.22	1	0.52
educpriv	0.06	0	0.23	0.19	0	0.39
is_primaryage	0.63	1	0.48	0.76	1	0.43
is_secondaryage	0.58	1	0.49	0.61	1	0.49
is_tertiaryage	0.45	0	0.5	0.4	0	0.49
agri	0.66	1	0.47	0.51	1	0.5
highesteduc	1.21	1	1.06	1.53	2	1.47
numchild	3.05	3	2.03	3.55	3	2.16
religion				1.5	1	0.52
has_english	0.36	0	0.48			

Table 18: Summary Statistics for Variables in Tables 8 and 17

Using the average, median and standard deviation values variables listed in Tables 8 and 17) that are shown in Table 18, we note that the measures for average budget shares (w_educ) as well as educational expenses (ln_tot_exp) are not dissimilar in both the economies. The average number of children in households that are of an age appropriate for primary, secondary or tertiary education are not far from each other either (see values for is_primaryage , is_secondaryage and is_tertiaryage in Table 18). A clear difference between Tanzania and Nigeria - however - is that of standard-deviation in asset density (assetdensity) - which is higher for Tanzania. Further, the predominance of agricultural occupations (see stdev values for agri) is higher for Tanzania as well.

It is worth pointing that barring such broad observations, the LSMS data used in our

[30]Despite the uniformity in LSMS data fields corresponding to education expenses, the collection methodology may not be the same across all the countries. This is evident from the much lower educational expenses in Nigeria than in Tanzania (see Table 18). Our comparison of the two economies (Tanzania and Nigeria) therefore does not rely on the measurement of educational expenses relative to one another.

analyses may not permit a cross country comparison for education expenses in a much finer detail. One reason is simply that the distribution of savings, income and employment opportunities is disparate in the two economies. The other reason is that there is also a difference in sizes or granularity of district classifications in the two economies. More specifically, the sizes of districts in Tanzania seem much larger (particularly in the rural parts) than in Nigeria. This is why the per-district density of secondary education facilities - which we measure with the variable `secondary_schools` - is reported lower in Nigeria (see values corresponding to `secondary_schools` in Table 18) - while the education levels of the consumer populations remains higher in Nigeria (see highest_educ in Table 18). The ruralness of districts - measured as number of wards declared as rural in a district (i.e. the variable `rural_wards`) - does not seem affected by this disparity in sizes as much (compare the values for `rural_wards` in Table 18) - since a rural-urban classification that declares boundaries of a district based on areas surrounding an urban (or semi-urban) centre tends to bring a uniformity to the number of rural wards in a district.

It is worth emphasising that the overall distribution of assets (durable goods stocks) in the two countries is disparate - as is clear with a direct comparison of asset values. Contrasting the Lorenz curves for total non-durable expenditure and total assets in the Figure 9 for in Nigeria and Tanzania, we note that distribution of assets is more sparse in Tanzania even though the overall expenditure appears similarly distributed in the two countries.

A geographical distribution of assets further details that higher-income occupations are far fewer in the hinterland and the southern regions of Tanzania (see Figure 10) - relative to the eastern and coastal regions that seem largely urban. The disparities in occupations are less in Nigeria (see Figure 11).

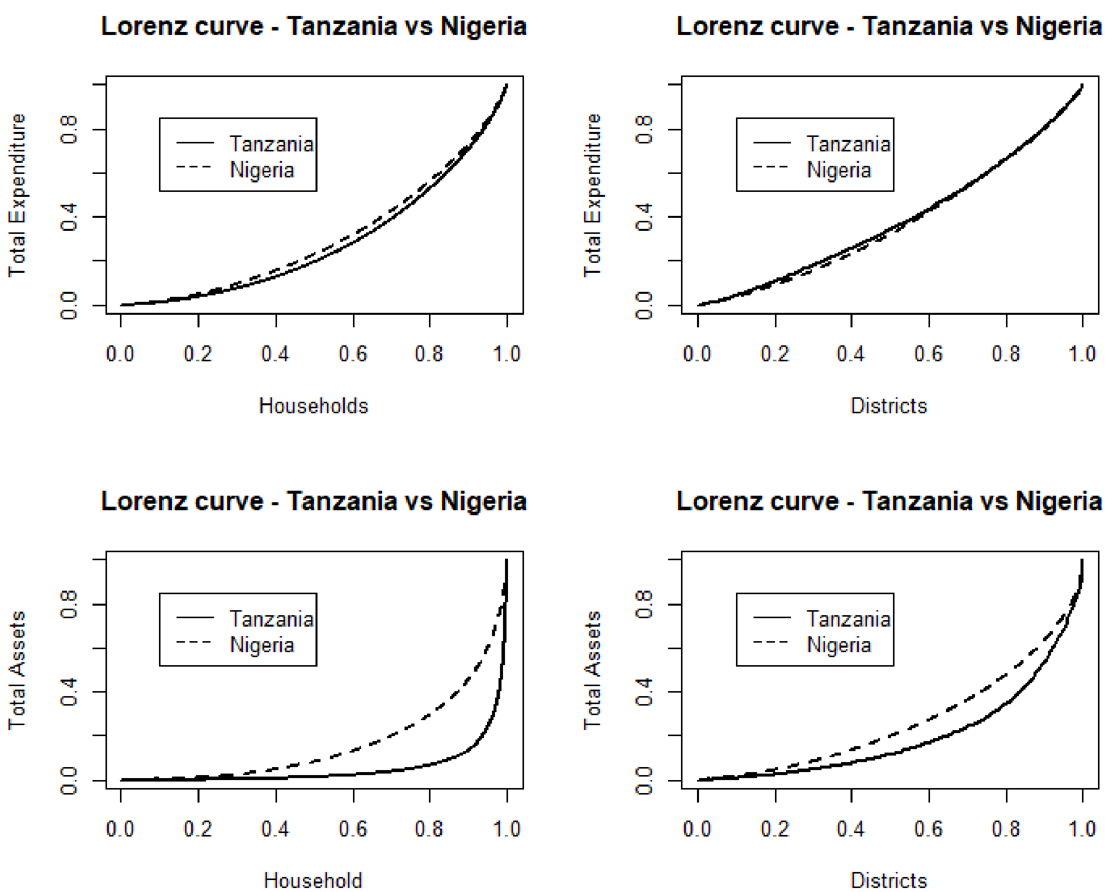

Figure 9: Inequality in assets and non-durable expenditure across households and districts

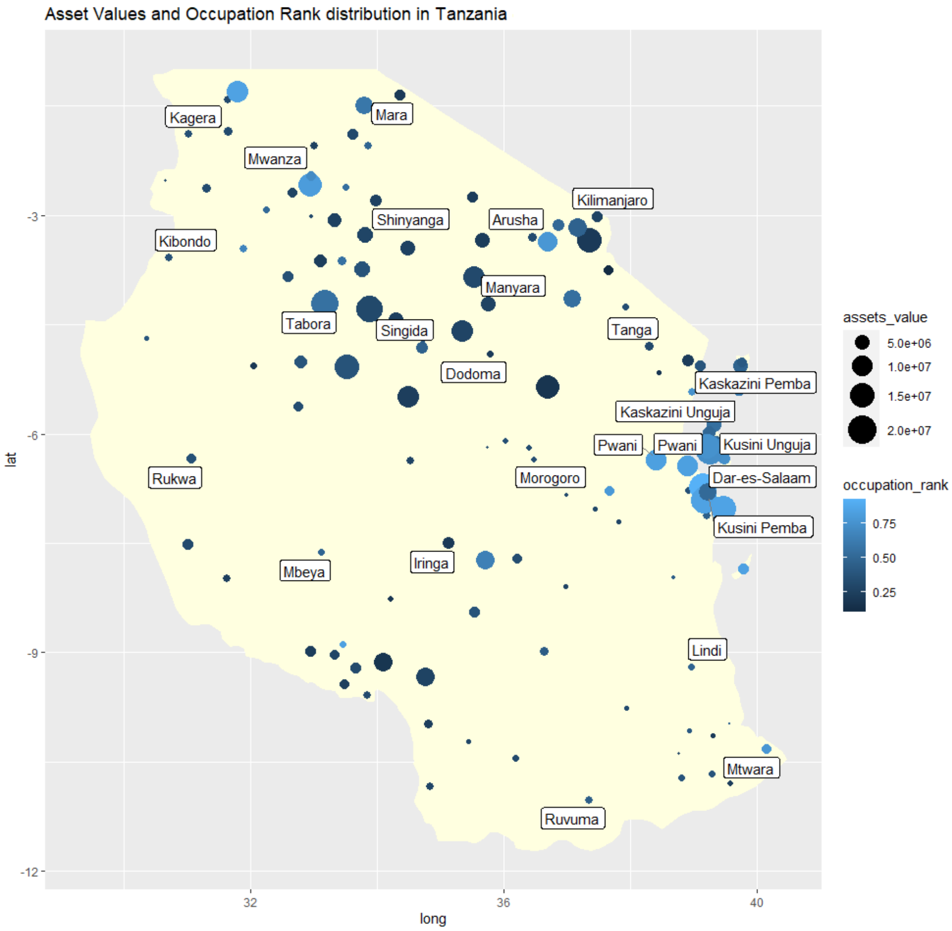

Figure 10: Occupations and consumer-owned assets in Tanzania

Note that the occupation ranks shown in Figures 10 (Tanzania) and Figure 11 (Nigeria) are based on the standardisation of various occupations in Tanzania and Nigeria. Since the range of occupations in the surveys from Tanzania and Nigeria is varied, the different occupations in the survey for Tanzania and Nigeria have been standardised into occupation ranks (ranging from 0 to 3) based on the data on income derived from the occupations in the survey so that a higher occupation rank represents an occupation that provides higher income. The reason why the income itself is not shown in the plots is that the data on income is far sparser than the recall of assets and the reporting of occupations in surveys from both the economies[31]. The mapping from specific occupations to the occupation-ranks for Tanzania and Nigeria is shown in Table 27 and 28 (respectively). A higher occupation rank represents occupations that bring higher income. As described in Section 4, the education levels are also mapped to education ranks denoting primary, secondary and higher education (see Table 25 for Tanzania and Table 26 for Nigeria in the Appendix). A higher education rank corresponds to a higher education level.

While we undertake a more detailed view on education expenses in the Section 5.3, the

[31]It is not uncommon for the empirical studies in SSA to have the data on occupation or education proxy the income differences (Alesina et al.Alesina *et al.* (2019)). The primary reason for this is the sparsity of income data - a problem that may be further aggravated because of a large informal sectors in the economies.

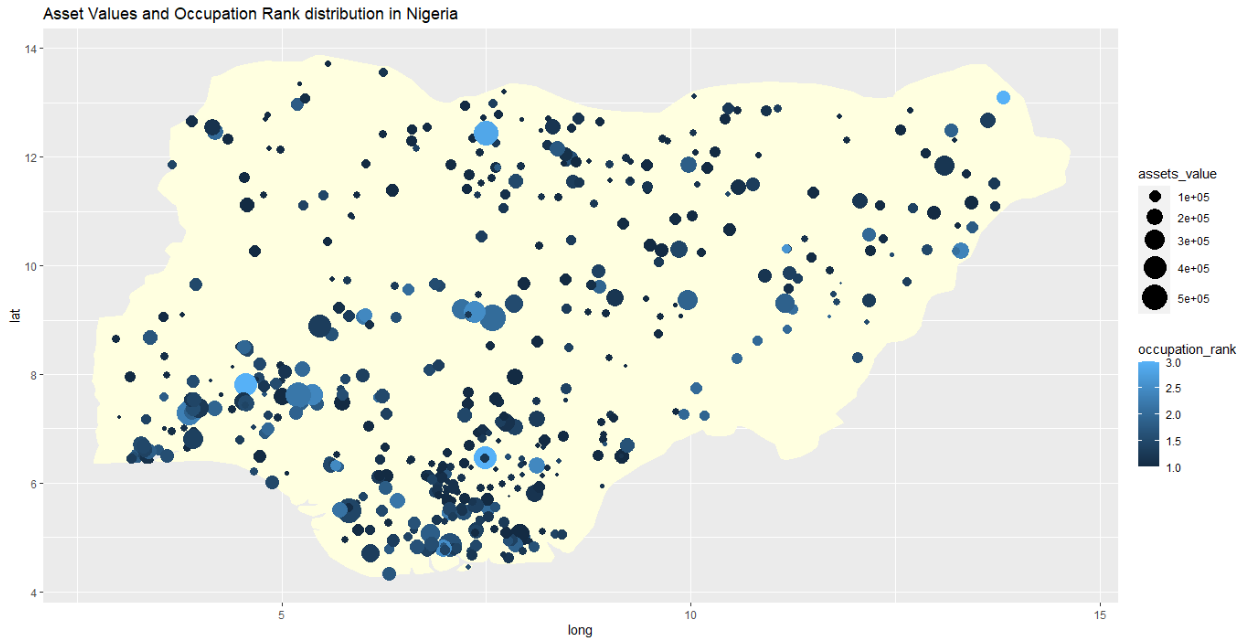

Figure 11: Occupations and consumer-owned assets in Nigeria

key observation from the data is that the disparities in income and durable goods are more localised in Nigeria while they are more extreme across wider geographical regions in Tanzania. More specifically, despite the southern areas of Nigeria having more higher-paid occupations and a higher expenditure on non-durable expenditure overall (see Figure 11), the disparity in durable-goods ownership across regions is not as extreme as in Tanzania. The particular interpretation of urbanisation is used to explain the implications of this non-uniformity on consumption and educational expenses in Section 5.3.

5.3 Results

The two dependent variables we use in the estimation described in Section 3 (see Equation 15) are the budget shares for educational expenses (w_{educ}) and total expenditures ($log(x_{educ})$) . These dependent variables are listed in Table 16 while controls used for the estimation are listed in Table 17.

The two main explanatory variables used in the study are the the logarithm of total expenditure `ln_tot_exp` and the urbanisation levels (measured as wealth-concentration `assetdensity`). As discussed before, an alternative formulation is also specified for comparison - where the two explanatory variables are the logarithm of total assets value (`ln_tot_assets`) and the urban/rural indicators (`rural_wards`). The physical access to education (i.e. `secondary_schools`) is an important control in both the formulations. Other controls used in the comparison are the indicator for an agrarian occupation `agri` (Ω), the paternal education level `highesteduc` (Γ^*), the religion and language indicators (`religion` χ used only for Nigeria indicated by 1 for Christianity, 2 for Islam, 3 for Traditional, 4 for other - and English-speaking ability i.e. the variable `has_english` ξ

indicating the ability to speak English used only for Tanzania), the access to private education (`educpriv` or π), the number of children (`numchild` or h) and their ages `is_primaryage` (μ_1), `is_secondaryage` (μ_2), `is_tertiaryage` (μ_3) indicating if they are eligible (due to age) for primary, secondary or tertiary education (respectively) and the non-durable consumption prices (`log_mean_cost_ne` p_{ne}). All of the controls remain the same for the main as well as alternative formulation. Recall that the non-durable consumption prices p_{ne} (see Section 4) - interpreted as the cost of living in the vicinity - is measured as `log_mean_cost_ne` - the logarithm of average consumption excluding the asset-related costs in the consumer's vicinity. Notice that the factor variables are prefixed with respective values `1.` , `2.` etc. in the results.

Of the control variables and explanatory variables discussed above, some are observed at the household level while others are observed at the level of the consumer's district. The logarithm of total expenditure `ln_tot_exp` and of the total assets-owned `ln_tot_assets` are observed at the level of the household. Similarly, the agricultural-occupation factor variable `agri` (indicating whether the household head is employed in agriculture related occupation or not), the number of children in the household `numchild`, the childrens' ages factor variables `is_primaryage` , `is_secondaryage` and `is_tertiaryage`), the private education factor variable `educpriv`, the highest education rank `highesteduc` corresponding to the paternal generations (father-relationship) in a household, the ability to speak English `has_english` (used only for Tanzania) and the household religion `religion` (used only for Nigeria) are all observed for a household. The variables observed at the district (or 6-km vicinity) are the number of wards with an accessible (within 6-km distance) secondary-schools (`secondary_schools`), the rural wards (`rural_wards`) in a district, the respective measures of the wealth-concentration `assetdensity` and the logarithm of the per-head cost non-durable consumption `log_mean_cost_ne` .

To reiterate, a significant number of household units in both the economies are made up of joint families where the reported educational expenses correspond to the grandchildren of the household head (HH). The education level of the HH would thus point to the penultimate generation for households where HH has grandchildren and the previous generation for younger households where HH has young children. To resolve this disparity, we avoid using the education rank of the HH and instead use the highest education rank in the generation of the students' parents [32] `highesteduc` instead. The paternal educational level `highesteduc` suffices for our analysis of expenditure spent over all the children in the household (rather than how education budget is distributed among the male/female children). As mentioned in the Section 3, the households with no children are ignored in the analysis. Nearly 22% of households in the Nigeria and 15 % of households in Tanzania are thus excluded from our comparison.

[32] Only relations with the household head are reported in the survey. Thus, there is no direct way of locating the parent of a child except through the relation with the household-head.

Notice also that the age-variables is_primaryage, is_secondaryage, is_tertiaryage for attendance of primary, secondary and tertiary education have been used in the analysis to get around the unavailability of the current-education level of the household member in the Nigerian LSMS survey data. Instead, we use a combination of the indicator variable telling whether a household member is in school or not (available in the surveys for both Tanzania and Nigeria) and the mean school attendance ages to define variables is_primaryage, is_secondaryage and is_tertiaryage that indicate whether there is a household member of an age appropriate for attending primary, secondary and tertiary education levels (respectively).

The results from the a tobit estimation for educational expenses (w_{educ}) and total expenditures ($log(x_{educ})$) with wealth-concentration assetdensity as one of the controls are shown in Table 19 for both Tanzania and Nigeria. The tobit uses a lower limit of zero given a number of houses have no expenditure on education. A zero expenditure is reported for nearly 65% households in the survey from Nigeria (2015) and 43% households in the survey from Tanzania (2014). This suggests that either the education expenses are recorded in more detail in Tanzania or that a certain basic level of expenses is not considered in the survey for Nigeria. The particular disparity also limits our ability to compare educational expenses relative to one another for the two economies. A discussion on the cross-section results from the latest available years 2014 for Tanzania and 2015 for Nigeria follows in Section 5.4 (see Table 19). The results from the alternative formulation - where the main explanatory variables are the logarithm of total assets value ln_tot_assets (used in place of household total expenditure) and the ruralness-score rural_wards derived from the survey's classification of rural and urban areas (used in place of wealth concentration assetdensity) - are also discussed in 5.4 (see Table 20).

5.4 Discussion

Results with w_{educ} as the dependent variable

The coefficient of the total expenditure (`ln_tot_exp`) in Table 19 for w_{educ} as the dependent variable suggest that an increase in the total expenditure (`ln_tot_exp`) causes a decrease in the budget share on education (w_{educ}) for both Tanzania and Nigeria. This seems largely due to the educational expenses forming a higher proportion of the total expenditure for poorer households - since the education expenditures $log(x_{educ})$ do seem to rise with the increase in total expenditure (`ln_tot_exp`) in Tanzania (see coefficient of `ln_tot_exp` under columns for $log(x_{educ})$ in Table 19). The effect of non-durable consumption prices (`log_mean_cost_ne`) is weak on education-budget share w_{educ} for both the economies (see coefficient of `log_mean_cost_ne` under w_{educ} in Table 19) . Thus while urbanisation must raise the prices of non-durable expenditure `log_mean_cost_ne`, the disparity in budget shares does not appear to be due to higher cost of living (non-durable consumption) alone. In other words, the expenditure on education is necessitated despite the lower or higher cost of living across the regions in both the economies.

Instead, we see a strong and positive effect of wealth concentration (`assetdensity`) towards educational budget shares (w_{educ}) in both the countries in Table 19 (see coefficients of `assetdensity` under w_{educ} in Table 19). This is an indication of the regional disparities in the economies. More particularly, the differences in density of assets indicate the level of urbanisation that have a strong effect on education expenses - despite controlling for the effect of availability of secondary-school education. While absence of educational facilities must clearly suppress education expenses in a region, the positive effect of assets-density after controlling for availability of education facilities also suggests relevance of certain environmental factors that contribute to education - such as a competition towards higher income social positions or presence of occupations requiring higher levels of education - factors with an important role after the availability of educational facilities has been considered.

The effects of household total expenditure are - however - relevant for private education - which is limited to the wealthier households in both the economies regardless of wealth-concentration (`assetdensity`). While a higher proportion of young population seems to be in private schools in Nigeria (see Figure 7), private education is slightly higher in budget share in Tanzania as the privately-educated households in Nigeria show higher budget shares w_{educ} (see coefficients of `educpriv` under w_{educ} for the two countries in Table 19). However, since private education only accounts for a minority of the population in both the economies (see Figure 7), the role of access to either or private or government secondary school i.e. we focus on the variable `secondary_schools` for our comparison of education expenses in the two countries.

Viewing the effect of the variable `secondary_schools` on education budget shares w_{educ}, we see a far stronger effect of `secondary_schools` for Tanzania (compare the coefficients for secondary-school s i.e. `secondary_schools` in Tables 19) . It also seems that the consumers are more likely to spend on primary education in Tanzania - as the access to secondary and tertiary-education remains much lower (this is further elaborated in discussion below of the results using education expenditure $log(x_{educ})$ as dependent variable).

The results from the alternative formulation using urban-rural indicators suggest a particular limitation of the use of urban-rural indicators from the survey. More specifically, the coefficients of rural-wards (`rural_wards`) for education budget shares w_{educ} are negative and significant for Tanzania in Table 20. However, the inference of a higher expenditure on education - when using urban-rural indicators - by the rural residents in Nigeria (see significance of rural-wards `rural_wards` in Table 20) may be improper as it ignores the fact that the wards identified as rural in Nigeria may not be as rural as those identified as rural in Tanzania. This is confirmed with the weaker role of wealth i.e. assets-worth-logarithm (`ln_tot_assets` in Table 20) and a strong role for wealth-concentration (`assetdensity` in Table 19) for Nigeria in the alternative formulation. Compared with urban-rural indicators, the wealth-concentration `assetdensity` seems to provide us a more clear-cut and standardised interpretation of urbanisation in the two economies.

Results with $log(x_{educ})$ as the dependent variable

Comparing the results with education-expenditure logarithm $log(x_{educ})$ as the dependent variable, we see that the education expenditures rise with the increase in total expenditure logarithm (`ln_tot_exp`) for Tanzania but the effect of total expenditure `ln_tot_exp` (in Table 19) is not significant for Nigeria. While the higher expenditure on education measured through total education expenditure logarithm $log(x_{educ})$ does seem to respond to the prices of non-durable consumption `log_mean_cost_ne` in Tanzania (see coefficient of `log_mean_cost_ne` under column $log(x_{educ})$ in Table 19), the effect of non-durable consumption prices `log_mean_cost_ne` remains weak on education-budget share w_{educ} for both the economies (see above discussion using budget share w_{educ} as the dependent variable). We also see that the educational expenditure $log(x_{educ})$ rises with the second explanatory variable i.e. the wealth concentration (`assetdensity`) for Nigeria while the effect of wealth concentration `assetdensity` is insignificant for Tanzania (compare coefficients for `assetdensity` against both the countries in Table 19 under columns for $log(x_{educ})$). In the alternative formulation where urbanisation is measured with the ruralness score (`rural_wards`), the ruralness score corresponds to a rise in educational expenditure $log(x_{educ})$ for Nigeria and a drop in educational expenditure $log(x_{educ})$ for Tanzania (see coefficients for `rural_wards` under columns for $log(x_{educ})$ in Table 20). The disparity in the role of `rural_wards` is however also due to differences in the extent to which density of educational institutions depends on `rural_wards` in the respective countries.

Continuing with the comparison of results with education-expenditure $log(x_{educ})$ as the dependent variable, we see that private-education indicator variable `educpriv` is insignificant for Nigeria (see Table 19). The education expenses in Nigeria therefore depend less often on whether education is provided through private educational institutions or not. The results also indicate lower access to secondary and tertiary-education in Tanzania (see coefficients of secondary-school-age `is_secondaryage` and tertiary-school-age `is_tertiaryage` in regression results with education expenditure logarithm $log(x_{educ})$ as the dependent variable in Table 19). In the alternative formulation, the results with education expenditure logarithm $log(x_{educ})$ as dependent variable in Tables 20 show the role of secondary-school access `secondary_schools` to be stronger for Nigeria when taking wealth i.e. total assets-worth logarithm `ln_tot_assets` into account. The wealth effect thus seems stronger than access in both the economies but is weaker for Nigeria where the enrollment into secondary and tertiary education is higher - regardless of the differences in long-term intergenerational wealth (measured with logarithm of assets-worth `ln_tot_assets`). The decomposed view of expenses on education in terms of secondary and primary education level further clarifies this observation - reflecting the far lower access to secondary education in Tanzania.

Other controls

The role of the number of children (`numchild`) also seems stronger in Tanzania than in Nigeria - but the effect is likely due the education expenses primarily driven by the primary education levels in Tanzania (as well as a higher percentage of households reporting no education expenditure in the survey from Nigeria). Another consequence of most households spending on primary education alone is that the agrarian households appear as spending higher on education after considering the wealth-concentration among households with the same educational-status. The education expenditure is higher for agrarian households in Tanzania after taking into account their poor educational status (see coefficients of agrarian-occupation-indicator `1.is_agri` in Table 19 under column for the education-expenditure-logarithm $log(x_{educ})$ dependent variable).

The wealth effects in Tanzania overall seem stronger, but they ought to be considered in light of the much lower expenditure on secondary (and higher) education and higher disparity in asset-ownership (even after taking into account the lower urbanisation levels) in Tanzania. The significance of logarithm of assets-worth (`ln_tot_assets` in Table 20) does indicate a general trend where those with higher inter-generational wealth and in urban areas (see significance of `ln_tot_assets` and `rural_wards` in Table 20 for Tanzania $log(x_{educ})$ as dependent variable) are far more likely to avail the education facilities, but a higher dependence on industrial output in Nigeria also seems to have contributed to a higher demand for secondary and tertiary education in the economy overall (compare with significance of `ln_tot_assets` , `1.is_secondaryage` and `rural_wards` in Table 20 for Nigeria with $log(x_{educ})$ as dependent variable). Another observation - the stronger role of father's education level in Tanzania - also seems related with these disparities in the two economies as well. A comparison of education expenditures across the two countries must take into account the different stages which the two countries appear to be in terms of urbanisation and economic development.

Finally, the role of social environment is found significant in both the economies. The role of English language seems significant in Tanzania - where the English-speakers spend significantly higher on education (see coefficients of `has_english` in Table 19 under $log(x_{educ})$) . In Nigeria, on the other hand, the educational expenses are higher among households identifying as Christian (see coefficients of `religion` in Table 19 under $log(x_{educ})$) . In both cases, the role of social characteristics may be rather inseparable from differences in educational institutions. In case of Tanzania, the ability to speak English is aligned with attending educational institutions while in Nigeria, the role played by Christian missionaries in establishment of educational institutions may be reflected in the disparity of access to educational facilities.

Table 19: Tanzania -Nigeria - Differences in Wealth Concentration

	w_{educ}		$log(x_{educ})$	
	Tanzania	*Nigeria*	*Tanzania*	*Nigeria*
ln_tot_exp	-0.00908**	-0.0283***	1.224***	0.133
	(0.004)	(0.000)	(0.000)	(0.744)
assetdensity	0.00488*	0.0299***	-0.0368	1.497***
	(0.015)	(0.000)	(0.758)	(0.000)
log_mean_cost_ne	0.0490	0.0479	9.165*	-0.155
	(0.467)	(0.672)	(0.023)	(0.981)
1.agri	0.00735	0.00990	0.953**	0.574
	(0.167)	(0.308)	(0.003)	(0.297)
1.educpriv	0.0756***	0.0475***	2.890***	0.815
	(0.000)	(0.000)	(0.000)	(0.197)
1.highesteduc	0.0109*	0.0829	0.694*	5.899
	(0.030)	(0.301)	(0.021)	(0.202)
2.highesteduc	0.00432	0.00679	0.366	0.363
	(0.711)	(0.585)	(0.598)	(0.607)
3.highesteduc	0.00457	-0.00520	0.473	-0.528
	(0.519)	(0.627)	(0.263)	(0.381)
4.highesteduc	0.0250*	0.0120	1.465*	0.183
	(0.011)	(0.506)	(0.013)	(0.859)
secondary_schools	-0.00138***	0.00738	-0.00569	0.384
	(0.000)	(0.373)	(0.734)	(0.414)
1.is_primaryage	0.0793***	0.0538***	8.842***	3.301***
	(0.000)	(0.000)	(0.000)	(0.000)
1.is_secondaryage	0.0123**	0.0605***	0.143	2.230***
	(0.005)	(0.000)	(0.580)	(0.000)
1.is_tertiaryage	-0.0131**	0.0174	-1.281***	0.931
	(0.001)	(0.056)	(0.000)	(0.071)
1.has_english	0.0584***		2.249***	
	(0.000)		(0.000)	
numchild	0.00433***	-0.00221	0.259***	-0.0499
	(0.000)	(0.360)	(0.000)	(0.714)
2.religion		-0.0455***		-2.043***
		(0.000)		(0.000)
3.religion		-0.0632		-2.160
		(0.170)		(0.396)
_cons	-0.151	-0.231	-41.97***	-22.99
	(0.346)	(0.352)	(0.000)	(0.103)
sigma				
_cons	0.0876***	0.173***	5.361***	9.969***
	(0.000)	(0.000)	(0.000)	(0.000)
N	2410	2192	2410	2192

Table 20: Tanzania-Nigeria - Urban-Rural Differences

	w_{educ}		$log(x_{educ})$	
	Tanzania	*Nigeria*	*Tanzania*	*Nigeria*
ln_tot_assets	-0.00590***	-0.00196	0.392***	0.363
	(0.000)	(0.576)	(0.000)	(0.065)
log_mean_cost_ne	-0.0548	-0.00483	9.559*	8.263
	(0.455)	(0.965)	(0.031)	(0.182)
1.agri	0.0106*	0.00507	0.925**	-0.0768
	(0.048)	(0.617)	(0.004)	(0.892)
1.educpriv	0.0800***	0.0506***	2.730***	1.016
	(0.000)	(0.000)	(0.000)	(0.113)
1.highesteduc	0.0107*	0.0948	0.679*	7.172
	(0.032)	(0.244)	(0.023)	(0.121)
2.highesteduc	0.00199	0.00689	0.512	0.481
	(0.864)	(0.583)	(0.462)	(0.495)
3.highesteduc	0.00359	-0.00767	0.607	-0.551
	(0.608)	(0.478)	(0.149)	(0.361)
4.highesteduc	0.0273**	0.0129	1.320*	0.486
	(0.005)	(0.480)	(0.025)	(0.636)
secondary_schools	-0.00111***	0.0147	0.00265	0.906
	(0.000)	(0.085)	(0.875)	(0.058)
1.is_primaryage	0.0797***	0.0562***	8.812***	3.408***
	(0.000)	(0.000)	(0.000)	(0.000)
1.is_secondaryage	0.0129**	0.0593***	0.145	2.259***
	(0.003)	(0.000)	(0.572)	(0.000)
1.is_tertiaryage	-0.0121**	0.0139	-1.240***	0.878
	(0.003)	(0.132)	(0.000)	(0.088)
rural_wards	-0.0229**	0.0133	-1.184*	1.848**
	(0.007)	(0.291)	(0.021)	(0.009)
1.has_english	0.0599***		2.436***	
	(0.000)		(0.000)	
numchild	0.00426***	-0.00354	0.304***	-0.0588
	(0.000)	(0.143)	(0.000)	(0.662)
2.religion		-0.0445***		-1.716**
		(0.000)		(0.003)
3.religion		-0.0725		-2.411
		(0.120)		(0.343)
_cons	0.143	-0.103	-30.47**	-29.99*
	(0.452)	(0.698)	(0.008)	(0.044)
sigma				
_cons	0.0870***	0.175***	5.357***	9.994***
	(0.000)	(0.000)	(0.000)	(0.000)
N	2410	2192	2410	2192

Table 21: Tanzania-Nigeria - around median assets-value

	w_{educ}		$log(x_{educ})$		w_{educ}		$log(x_{educ})$	
	Above Median *Tanzania*	Above Median *Nigeria*	Above Median *Tanzania*	Above Median *Nigeria*	Below Median *Tanzania*	Below Median *Nigeria*	Below Median *Tanzania*	Below Median *Nigeria*
ln_tot_exp	-0.00338	-0.0168	0.783**	0.411	-0.0121**	-0.0458***	1.272***	-0.582
	(0.483)	(0.113)	(0.005)	(0.511)	(0.006)	(0.000)	(0.000)	(0.321)
assetdensity	0.00512	0.0321***	-0.160	1.818***	0.00592	0.0227*	-0.0190	0.819
	(0.061)	(0.000)	(0.311)	(0.000)	(0.052)	(0.024)	(0.919)	(0.131)
log_mean_cost_ne	-0.0900	-0.00476	11.02	-6.579	0.165	0.100	7.127	5.568
	(0.363)	(0.976)	(0.056)	(0.479)	(0.080)	(0.539)	(0.219)	(0.528)
1.agri	0.00286	0.00554	0.758	0.341	0.0129	0.0157	1.151*	0.809
	(0.671)	(0.665)	(0.052)	(0.650)	(0.139)	(0.294)	(0.031)	(0.314)
1.educpriv	0.0850***	0.0348*	3.219***	0.726	0.0527**	0.0711***	2.083	0.896
	(0.000)	(0.010)	(0.000)	(0.364)	(0.004)	(0.000)	(0.074)	(0.406)
1.highesteduc	0.0102	0.0847	0.443	8.091	0.0118	0.107	0.850*	5.336
	(0.156)	(0.482)	(0.292)	(0.263)	(0.089)	(0.323)	(0.047)	(0.368)
2.highesteduc	0.0208	0.00761	0.759	0.178	-0.0235	0.00660	-0.380	0.618
	(0.170)	(0.645)	(0.390)	(0.855)	(0.207)	(0.727)	(0.735)	(0.543)
3.highesteduc	-0.000380	-0.00517	-0.0789	-0.359	0.0114	-0.00197	1.171	-0.594
	(0.967)	(0.711)	(0.882)	(0.661)	(0.310)	(0.906)	(0.092)	(0.508)
4.highesteduc	0.0204	0.00328	0.796	-0.695	0.0368	0.0426	2.572*	2.785
	(0.079)	(0.877)	(0.240)	(0.577)	(0.062)	(0.222)	(0.036)	(0.139)
secondary_schools	-0.00128***	-0.00325	-0.00576	-0.524	-0.00161**	0.0230	0.00286	1.669*
	(0.000)	(0.764)	(0.770)	(0.413)	(0.001)	(0.077)	(0.926)	(0.018)
1.is_primaryage	0.0610***	0.0465**	7.280***	2.766**	0.101***	0.0664***	10.53***	3.983***
	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
1.is_secondaryage	0.00978	0.0692***	0.0488	2.637***	0.0161*	0.0502***	0.243	1.706*
	(0.100)	(0.000)	(0.887)	(0.000)	(0.011)	(0.000)	(0.533)	(0.020)
1.is_tertiaryage	-0.0109*	0.0152	-1.381***	0.727	-0.0151*	0.0193	-1.311***	1.108
	(0.043)	(0.197)	(0.000)	(0.292)	(0.015)	(0.181)	(0.001)	(0.152)
1.has_english	0.0496***		1.789***		0.0704***		2.575***	
	(0.000)		(0.000)		(0.000)		(0.000)	
numchild	0.00204	-0.00315	0.267**	-0.115	0.00657***	-0.00143	0.231*	0.0342
	(0.167)	(0.307)	(0.002)	(0.523)	(0.000)	(0.713)	(0.027)	(0.870)
2.religion		-0.0439***		-1.963*		-0.0466**		-2.037*
		(0.001)		(0.011)		(0.003)		(0.015)
3.religion		-0.121		-6.104		-0.0373		-0.447
		(0.144)		(0.192)		(0.516)		(0.882)
_cons	0.145	-0.250	-36.11**	-13.01	-0.447	-0.103	-39.80**	-22.74
	(0.521)	(0.475)	(0.006)	(0.527)	(0.061)	(0.777)	(0.007)	(0.246)
sigma								
_cons	0.0861***	0.169***	5.114***	10.13***	0.0877***	0.176***	5.545***	9.644***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	1233	1192	1233	1192	1177	1000	1177	1000

5.5 Robustness Checks

Assets ownership in poorer and richer sub-samples

To confirm that the assets-ownership does influence the access to education, we inspect the role of assets in lower and higher sub-samples of the surveyed population. We thus re-estimate the results with wealth concentration `assetdensity` as the explanatory variable for those with less than the local median wealth i.e. assets-worth logarithm `ln_tot_assets` and for those above it. The results demonstrate how the education expenditures (coefficients for education budget-shares w_{educ} and education-expenditure logarithm $log(x_{educ})$) differ between the poorer and richer households in a given locality. The results for above and below local median-assets possession using education budget-shares w_{educ} and education-expenditure-logarithm $log(x_{educ})$ as the dependent variables are shown in Table 21 for both above and below median assets-possession levels in the two countries.

While the role that the wealth-concentration `assetdensity` plays towards access to education appears similar for the rich and poor halves in a locality as well, we do see a higher economic significance of wealth-concentration `assetdensity` for the below-median-assets household in Nigeria - possibly because of high education costs in urban areas where asset-possession may be lower. The access to private education and to higher education favour the richer households in both economies - as the economic significance of private-education factor variable `educpriv` is consistently higher for richer households as is the expenditure on tertiary level education in both the economies (considering the budget shares). The significance of social factors - on the other hand - remains unaffected by whether the consumers have above or below the median asset ownership level. More specifically, the factor variables for English-speaking ability `has_english` and (i.e. `religion`) are significant in results from Tanzania and Nigeria (respectively) for both richer and poorer households. The factor variable for English-speaking ability `has_english` is significant for consumers both above and below media asset possession level (the coefficient for variable `religion` is significant for Nigeria for above and below median asset possession level in Table 21). The effect of secondary-schools `secondary_schools` is also the same for both richer and poorer halves of a given locality.

Variable	Variable Name	Description	Additional Controls
r	`assetdensity`	Average over geographical vicinity (district)	Ω , education-rank
r_Γ	`assetdensity_educ`	Separate averages over Γ	Ω
r_Ω	`assetdensity_agri`	Separate averages over Ω	education-rank

Table 22: Prosperity levels and control variables used

Asset-density interpretations based on similar neighbours

To ensure that the effect of assets remains strong after accounting for occupation or

Table 23: Tanzania-Nigeria - $assetdensity_{educ}$

	w_{educ}		$log(x_{educ})$	
	Tanzania	*Nigeria*	*Tanzania*	*Nigeria*
ln_tot_exp	-0.00927**	-0.0291***	1.229***	0.0988
	(0.004)	(0.000)	(0.000)	(0.809)
assetdensity_educ	0.00262	0.0272***	-0.0349	1.323***
	(0.102)	(0.000)	(0.714)	(0.000)
log_mean_cost_ne	0.0535	0.0570	9.210*	0.361
	(0.428)	(0.614)	(0.022)	(0.955)
1.agri	0.00598	0.00747	0.957**	0.449
	(0.256)	(0.440)	(0.002)	(0.412)
1.educpriv	0.0763***	0.0471***	2.887***	0.799
	(0.000)	(0.000)	(0.000)	(0.207)
1.highesteduc	0.0109*	0.0819	0.697*	5.867
	(0.031)	(0.307)	(0.020)	(0.204)
2.highesteduc	0.00402	0.00520	0.369	0.285
	(0.731)	(0.676)	(0.595)	(0.687)
3.highesteduc	0.00452	-0.00734	0.475	-0.635
	(0.524)	(0.492)	(0.261)	(0.293)
4.highesteduc	0.0250*	0.0105	1.469*	0.111
	(0.011)	(0.563)	(0.013)	(0.914)
secondary_schools	-0.00133***	0.00756	-0.00571	0.400
	(0.000)	(0.361)	(0.732)	(0.395)
1.is_primaryage	0.0791***	0.0529***	8.844***	3.258***
	(0.000)	(0.000)	(0.000)	(0.000)
1.is_secondaryage	0.0119**	0.0599***	0.148	2.199***
	(0.006)	(0.000)	(0.566)	(0.000)
1.is_tertiaryage	-0.0133**	0.0177	-1.276***	0.950
	(0.001)	(0.051)	(0.000)	(0.065)
1.has_english	0.0579***		2.253***	
	(0.000)		(0.000)	
numchild	0.00432***	-0.00231	0.260***	-0.0547
	(0.000)	(0.337)	(0.000)	(0.687)
2.religion		-0.0441***		-1.971***
		(0.000)		(0.001)
3.religion		-0.0609		-2.074
		(0.185)		(0.414)
_cons	-0.124	-0.208	-42.21***	-21.67
	(0.438)	(0.401)	(0.000)	(0.124)
sigma				
_cons	0.0877***	0.173***	5.361***	9.974***
	(0.000)	(0.000)	(0.000)	(0.000)
N	2410	2192	2410	2192

Table 24: Tanzania-Nigeria - $assetdensity_{occup}$

	w_{educ}		$log(x_{educ})$	
	Tanzania	*Nigeria*	*Tanzania*	*Nigeria*
ln_tot_exp	-0.00924**	-0.0308***	1.147***	0.00661
	(0.003)	(0.000)	(0.000)	(0.987)
assetdensity_agri	0.00322	0.0276***	-0.00759	1.352***
	(0.066)	(0.000)	(0.942)	(0.000)
log_mean_cost_ne	0.0225	0.0496	3.952	-0.206
	(0.718)	(0.654)	(0.287)	(0.974)
1.educpriv	0.0761***	0.0449***	2.930***	0.677
	(0.000)	(0.000)	(0.000)	(0.281)
1.highesteduc	0.0109*	0.0882	0.670*	6.186
	(0.029)	(0.273)	(0.025)	(0.182)
2.highesteduc	0.00401	0.00573	0.320	0.310
	(0.732)	(0.644)	(0.646)	(0.660)
3.highesteduc	0.00444	-0.00658	0.433	-0.603
	(0.531)	(0.535)	(0.306)	(0.314)
4.highesteduc	0.0250*	0.0104	1.382*	0.0953
	(0.011)	(0.563)	(0.019)	(0.926)
secondary_schools	-0.00138***	0.00712	-0.0110	0.374
	(0.000)	(0.389)	(0.514)	(0.425)
1.is_primaryage	0.0794***	0.0542***	8.922***	3.328***
	(0.000)	(0.000)	(0.000)	(0.000)
1.is_secondaryage	0.0124**	0.0621***	0.168	2.314***
	(0.004)	(0.000)	(0.516)	(0.000)
1.is_tertiaryage	-0.0130**	0.0179*	-1.287***	0.968
	(0.001)	(0.048)	(0.000)	(0.059)
1.has_english	0.0585***		2.294***	
	(0.000)		(0.000)	
numchild	0.00444***	-0.00169	0.279***	-0.0231
	(0.000)	(0.479)	(0.000)	(0.864)
2.religion		-0.0456***		-2.063***
		(0.000)		(0.000)
3.religion		-0.0641		-2.216
		(0.163)		(0.383)
_cons	-0.0517	-0.172	-27.46***	-19.34
	(0.711)	(0.469)	(0.001)	(0.153)
sigma				
_cons	0.0877***	0.173***	5.372***	9.965***
	(0.000)	(0.000)	(0.000)	(0.000)
N	2410	2192	2410	2192

education level, we recompute the wealth concentration by considering only those in the household's vicinity with the same value of the indicator for primary/higher-than-primary education-level of the household-head and then again with the same value for the agrarian/non-agrarian occupation indicator. Three types of vicinities thus implied - are summarised in Table 22. The first interpretation is one that we have already described in Section 5.4 - where a simple average of the total assets owned by the households in the consumer's district is used. Both education rank and an agrarian-occupation factor variable Ω indicating whether the household head's occupation is agrarian or not are used as controls in this interpretation of the vicinity. The second interpretation of the vicinity presented as r_{educ} in Table 23 is based on a supra-primary factor variable Γ indicating whether the education level of the household-head is higher than primary school or not. More specifically, this second interpretation uses the prosperity within the educational levels implied by supra-primary factor variable Γ (i.e. primary and higher-than primary educational levels). The agrarian/non-agrarian factor variable Ω is also used as the additional control in this second interpretation. Finally, the third interpretation of vicinity is based on the average prosperity in the agrarian vs non-agrarian occupations (i.e. Ω) and uses educational rank as the additional control variable. The results from this third interpretation of vicinity are presented in Table 24.

Observing the differences in coefficients for wealth-concentration calculated over a supra-primary education vicinity (`assetdensity_educ`) and over agrarian/non-agrarian vicinity (`assetdensity_agri`) in Tables 23 and 24 (respectively) for Tanzania and Nigeria, we see again that while the wealth concentration corresponds to a rise in educational expenditure logarithm $log(x_{educ})$ for Nigeria, its effect is insignificant (whether one uses the wealth-concentration in the supra-primary-educated neighbourhood `assetdensity_educ` or wealth-concentration in the agrarian-neighbourhood `assetdensity_agri`) for Tanzania. Further, since the coefficients for secondary-age indicator `is_secondaryage` seem higher for the agrarian/non-agrarian vicinity (i.e. the coefficient for wealth-concentration in `assetdensity_agri`) than for the supra-primary education vicinity (i.e. wealth-concentration in `assetdensity_educ`), it can be argued that education expenses are more often clustered by agrarian or non-agrarian occupations than by education levels the populations have attained.

6 Conclusions

We had set ourselves to examine the extent to which educational expenses are limited by wealth effects by testing if local wealth effects are more important than urbanisation levels for education expenses in two economies of the SSA that are dissimilar in terms of industrial output. While there are idiosyncratic differences between the two countries we've used for our comparison, the weakening of wealth effects with higher urbanisation is a notable implication relevant to both the concern for aspiration consumption and the education policy in the region.

Since the agrarian consumers maintain a high budget share on education expenses in the poorer economy (Tanzania) and since higher education ranks correspond to higher education expenses in the more developed economy (Nigeria), one can argue that the educational expenses are likely to remain high as more of the population attains education as the regional prosperity rises. This also seems aligned with the recent finding from a cohort-study by Porzio *et al.* (2021) that the labour with skills added through education is less willing to stay in agricultural activities.

There are two main findings that can be highlighted from our results. First, the effects of urbanisation levels - whether interpreted as wealth concentration or as urban-rural indicators from the survey - are significant on education expenses in both the economies. Second, the lower wealth continues to prevent access to education and mobility in both the economies - even though rises in education expenses seem inevitable when the employment opportunities increase in an economy. In light of both the findings, the wealth effects seem less extreme in the higher developed economy (i.e. Nigeria) than in the less developed economy (i.e. Tanzania). In other words, wealth effects - after accounting for urbanisation - appear to become weaker with rise in urbanisation. A rise in urbanisation associated with weaker wealth effects supports a view of conventional pathways to equity in both income and equality (Kuznets (2019)). Considered as aspirational consumption, the educational expenses are thus expected to rise in the region with more urbanisation.

That said, the importance of urbanisation does not discount the need to improve access to education for the lower and middle-income populations in the region. Even though the literature often notes a higher significance of wealth effects, the consideration of urbanisation suggests that role of physical access may continue to be important in economies with wide disparities in urbanisation levels. This is of crucial importance also because the private educational institutions - which are more common in Nigeria - do not yet play a major role in the provision of education in the region. Instead, a more significant role continues to be played by the state-institutions in both the economies. The role of social differences indicated by the significance of social characteristics in education expenses for both the economies - further emphasises the need to improve access to education. These findings are aligned with the wider observations made by Alesina *et al.* (2019) who elaborate on the significant role of religious and colonial institutions in the educational mobility across sub-Saharan Africa.

In summary, the development of the education sectors seems to be at different stages of development in the Tanzania and Nigeria. The privatisation of education in Nigeria seems to have coincided with attendance of higher level education in a way that is yet to be seen for Tanzania - where education has not expanded as much yet. The wealth effects do seem strong in both the economies, but the relevance of wealth-concentration in the population having higher education levels points to a promising albeit precarious direction where more urbanisation could improve access to education and employment opportunities in the region while increasing expenses on education overall.

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Table 25: Education levels as ranks in Tanzania

	education code	education rank
PP	1	1
ADULT	2	2
D1	11	2
D2	12	2
D3	13	2
D4	14	2
D5	15	2
D6	16	2
D7	17	2
D8	18	3
OSC	19	3
MS COURSE	20	3
F1	21	3
F2	22	3
F3	23	3
F4	24	3
O COURSE	25	4
F5	31	4
F6	32	4
A COURSE	33	4
DIPLOMA	34	4
U1	41	4
U2	42	4
U3	43	4
U4	44	4
U5&	45	4

Table 26: Education levels as ranks in Nigeria

	education code	education rank
None	0	0
N1	1	1
N2	2	1
P1	11	2
P2	12	2
P3	13	2
P4	14	2
P5	15	2
P6	16	2
JS1	21	3
JS2	22	3
JS3	23	3
SS1	24	3
SS2	25	3
SS3	26	3
Lower 6	27	3
Upper 6	28	3
Teacher training	31	4
Vocational/Technical	32	4
Modern school	33	3
NCE	34	3
Poly/prof	41	4
1st degree	42	4
Higher degree	43	4
Quranic	51	3
Integrated Quaranic	52	4
Adult Education	61	3

Table 27: Occupations as ranks in Tanzania

code	occupation area	occupation rank
14	Student	0
13	Job Seeker	0
12	Paid Family Work	0
16	Unemployed	0
11	Unpaid Family Work	0
17	Unemployed (too young)	0
1	Livestock/Agriculture	1
2	Fishing	1
3	Mining	1
4	Tourism	1
7	Private Sector	2
9	Non-Agricultural (w Employer)	2
10	Non-Agricultural (w/o Employer)	2
8	Non-Government/Religious Org	3
5	Government	3
6	Parastatal	3

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
3461	decorators and commercial designers	1
7321	potters and related clay and abrasive formers	1
8251	printing machine operators	1
2144	electronic and telecommunications engineers	1
3139	other optical and electronics equipment controllers not elsewh	1
6122	poultry products	1
7432	weavers, knitters and other hand textile products makers	1
9111	street foods vendors	1
7424	basketry weavers, brush markers and related workers	1
3114	mechanical engineering technicians	1
3441	custom and border professionals	1
7331	handicraft workers in wood and related materials	1
7313	jewelry and precious metal trade workers	1
7413	food beverage testers and graders	1
8277	tea coffee cocoa and chocolate preparing and producing machine o	1
8152	cooking, roosting and related heat - treating plant operators	1
7224	metal grinder, polishers and tool sharpeners	1
8279	brewers, wine and other beverage machine operators	1
7412	bakers, pastry cooks and confectionery makers	1
8221	pharmaceutical and toiletry products machine operators	1
8263	sewing and knitting machine operators	1
7121	builders traditional materials	1
313	building construction labourers	1
2429	other legal professionals	1
1312	general managers in manufacturing	1
7332	handicraft workers in textile, leather and related materials	1
5149	other personal services workers not elsewhere classified	1
7442	shoe makers and related good workers	1
8151	crushing mixing and grinding equipment operators	1
7211	metal moulds and core makers	1
8284	metal, rubber and plastic products assemblers	1
7129	other building frames and related workers	1
9332	hand and pedal vehicle drivers	1
3340	other teaching associate professionals	1
5141	hairdressers, barbers, beauticians and related workers	1

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
9162	sweepers and related labourers	1
6114	mixed crop growers	1
5133	home-based personal care workers	1
6151	aquatic liege cultivation workers	1
9321	assembling labourers	1
3116	chemical engineering technicians	1
3421	trade brokers	1
8275	baked goods producing and cereals processing machine operators	1
8113	well drillers and borers and related workers	1
3213	farming and forestry advisers	1
7433	tailors, dress makers and hatters	1
3416	buyers	1
5230	stall and market salespersons	1
2332	pre-primary education teaching professionals	1
3131	photographers and image and sound-recording equipment controller	1
6141	forestry worker and loggers	1
7411	meat and fish butchers and preparers	1
8229	other chemical products machine operators	1
7123	concrete placers, concrete finishers and terrazzo-workers	1
8321	motorcycle drivers	1
1313	general managers in construction	1
7136	building and related electricians	1
3417	appraisers and values	1
5112	transport conductors	1
8123	metal heat - treating plant operators	1
8264	textile bleaching, dyeing and cleaning machine operators	1
2455	film, stage and related actors and directors	1
5121	house stewards and house keepers	1
5220	shop sales persons and demonstrators	1
6111	field crops and vegetable growers	1
6210	subsistence agricultural and fishery workers	1
1228	research and development managers	1
3444	government licensing officials	1
6152	inland and coastal waters fishery workers	1
7131	roofers	1
6121	dairy and livestock producers	1

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
6154	hunters and trappers	1
7222	tool maker, metal patter makers and metal makers	1
1130	traditional chiefs and head of villages	1
3229	other health associate professionals (except nursing)	1
1316	general managers in transportation	1
7213	sheet-metal workers	1
7422	cabinet makers and related workers	1
9213	fishery, hunting and tapping labourers	1
1229	other specialized managers	1
7214	structural metal prepares and erector	1
6130	market oriented crop and animal producers	1
8224	photographic products machine operators	1
7135	plumbers and pipe fitters	1
5210	fashion and other models	1
9322	hand packers and other manufacturing labourers	1
7122	bricklayers, stonemason and tile setters	1
2143	electrical engineers	1
9133	hand launderers and pressers	1
9131	domestice helpers and cleaners	1
7124	carpenter and jointers	1
8240	wood products machine operators	1
5139	other personal care workers	1
2359	other teaching professionals not elsewhere classified	1
8285	wood related materials products assemblers	1
9211	farmland and labourers	1
9212	forestry labourers	1
3442	government tax and excise officials	1
4133	transport clerks	1
7423	wood working machine setter operators	1
1315	general managers in resturants and hotels	1
3222	sanitarian	1
7322	glass formers, cutters grinder and finishers	1
9112	street vendors, other products	1
2146	chemical engineers	1
7221	blacksmiths, hammersmith’s, forging-press workers	1
3227	veterinary assistants	1

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
8332	earth-moving and related machinery operators	1
9132	helpers and cleaners in offices and hotels and related workers	1
7435	textile patternmakers and cutters	1
9152	watchers and doorkeepers	1
1210	directors and chief executives	1
8239	other rubber and plastics machine operators	1
2113	chemists	1
5113	travel guides and ground hosts	1
9153	private security guards	1
2460	religion professionals	1
3212	agronomy and forestry technicians	1
6123	mixed animal producers	1
3449	other government associate professionals	1
9333	drivers and operators of animal-drawn vehicles and machinery	1
9141	building caretakers	1
1223	personel and industrial relations managers	1
6113	gardeners, horticultural; nursery growers	1
7243	radio and television service	1
7231	motor vehicle mechanics and filters	1
7437	upholsterers and related workers	1
7133	insulators	1
7241	electrical mechanics	1
7311	precision instrument makers	1
5122	waiters	1
2453	musicians	1
8269	textile machine operators	1
7312	musicians (acoustic)	1
8223	metal finishers	1
7324	ceramic painters	1
4144	scribes	1
3320	education specialists(1)	1
7341	type setters	1
3418	auctioneers	1
3122	computer equipment operators	1
7216	under-water workers	1
3223	dieticians and nutritionists	1

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
7345	textile printers	1
3224	optometrists	1
8312	railway workers	1
7436	embroiderers	1
8122	metal melters	1
3141	ship engineers	1
7344	bookbinders	1
3226	physiotherapists	1
7111	miners	1
8132	ceramic plant operators	1
8334	lift-truck operators	1
9120	shoe-cleaners	1
8159	chemical-plant operators	1
3228	pharma assistants	1
8282	elec and machinery assemblers	1
3151	building and fire inspectors	1
812	cement and materials processing machine operators	1
9161	garbage collectors	1
8143	paper plant operators	1
2133	computer programmers	2
6112	tree shrub crop growers	2
3221	medical assistants	2
4143	coding, proof-reading and related clerks	2
1314	general managers in retail and wholesale trade	2
3422	clearing and fowarding agents	2
7113	stone-splitters, cutters and carvers	2
2412	personnel and careers professionals	2
3465	athletes and related workers	2
4122	statistical and finance clerks	2
8262	weaving and knitting machine operators	2
3310	primary education teaching associate professionals	2
3415	technical and commercials sales representatives	2
2340	special education teaching professionals	2
8141	sawmill, wood panel and related wood-processing plant operat	2
7212	welders and flame-cutters	2
8322	cart, taxi and light van drivers	2

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
8323	bus and train drivers	2
9151	messengers package and luggage	2
4142	mail carriers and sorting clerks	2
8169	other power generating and related operators	2
1224	sales and marketing managers	2
8290	other stationery machine operators and assemblers	2
9142	windows cleaners	2
3411	securities, finance dealers and brokers	2
4141	library and filling clerks	2
7141	painters and paperhangers	2
8272	dairy products machine operators	2
7421	wood treaters	2
2145	mechanical engineers	2
2331	primary education teaching professionals	2
3118	other physical science and engineering technicians	2
8324	heavy truck drivers	2
2229	other health professionals (except nursing)	2
3429	other business services agent and trade brokers	2
3330	special education teaching associate professionals	2
3113	electrical engineering technicians	2
3439	other administrative associate professionals	2
8231	type making and vulcanizing machine operators	2
2446	social work professionals	2
3121	computer assistants	2
7112	short fires and blasters	2
4132	production clerks	2
8161	power-generating plant operators	2
7242	electronic fitters and services	2
3152	safety, health and quality inspectors (vehicles, processes	2
7434	fur tailor and related workers	2
1222	finance and administration managers	2
2230	nursing and midwifery professionals	2
3423	labour contractors and equipment agents	2
5143	undertakers and embalmers	2
6142	charcoal burners and related workers	2
7223	machine tool setter operators	2

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
9311	mining and related labourers	2
9312	construction and maintenance labourers road, dams and similar co	2
3414	travel consultants organisers	2
5131	institution-based personal care workers	2
3431	administrative and related associate professionals	2
4131	stock clerks	2
2139	other computing professionals	2
2452	sculptors, painters and related artists	2
3463	street, nightclub and related musicians, singers and dancers	2
2141	architects, town and traffic planners	2
1120	senior government officials	2
1226	supply and distribution managers	2
2211	biologists	2
3470	religion associate	2
2351	education specialists(2)	2
2441	economists	2
3132	broadcasting equipment controllers	2
3412	insurance representatives	2
1317	business managers	2
3145	air-traffic safety technicians	2
2422	judges	2
2147	mining engineers	2
2213	agronomists and related professionals	3
8153	filtering and separating equipment operators	3
3413	estate agents	3
1311	general managers in agriculture	3
2142	civil engineers	3
2320	secondary education teaching professionals	3
6153	deep-sea fishery workers	3
1141	senior officials of political party organisation	3
3445	commissioned police officers and detectives	3
2223	veterinarians	3
2421	lawyers	3
3143	aircraft pilot and related workers	3
1227	computing services managers	3
3419	other finance and sales associate professionals	3

Table 28: Occupations as ranks in Nigeria

code	occupation name	occupation rank
3450	social work associate professionals	3
2149	other architects, engineers and related professionals	3
3443	government welfare and pension officials	3
2352	school inspectors	3
3462	radio, television and other announcers	3
2411	accountants	3
2419	other business professionals	3
2451	authors, journalist and other writers	3
2122	statisticians	3
1318	general managers in personnel care, cleaning repairs and rel	3
2310	colleges, university and higher education teaching professiona	3
8155	petroleum refining plant operators	3
1221	production and operations managers	3
2224	pharmacists	3
2148	cartographers and surveyors	3
2221	medical doctors	3
3112	civil engineering technicians	3
5111	flight attendants and travel stewards	3
1110	legislators	3
1142	senior business officers	3
3432	legal professionals	3

Part III

Status competitions under Income Inequality

Abstract

Status motivations for consumption have generated an immense interest at a time when social mobility has been relatively stagnant - but the consequences of inequality within societies on patterns of development are still poorly understood. In the proposed chapter, we consider an economy with a hierarchy of positions that consumers are able to move between. We then ask how the relative incomes associated with each position within this setting influence the agents' saving, consumption and labour supply decisions. With greater effort improving one's chances of moving to a higher position, two competing forces arise. On one hand, the inequality in incomes associated with different positions motivates striving for a high position holding the chance of winning that position fixed. But on the other hand, ensuring that the probabilities of moving up and moving down are equal across the society reveals that these positional contests can become uncompetitive. Greater inequality lowers the chances that striving effort pays off. The resulting non-linear relationship between inequality and steady state production are anlaysed in the chapter.

1 Introduction

The consumer response to relative income has appealed to economists since at least as far back as Veblen (1899). While the post-war period of relative stability and life-style improvements have renewed an interest in the positional concerns (Frank (1993); Hirsch (1977)), there remains a disconnect between the descriptive theories - which explain the effects of a consumer's social context on her choices - and the theories of long-term economic growth (see Kay & King (2020); Dhami (2016)). Status competitions may have been argued to be ubiquitous - but the empirical explorations of how the microeconomic behaviour of a status-seeking consumer could relate with the economic inequality are rare (see Knell (1999); Hopkins *et al.* (2004); Corneo & Jeanne (2001) for theoretical arguments). To assist such an exploration, we focus on two questions pertaining to inequality in the context of status competitions in the current chapter. First, we attempt to answer if investments towards status that contribute to future probable success - should increase or decrease with a rise in income inequality or not. Second, we clarify if income inequality contributes to consumer accumulations in the long-term through status competitions. In addressing these questions, we focus on status games that provide direct gains to the consumer - while treating the uncertainty in intergenerational or spatial mobility explicitly as probabilistic rewards from investments towards status.

The stylised model of a status game where gains are driven by one's investments follows a contest-theory approach (Lockard & Tullock (2001)) where the consumer's accumulations are constrained with the long-term stability of consumer populations. The status goals and economic goals of the consumer are treated equivalent in this approach - a feature that bears similarity with model proposed by Cole *et al.* (1992) where status is viewed as a ranking device for non-transactional environments directly influencing the consumer income. Simply put, our approach equates the status goals of the consumer with her economic goals - viewing status as the expected secure wealth maximised by the consumer. Status consumption then becomes the investments or cost to participate in a tiered rewards game. The approach may be of a limited value in cases where status consumption is treated as necessarily futile, but a view of status consumption as investments towards economic status is relevant for growing economies that provide new opportunities to gain wealth amidst an environment of severe income inequalities.

As such, the recent debates surrounding the two questions that we address in the current chapter seem to offer little clarity on the relationship of status consumption with inequality in an economy. A contradiction seems to persist for the first question since there are contrasting views in the literature on whether inequality has a negative or positive effect on status consumption. The post-war literature on status competitions argues that a fall in income inequalities and improvement in life-standards has resulted in a higher focus on status goods (Hirsch (1977); Galbraith (1958, 1994, 2001)) while the empirical literature finds more often that status consumption increases with rising inequality. It is worth emphasising that the sociological observations of increased status needs in response to falling inequality in the post-war era are associated with normative rather than descriptive concerns. Therefore, it need not follow from such observations that consumers feel a higher need for status as the inequality rises (or vice versa) - only that the avenues for indicating status may decline as the life-standards become uniform with decrease in income inequality (Harrod (1958); Hirsch (1977)). When equipped with subjective welfare data, the recent empirical analyses on how status competitions could relate to observed income inequality have instead found a positive effect of income inequality on status consumption. In other words, it is more often - particularly in the developing world - that status consumption increases with rising inequality. In a study focusing on education expenses for status purposes in China, Jin *et al.* (2011) find, for example, that higher inequality increases the consumption towards status. Similarly, Jaikumar & Sarin (2015) also report that consumers in India have increased conspicuous consumption with rise in inequality. An appropriate line of research has been to examine the environment where inequality is experienced (often relying on social attitudes surveys). Mijs (2019), for example, use the data from International Social Survey to detail how a rise in inequality might have cemented a belief in meritocracy in the developed economies and coincided with segregation rather than a healthy competition. A causal relationship between inequality and status consumption remain elusive since the growth environment as well as social context of an economy create an evident omitted variable bias for empirical studies. Thus the demands for status could be different in a rising economy than in a stagnant economy or vary within the same country due to significant income-segregation (Reardon & Bischoff (2011); Minkoff & Lyons (2019)). Since status competitions are tied with particular social contexts, an econometric analysis must also deal with the environment where inequality is experienced. The effect of income opportunities and resource-constraints on status competitions is thus an important consideration for the current chapter.

The second question examines if an increase in status consumption could result in more or less accumulations for the consumers. The debates on the relationship between inequality and growth in the literature have been divisive. The conventional wisdom has relied on the early works from Kuznets (2019) who had argued that inequality rises in a country's early (agrarian) stages of economic development before declining as its economy matures (industrialises). However, later empirical works have argued for both positive and negative effects of inequality on long-term economic growth. Those who argue for a positive effect of inequality on growth often emphasise how inequality helps innovation (Foellmi & Zweimüller (2006)) and supports high-return projects (Rosenzweig & Binswanger (1992)). The negative effect of inequality on growth has been argued through unfavourable fiscal policies (Perotti (1993)), political instability (Benabou (1996)) or decline in human capital (Galor & Zeira (1993); Berg *et al.* (2018)). Unless a particular mechanism of growth is inspected, an omitted variable bias is likely in such international comparisons as well

(Forbes (2000); Banerjee & Duflo (2003)). More importantly, one must also consider the time-period over which growth is measured (Halter *et al.* (2014); Banerjee & Duflo (2003)). As Halter *et al.* (2014) elucidate, the positive effects of inequality tend to be short-term while the negative effects are often long-term. More recent empirical approaches have highlighted the role of inequality in opportunity towards growth in the economy (Aiyar & Ebeke (2020); Bradbury & Triest (2016); Marrero & Rodríguez (2013)). Interpreted as non-necessary consumption, status consumption has also been explored as a mechanism that could affect growth. Knell (1999), for example, delineate how status competitions may lead to a negative effect on growth in the developed economies. Corneo & Jeanne (2001) have also shown a negative effect of status competitions on growth while Hopkins *et al.* (2004) have highlighted that the positive effect of inequality on growth hinges on how the society treats its lowest individuals. The proposed model in the current chapter focuses only on the accumulations for the consumers rather the the growth in the economy and finds that the total consumer accumulations (for the poor as well as the rich) decline in an economy if economic inequality rises while all consumers participating in status competitions.

It is worth emphasising that unlike in the literature on visible consumption, the status competitions in this stylised model are not wasteful. While the long-term income inequalities are permanent in the model (as is often the case - particularly in the developing economies), the consumers are allowed to transition through income bands through investments towards status (economic) gain with a certain probability. The probabilistic transition implies both a promotion and demotion of a consumer to the higher and lower income-bands in the economy. The basic set up relies on the observation first made by Harrod (1958) that social mobility and status are constrained due to necessarily limited positions for high status. With the consumer needs fixed for a given income-band, a consumer obtains a fixed disposable income by merely belonging to the income band (at a a given time) and the only sense of status in the economy is derived from the expected accumulated wealth at a certain risk over the long term. The status competitions in every income band provide an uncertain transition to a richer income band (except for the richest band) - a transition whose probability is increased by higher expenditure towards status. Similarly, the probability of demotion to a lower income band is reduced with a higher expenditure towards status. While status competitions are ubiquitous in the model through participation of all consumers (a representative consumer in each band), the status competitions are constrained by the transition functions that limit high status to a small section of society. With an approach that equates economic goals with goals of social status, the status is achieved in the process of the consumer's maximisation of the consumer's projected assets-accumulation using the incomes received from the variety of income strata she may belong to in the future (due to transitions through the income bands). The key feature of this model is that it outlines a particular set of functions for such mobility across income bands and considers the constraints that the mobility functions must conform to.

The solution of the dynamic equilibrium implied by the above model that we use to answer the two questions relies on two conditions. First is a condition of population stability i.e. the long-term stability of sub-populations within these bands that ensures the number of consumers leaving a band being balanced with the number entering the band. The second condition is the ordering of utilities for richer and poorer consumer in a society. Since the recurrent bands (nodes) in the model are the poorest and the richest bands, a particular ordering of how rich and poor consumers benefit from their respective utilities from accumulated wealth is assumed for two bands in the economy. In the long-term equilibrium under these conditions, a consumer balances the accumulation of her wealth at risk with maintenance of a fair chance to improve (or hold) her socioeconomic position. In this simplified consideration of two-income bands, we then discuss the implications from rising income equality on the steady state levels of status consumption - seen as investments - as well as the long-term asset accumulations. While the game does permit a zero investment by either of the consumers (i.e. a withdrawal from the status competition), a non-zero investment for both the consumers means that the rich consumer must not find the investment for promotion - that the poorer consumer is offered a chance to be rich with - to be too little and the poorer consumer must not find that there is nothing on offer for mobility through status competitions to the richer position. In other words, the zero-consumption from either of the consumer does not constitute an equilibrium where both poor and rich consumers participate in the status competition.

One of the implications of the two long-term equilibrium conditions - i.e. the conditions of band population stability and the ordering of rich and poor asset utilities - is that the expenditure towards status for the poorer consumer need not decline with narrowing of income differences in the long-term. Equivalently, the costs to maintain the high accumulation for the richer consumer may rise with narrowing of income differences in the long-term. Given the evidence of myopia of consumption (Muellbauer (1988)), one is often concerned with the consumer motivations in the short-term. The implication of the long-term equilibrium are - on the other hand - different from the short-term competition where wider income differences (rise in inequality) always intensify status competitions (i.e. increase the expenditure towards status). This serves as a key insight towards the first question we're interested in. While wider income differences (rise in inequality) tend to intensify status competitions and should increase the expenditure towards status in the short-term (as is validated by empirical assessments discussed above), the long-term equilibrium conditions of population stability imply a different dynamics where the wider income differences may act to reduce expenditure towards status by making band-promotion more difficult (for the poor consumers) and band-security cheaper (for the richer consumers). Similarly, a narrowing of income-differences in the long-term increases the value of (utility from) the expenditure towards status for poorer consumers - so that the poorer consumers spend less on status investments while the richer consumers raise their expenditure towards status to maintain their position of wealth in the long-term. Inequality can thus have a separating effect of pushing status-related investments away from each other in the long-term so that it discourages investments towards status in the stylised model.

Focusing on the net accumulations for the consumers in the steady state, we also show that asset accumulations can either decline or rise with inequality depending on the transition functions - so long as the population stability criterion is maintained. In other words, a consumer may strive for more mobility in the short-term as income differences rise, but if the long-equilibrium were to move from a low-income differences (income inequality) setting to a higher income-differences setting, it is possible that poor consumer withdraws from the status competitions (zero status investment). The net effect of inequality on growth is thus determined by how the combined asset accumulation for the rich and the poor rise or fall with inequality in the long-term equilibrium. This also means that inequality could rise while maintaining the same steady-state growth in the model - so that a decline in poor consumer's investments towards status are compensated by the rise in rich consumer's investments towards status. If one may view the demotion in the model as equivalent of a redistribution mechanism, the particular results are similar to those arrived at by Benabou (1996) using a prisoner's dilemma formulation with possible expropriation of a common pool of assets. In other words, the long-term equilibrium results suggest that inequality may increase redistribution through rise in investments for status.

The contest-theory approach followed in the chapter is more general and may be better suited for examining the effect of inequality on expenditures such as education - which are not always wasteful (particularly in developing economies) and provide a real, albeit uncertain, opportunity for gain in positional or economic improvement. As social customs typically lag behind the rapid changes through introduction of newer occupation-related contests experienced in many such developing economies, the long-term income inequalities can be assumed to be as stable as the status competitions that represent institutional structures which maintain social hierarchies. Under these settings, one can both make the case for a positive externality from status games (Congleton (1989))[33] and argue more generally that consumer welfare is derived from contests for achieving status (Snower & Bosworth (2016)). We thus avoid a utility based on wasteful consumption (Ireland (1994); Hopkins & Kornienko (2004)) in favour of one based on the total asset accumulations (e.g. those used by Halter *et al.* (2014); Corneo & Jeanne (2001)) in the current chapter. Other than the appropriateness of status games for expenses such as education, there are two further advantages of the explicit treatment of uncertainty in status gains with the contest-theory approach. First, fewer assumptions are needed on savings behaviour of the consumer (such as a constant savings rate) and the steady state of growth (such as a knowledge spill-over assumption in Benabou (1996); Knell (1999)) - as the constraints of population stability in income bands are directly factored in. Second, the model may be

[33]Congleton (1989) argue that some status games being more productive than others could evolve into institutional arrangements that promote "benign" status games i.e. games with positive externality.

better suited for empirical measurement of status consumption where income disparities are more readily observed than the reference level consumption.

The results from the model contribute to the literature in a few different ways. First, the framework with uncertainty in consumer choice proposed in the chapter may be better suited for incorporating choices that affect intergenerational or spatial mobility (including social hierarchy) that in turn correspond to material gain from status competitions. Second, the model addresses status-related investments in education or professional club memberships that are often ignored in the discussion of status consumption due to possible contribution to consumer wealth from such investments. Third, it establishes that the steady state conditions for composition of populations in income-bands are enough to reverse the appeal for investment towards status. The findings from the chapter have a fundamental implication for policy - that while income inequality may motivate the consumer in the short-run, the long-term equilibrium would result in a social ossification.

To sum up, while a certain mobility through status competitions may provide stability (through perceptions of fairness in competitions) in an economy where stability of income-differences in the long-term widens the differences in accumulated wealth (through inheritance etc.), the conditions for long-term stability may reverse the implications of the widening of income differences on status competitions that are implied in the short-term. The conditions and the implications from the probabilistic model for status gains are detailed in the subsequent sections. In what follows, Section 2 briefly discusses the literature that the model relates with, Section 3 details the model and Section 4 discusses the findings and conclusions.

2 Literature Survey

The renewed interest in status competitions pertaining to consumption problems in recent decades (Frank (1985, 1993); Corneo & Jeanne (1997)) follows a much earlier exploration in the first half of 20th century detailing economic implications of a consumer's pursuit of status. In particular, the present-day considerations of reference points in consumer decision problems (Runciman (1966); Markowitz (1952)) owe much to the studies in psychology in this early literature (Hyman (1942); Roper (1940)). The more recent behavioural economics approaches - both theoretical and empirical - have also drawn upon insights from psychology e.g. by using ideas of self-esteem and self-identification (Frank (1993); Corneo & Jeanne (1997)) to explain the influence of status competitions on consumer.

Although the recent behavioural approaches emphasise the role of choice under uncertainty in consumer decisions, only few of the approaches - such as Hopkins & Kornienko (2009) - have used an explicit treatment of uncertainty to explain the consumer decisions in status competitions. The current chapter focuses on how the uncertainty in a transition to bands of disparate income - encapsulating the effects of social structures - could influence the investments towards status. The notion of uncertainty in the model encompasses the indeterminate processes of promotion to social positions that directly influence the income towards accumulations. The status competitions as a game for long-term asset accumulations under uncertain income band transitions - motivates our use of a contest theory approach - based on a problem first formulated as a sequential game by Lockard & Tullock (2001) in the context of a competition towards positions under uncertainty in rent-seeking problems. The stylised model in the chapter is then used to address the specific question of how the increases in income inequality could influence the status investments and future asset accumulations.

Despite this similarity with the contest-theory approach first proposed by Lockard & Tullock (2001), there are some key differences between our approach and the Tullock competition. While the status game - much like a Tullock competition - is a full information game, the approach in the current chapter is more concerned with the implications of a long-term equilibrium than the sequential setting that is at the heart of a Tullock contest. Further, instead of operating as Tullock's bidding competition, our model uses a logistic probability function for transition across income bands that is constrained by population stability of income bands and a particular ordering of asset utilities for consumers in income bands. The probability function used in the model is thus different from that in the Tullock contest - which has a unique probability function necessitated by its setting (Kooreman & Schoonbeek (1997)). Also, since the number of players is fixed in the long-term equilibrium due to the population stability condition, the issue of multiple players does not arise in our simultaneous formulation either. Finally, in contrast with the discussions of the short-term (symmetric) Nash equilibria for Tullock rent-seeking games with a discrete strategy(see Baye *et al.* (1994, 1996)), our focus is on the feasibility of transition probability functions under a long-term equilibrium.

It is worth highlighting that the conditions on the feasibility of transition probability also address the issue of dissipation - the total invested resources in the rent-seeking game being less than the total rents - an issue that is not considered in the original Tullock contest. More specifically, the original Tullock competition does not consider that the total rent would be lower than the total resources invested in rent-seeking (Lockard & Tullock (2001); Corcoran (1984); Hillman & Katz (1984)). A useful extension is offered by Michaels (1988) by considering an external agent who profits from selling input to the rent-seeking contest. Michaels (1988) thus address the issue of dissipation by setting the parameters of the Tullock contest so that the profit for the external agent in the setup is maximised - an issue that is addressed indirectly in our model through the long-term equilibrium conditions for the particular status promotion probability function. The cooperative solution used in the current chapter also relies on an external planner - similar to the external agent setup used by Michaels (1988).

The view of status as an economic goal that corresponds to a possible future monetary benefit to the consumer - rather than a non-monetary utility is unlike the view of status signaling used in many studies on conspicuous consumption (Heffetz (2011); Ireland (1994); Omori & Smith (2015); Charles *et al.* (2009); Kaus (2013); Khamis *et al.* (2012); Friehe & Mechtel (2014); Jaikumar & Sarin (2015); Knell (1999); Falk & Knell (2004)). More particularly, the visible consumption studies consider a utility from status consumption that is both necessarily futile and entirely separable from a private (non-visible) utility. Our specific consideration of status - an approach that equates the social goals of the consumer with her long-term economic goals - bears more similarity with the approach followed by Cole *et al.* (1992); Corneo & Jeanne (2001); Halter *et al.* (2014). As a result, the exposition of the effect of income inequality on assets accumulations and status investments in the current chapter differs significantly from Knell (1999); Falk & Knell (2004) who explain the effect of inequality on growth using a signaling-utility from status consumption for upward comparisons (i.e. comparisons with those with higher or same income as one's own reference income).

Unlike the utility from consumption in excess of a certain reference level of consumer needs, the current approach views status consumption as investments towards material gains that are selected to maximise the assets accumulated under a scheme of uncertain promotions and demotions. This view of status consumption as investments towards future economic goals in an unequal setting also takes into consideration the recent insights in the inequality and growth problem that have emphasised the role played by opportunities for the poorer sections in an economy (Aiyar & Ebeke (2020); Corneo & Jeanne (2001); Hopkins *et al.* (2004)).

As we detail in the next section, the optimal status consumption in the model entails a balance between i) the consumers in the higher income band who are favoured in the game due to higher income and ii) the poorer consumers who participate in the game only as long as there is some probability to improve their future wealth. To investigate the effect of inequality, we focus on how higher income differences may increase the investment towards status when there are two particular constraints for the game in the long term - namely the population constraint and a particular ordering of utilities from assets for the richer and poorer consumers.

3 Model

The goal of the proposed model is to explain how status consumption - viewed as investments towards maintaining long-term wealth - could change in response to income differences across disparate bands. The consumer's mere belonging to these bands implies a particular disposable incomes for the consumer i.e. a consumer obtains a certain disposable by merely being in a band. More formally, the consumers in band k obtain a disposable income y_k in any given period. The choice faced by the consumer faces is to either i) save for a gain the utility from assets while staying in her current income band or ii) spend a certain amount ν out of y_k while staying in the band k to participate in a status competition that may promote her to a higher income band in a certain probability depending on ν or demote her to a band $k-1$ with a certain probability $L_k(\nu)$. We assume no credit line towards ν so that a consumer in band k with expenditure towards statusν_k always has $\nu_k \leq y_k$.

Assuming that the income bands range from 1 to n in an economy so that $y_k < y_{k+1} \forall k \in [1, n-1]$, we associate a probability function $W_k(\nu)$ with the promotion of a consumer in band k to the next income band $k+1$ ($W_k(\nu)$ is not defined for the highest band n). The consumer could also be demoted to an immediate lower income band $k-1$ with a probability $L_k(\nu)$ (not defined for the lowest band 1). The consumer chooses ν from her disposable income y_k to maximise the expected utility from the future assets in the respective income bands she may be in the future. The incomes are distinguished based solely upon rewards of status competitions i.e. the differences in disposable income $y_{1\ldots n}$ that are provided in the respective income band (the disposable income excludes the cost of a consumer's needs and is the same for all consumers in a particular asset-band). We summarise the assumption as follows.

Assumption 1. *The incomes bands are characterised only by the levels of disposable incomes.*

Every consumer strives to achieve the highest assets in the economy. Since the disposable income y_k in every band can be used to accumulate towards assets under risk of loss or participate in tournaments of unobserved ability, the wealth differences among consumers in this economy arise only due to their performance in status competitions. The status competitions are meant to arise due to institutional arrangements that grant some mobility across income bands while not completely getting rid of the stratification that prevents more participation. In other words, the success in status competitions serves both as an evidence of ability and as a barrier to entry for those with less proven abilities. The ability pertinent to one's status may thus be innate, unobserved and responsible for success in the status competitions, but it is relevant only through probabilistic monetary success in the long-term and is revealed to the consumer only through status competitions.

The differences in income across bands makes the the competition biased in favour of the high spender, so that more expenditure towards status increases the probability of one's successes in the status competitions through the function $W_k(\nu)$ and decreases that of failure $L_k(\nu)$. The function $W_k(\nu)$ (and equivalently $L_k(\nu)$) is defined so that a consumer with a higher ν is rewarded more often and so that no amount of ν can ever provide guarantee to be in the next band ($W_k(\nu) \to 1$ for high ν for all k).

We also assume that the functions $W_k(\nu)$ and $L_k(\nu)$ have the same structure across income bands i.e. their dependence on ν varies only in parameters that vary across bands k.

Assumption 2. *The mechanism for the competitions are fundamentally the same across all bands.*

A lower band (e.g. a poorer underlcass in an economy or a poorer country in the global economy) may thus have a lower base-level expenditure towards status (e.g. mean) but the

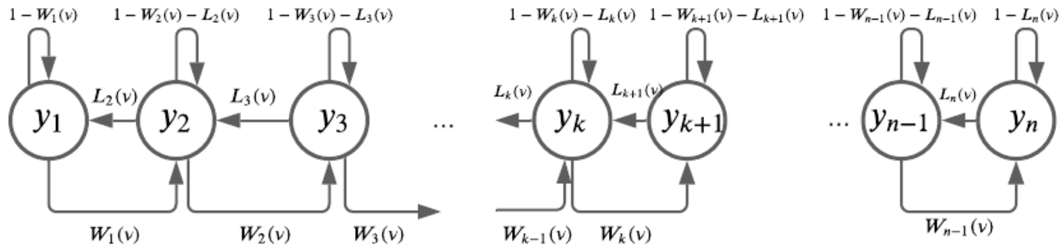

Figure 12: Markov Chain corresponding to n income bands

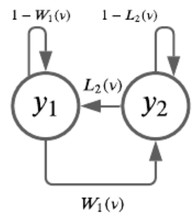

Figure 13: Chain implied by two income bands

outperformers in a poor environment are expected to improve their fortunes through the same mechanism that a consumer in a higher-income band would. This is a fundamental assumption for the status competitions in the model that determines the structure of $W_k(\nu)$ and $L_k(\nu)$.

It is worth emphasising again that the consumers of varying characteristics (age, skills, talent etc.) observe the same likelihood of promotion to the next band as long as they are in the band k i.e. $W_k(\nu)$ and $L_k(\nu)$ for band k offer exactly the same probability to all the consumers in the band k. Further, since the status competitions in a band $i-1$ to be promoted to band i are not open to any consumers in a band j that is lower than the band $i-1$, it follows that for a consumer to be in a band higher than the next she must go through the next band. A consumer in band i can reach to another band j only by going through bands $i+1, ..., j-1$. Consequently, a Markovian property is implied for the consumer's future utility from assets. In other words, status is the expected future utility at any point that the consumers maximise with the income received in their income band by either staying in the same band i or having moved to any of the bands different from their own. This scheme of transitions implied by this property in an economy of $1...n$ bands is shown in Figure 12.

As we have highlighted before, the only goal of the consumer is to maximise her final assets and that the disposable income differences don't directly influence her choice except through status investments ν - which in turn determines the future expected value of assets.

3.1 Finite-horizon equilibrium

The above set up for status competitions implies a short-term equilibrium as consumers maximise the total accumulated assets in their band-reference within a given (finite) period of time. While the assets to be maximised are may be at risk of loss in the long-term, the short-term optimisation must be unaware of the assets being lost in the short-term finite horizon. For the discussion of the short-term equilibrium, therefore, we use an economy of two bands represented in Figure 13. Without loss of generality, we consider the equilibrium when the consumers in the economy comprising of a poor band 1 and a rich band 2 maximise the assets accumulated in a single (finite) period.

Notice first that the consumer in the two-band economy can either be demoted or promoted over time and her expected future wealth would be the expected sum of incomes from the future bands she can be in over the finite time-horizon. In the Markov chain implied in Figure 13, the future state of the consumer is thus based on either of the future bands she could be in with the respective probabilities associated with the transition i.e. the consumer in band 1 could expect to have either y_1 or y_2 income in the next period with probabilities $1 - W_1(\nu)$ and $W_1(\nu)$ respectively. In the period after next, she could be in y_1 or y_2 as $y_1 \to y_1 \to y_1$, $y_1 \to y_2 \to y_1$, $y_1 \to y_1 \to y_2$, $y_1 \to y_2 \to y_2$ and end up as $y_1 \to y_1 \to y_2 \to y_1$, $y_1 \to y_2 \to y_1 \to y_1$ and so on in further periods. Similarly, the consumer in band 2 could be in band 1 or 2 in the next period with the respective probabilities $L_2(\nu)$ and $1 - L_2(\nu)$ and so on.

Considering the optimisation of expected utility over a (finite) two-periods, the representative consumer in the two-bands economy has - as it were - just one life and the one-shot-investment for her life-time status as she maximises the utility from assets under no risk. The probability functions associated with the promotion and demotion $W(\nu)$ and $L(\nu)$ respectively are shown in Figure 13. In the short-term finite horizon equilibrium, the representative consumer must maximise the assets at the end of the first-time horizon. It being a finite time-horizon, the consumer is not expected to spend on expenditure towards status at the end of her life. Thus, as is common in the applications of the life-cycle model (see Deaton & Muellbauer (1980b)), the finite-time horizon optimisation means that the consumer isn't concerned with the life after the time-horizon. In other words, the short-term equilibrium requires that the consumer does not worry about her poorer or richer future state expect for the final assets at the end of time finite time-horizon. We thus set the expenditure towards status ν in the last period as zero for all the consumers regardless of the value of assets they have amassed.

Let's denote the expenditure towards status competitions in the period t in band k as ${}^t\nu_k$. Considering the one-period horizon, the consumer in band 1 must choose ${}^1\nu_1$ to maximise her expected utility in bands 2 and 1. As the values $\begin{pmatrix} {}^2\nu_1 & {}^2\nu_2 \end{pmatrix} = \begin{pmatrix} 0 & 0 \end{pmatrix}$ are known for both the consumers, the consumer in band 1 with a starting wealth A would select ${}^1\nu_1$ so that her expected utility in the next period is the following

$$W(^1\nu_1)\, u(A + y_1 - {}^1\nu_1 + y_2) + (1 - W(^1\nu_1))u(A + y_1 - {}^1\nu_1 + y_1) \tag{17}$$

The first term in Equation 17 includes the consumer's expected accumulation if she reaches the band 2 while the second term considers the accumulation if she remains in the band 1. The first-order conditions for above optimisation would have ${}^1\nu_1$ as the only unknown so that with a known $W_1(0)$ an initial value linear differential equation would follow.

To consider the properties of the short-term equilibrium in the above set up, we use the following concave utility from assets Λ for the consumer with Γ as a constant

$$u(\Lambda) = \Gamma\Lambda^{\alpha}, 0 < \alpha < 1 \tag{18}$$

Notice that the Equation 18 considers the total assets acquired by the consumer rather than the new income received in the successive period. Assuming the consumers use a risk-neutral expected utility (EUT), Equation 18 implies the following expected utility maximised by the band 1 consumer (see Equation 17)

$$W(^1\nu_1)\, \Gamma \cdot (A + y_1 - {}^1\nu_1 + y_2)^{\alpha} + (1 - W(^1\nu_1))\Gamma \cdot (A + y_1 - {}^1\nu_1 + y_1)^{\alpha}$$

Representing $M_1 \equiv A + y_1 + y_1$and $M_2 \equiv A + y_1 + y_2$, the solution for optimisation of the above expected utility (see Appendix) is the following

$$W(\nu_1) = \frac{W(0)({M_2}^{\alpha} - {M_1}^{\alpha})}{(M_2 - \nu_1)^{\alpha} - (M_1 - \nu_1)^{\alpha}} + \frac{{M_1}^{\alpha} - (M_1 - \nu_1)^{\alpha}}{(M_2 - \nu_1)^{\alpha} - (M_1 - \nu_1)^{\alpha}} \tag{19}$$

The singularity is avoided in the above solution as long as the condition $(M_2 - \nu)^{\alpha} - (M_1 - \nu)^{\alpha} \to 0$ is not true. In other words, the status competition in the short-term falls apart when $W(\nu)$ is too high for there to be a ν selected by the consumer i.e. if a negligible ν is enough to promote a poorer consumer to the richer band. As a probability function, $W(\nu)$ is a bounded (i.e. $W(\nu) \in [0, 1]$), non-decreasing and a convex function while the right hand side of Equation 19 is an increasing function - implying that there would always be a unique solution to the Equation 19 (for given initial conditions e.g.$W(0)$,$L(0)$).

An equivalent solution is implied for the consumer in band 2. Considering the utility corresponding to the Equation 17 the consumer in band 2 would maximise the following utility.

$$(1 - L_2(^1\nu_2))\, u_2(A + y_1 - {}^1\nu_2 + y_2) + L_2(^1\nu_2) u_1(A + y_1 - {}^1\nu_2 + y_1) \tag{20}$$

Using the same notation as above, the utility can be rewritten as

$$(1 - L(\nu))(M_2 - \nu)^\alpha + L(\nu)(M_1 - \nu)^\alpha$$

The first order conditions for the above function lead to the following equation

$$L'(\nu) = L(\nu)\alpha \frac{(M_1 - \nu)^{\alpha-1} - (M_2 - \nu)^{\alpha-1}}{(M_1 - \nu)^\alpha - (M_2 - \nu)^\alpha} + \frac{\alpha(M_2 - \nu)^{\alpha-1}}{(M_1 - \nu)^\alpha - (M_2 - \nu)^\alpha}$$

The solution for the above equation is

$$L(\nu_2) = \frac{L(0)({M_2}^\alpha - {M_1}^\alpha)}{(M_2 - \nu_2)^\alpha - (M_1 - \nu_2)^\alpha} + \frac{M_2^\alpha - (M_2 - \nu_2)^\alpha}{(M_2 - \nu_2)^\alpha - (M_1 - \nu_2)^\alpha} \tag{21}$$

Looking at the comparative statics of the above solution, increasing the disposable income y_1 decreases the required ν_1 by pushing the right-hand-side (RHS) of the solution equation 19 upwards. The status pressures seem to be relieved as income gap narrows. Increasing y_2 moves the RHS of Equation 19 down and requires a higher amount ν to have a matching $W(\nu)$. The status competitions seem to intensify as the income gap grows. As suppressing y_1 and increasing y_2 both increase expenditure towards status in the model, the argument that lower relative incomes may give the consumers more incentives to improve their well-being may still hold but only as long as the status competitions are feasible. Equivalently for $L_2(\nu)$, increasing y_1 implies less ν_2 required in the short-term equilibrium for security of staying in the band (i.e. consumers in band 2 care less about losing their band) and increasing y_2 shifts $L(\nu_2)$ down and requires more ν_2 to be put up by consumers for them to preserve their band identity. Once again, the narrowing of income bands decreases expenditure towards status - as if closer incomes gaps were to cause less "insecurity".

With the starting wealth A, we see that increasing A lowers the required ν for $W(\nu)$ while decreasing A would raise the required ν. With $L(\nu)$, higher starting assets A move the RHS of the solution in Equation 21 up and lower the required ν . Similarly, low A requires higher ν for $L(\nu)$. With higher assets to start with, the consumers are expected to be less worried about asset loss.

As such the short-term finite horizon equilibrium expects that narrowing income differences would decrease the expenditure towards status . However there is a serious limitation to our interpretations from the short-term equilibrium due the assumption of

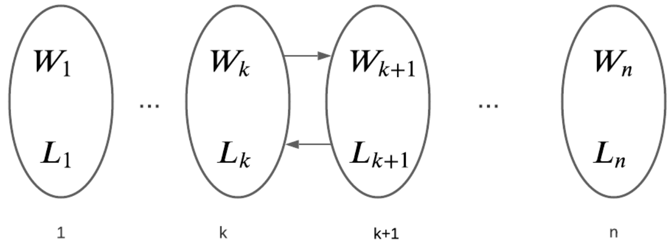

Figure 14: Winners and losers in a status competition exchange

exogenous $W(\nu), L(\nu)$ in the above model. A change $\Delta \equiv y_2 - y_1$ (across the section or over time) in the long-term would evidently change the status competitions themselves, so that a new set of $W_k^{T'}(\nu)$ and $L_{k+1}^{T'}(\nu)$ at time T' may replace the old $W_k^{T}(\nu)$ and $L_{k+1}^{T}(\nu)$ at time T. The above specification of a short-term equilibrium does not consider how $W(\nu)$ and $L(\nu)$ may themselves also change as Δ changes. For us to derive conclusions for the long-term equilibrium, we consider long-term stability of asset differences so as to infer the dependence of $W(\nu)$ and $L(\nu)$ on income differences in the next subsection.

3.2 Long-term equilibrium

For the purposes of our discussion on long-term conditions, we continue to use the simplified chain with only two income bands which the consumers can transition in between. The simplification - shown in Figure 13 - could be extended to higher bands (see Figure 12) for empirical assessments but does not change the core of our arguments. The fundamental condition for long-term stability that we impose is that of the stability of income band populations. More specifically, the number of consumers who leave an income band in the long-run must be balanced by those entering the income band in the long-term. The essential claim that is inherent is that the consumers expectations are rational and are not detached from the population constraint. An equilibrium with long-term income inequalities thus cannot exist if not for such a population preserving status competition.

The long-term status competitions with a population preserving mechanism - are equivalent to a scheme where an equal number of consumers are selected in successive bands and swapped with each other at a certain cost (see Figure 14). With such a swapping mechanism, if $W_k(\nu)$ represents the probability of a consumer moving from band k to $k+1$ (not defined for $k = n$ in an economy of n bands) and $L_{k+1}(\nu)$ represents the consumer transition from band $k+1$ to k (not defined for $k = 1$ i.e. the lowest band), then the population constrain means the following

$$W_k(\nu) = L_{k+1}(\nu) \tag{22}$$

It is worth emphasising that the long-term income inequalities without any redistribution (or a status competition defined as above) cannot provide a stable long-term equilibrium for asset values. More specifically, if we rule out any institutions of direct redistribution of income, the accumulations $A_i = \sum_t^T {}^t y_i$ - where ${}^t y_i$ represents the disposable income for the band i in period t (${}^t y_i = y_i \forall t$) - would lead to divergent differences in accumulated wealth - unless there is a risk of loss associated with the accumulation of wealth so that accumulations remain bounded. While it may seem plausible that an equilibrium of assets under no risk but with different disposable incomes may arrive as long as the consumers can move across bands often enough through status competitions, it can be shown that no redistribution or status competition can allow for a long-term equilibrium of asset values in the above economy with unequal incomes (see Appendix II). Another way to say this is that status competitions under no risk of loss to assets can never be "random enough" for a long-term equilibrium - since the redistribution implied through the random swap (i.e. transition in the long-term where assets are carried over with the consumer) cannot lead to a steady state. The only exception to this rule is when there are no net gains at from expenditure towards status at all for either of the consumers i.e. status consumption is completely futile for asset gain purposes. When assets accumulated are under risk (for both rich and poor consumers), however, a stable steady state is easily achieved.

For details of the long-term equilibrium, we make another assumption stating that the functions $W(\nu), L(\nu)$ - which the consumer considers for accumulation - must change exactly at the horizon considered for loss of accumulated assets.

Assumption 3. *The $W(\nu)$ and $L(\nu)$ relevant for consumer decisions change only at the end of the time-period at which the loss of assets is considered.*

The above assumption allows us to consider an independent stochastic variable N_t that drives a complete loss of asset accumulations with a certain probability for both the consumers. In other words, $N_t = 1$ resets the ${}^t A_1$ and ${}^t A_2$ with a probability known to both the consumers so that $W(\nu), L(\nu)$ remain the same until t due to above assumption

$$
{}^{t+1}A_1 = \begin{cases} {}^t A_1 & N_t = 0 \\ 0 & N_t = 1 \end{cases}
$$

$$
{}^{t+1}A_2 = \begin{cases} {}^t A_2 & N_t = 0 \\ 0 & N_t = 1 \end{cases}
$$

Assuming that $N_t = 1$ occurs infrequently after an expected time period T and defining ${}^t I_1, {}^t I_2$ as disposable income from the period t for consumers in the bands 1 and 2 respectively, the long-term asset accumulations for the consumer would tend to the following finite values

$$A_1^* \rightarrow \frac{1}{T}\sum_{t=1}^{t=T} {}^{t}I_1$$
$$A_2^* \rightarrow \frac{1}{T}\sum_{t=1}^{t=T} {}^{t}I_2 \tag{23}$$

N_t being observed by both the consumers independently implies that the above set up also allows us to ignore the role of starting assets consider $A_1 = A_2 = 0$ for both the consumers in the long-term. The consumer accumulations are expected to be reset at a time $t = T$ and the consumer thus minimises her accumulation at the time T. However, given that assets are to be maximised in the longer-term, the consumer must also strike a balance between i) taking a fair chance to be in the richer band and ii) accumulating as high assets as possible towards the expected reset-frequency T. In the long-term - over which the population constraint on $W(\nu)$ and $L(\nu)$ is maintained (see Assumption 3) - the consumers thus select the same investment values $\bar{\nu}_1$ (for the poorer consumer) and $\bar{\nu}_2$ (for the richer consumer) in every period and maximise their utility from the sum of incomes in Equation 23 over the period T.

Considering a particular instance similar to the one used in Section 3.1 (with $T = 2$), the consumer has one period to choose how much to accumulate and the last period to participate in the status game alone and start over with no assets. Notice also that due to Assumption 3, $W(\nu)$ and $L(\nu)$ do not change in this period. Acting as a long-standing dynasty, the consumers in such a long-term equilibrium consider both the short-term horizon in which they would become richer through accumulation and the band transition over the long-term for them to start over with. The long-term band 1 consumer would thus choose $\bar{\nu}_1$ so that her utility from asset accumulation across both $t = 1$ and $t = 2$ is maximised. The choice for the consumers in band 1 and 2 in the long-term is shown in Figures 15 and 16 respectively. As the consumers expect their assets to disappear at time $T = 2$, the consumer in band 1 has the following expected assets in the period before last as her assets reset in the last period

$$E_1(\bar{\nu}_1) = W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1$$

Similarly, the consumer in band 2 has the following expected assets at time before the last period as her assets reset in the last period

$$E_2(\bar{\nu}_2) = (1 - L(\bar{\nu}_2))y_2 + L(\bar{\nu}_2)y_1$$

Assuming that the consumers consider only the assets before removing $\bar{\nu}_1$ or $\bar{\nu}_2$ from y_1 or y_2 respectively after the reset, the long-term equilibrium implies that the consumer 1 and

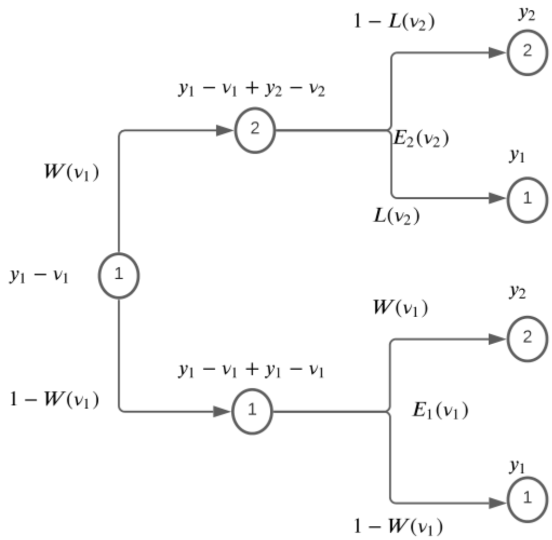

Figure 15: Two period choice for consumer 1

2 have the same expected asset value from being in band 1 or band 2 after the reset. In other words, the consumer 1 and consumer 2 would replicate each other's behaviour when they swap places with each other in the status game. Thus at $t = 1$, the consumer in band 1 would maximise the utility from the total assets over the two periods

$$u_1(\bar{\nu}_1, \bar{\nu}_2) \equiv W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) + (1 - W(\bar{\nu}_1))u(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) \tag{24}$$

On the other hand, the consumer in band 2 would maximise the following expected utility from total assets over the two periods

$$u_2(\bar{\nu}_1, \bar{\nu}_2) = L(\bar{\nu}_2)u(y_2 - \bar{\nu}_2 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) + (1 - L(\bar{\nu}_2))u(y_2 - \bar{\nu}_2 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) \tag{25}$$

The key difference from the finite-horizon short-term equilibrium is that the expected utilities depend both on $\bar{\nu}_1$, $\bar{\nu}_2$ for the consumers. As they choose $\bar{\nu}_1$, $\bar{\nu}_2$ only once, a high $\bar{\nu}_1$, $\bar{\nu}_2$ means hope for a favourable transition while choosing a low $\bar{\nu}_1$, $\bar{\nu}_2$ means relying on accumulation. While the above could be generalised for a general T, we continue to look at the implications for the optimal choice in the long-term in more detail with the above two-period set up.

The above long-term conditions imply that a higher $\bar{\nu}_1$ makes the loss to a lower band more acceptable for the consumer in band 2. A peer effect kicks in some sense - due to the

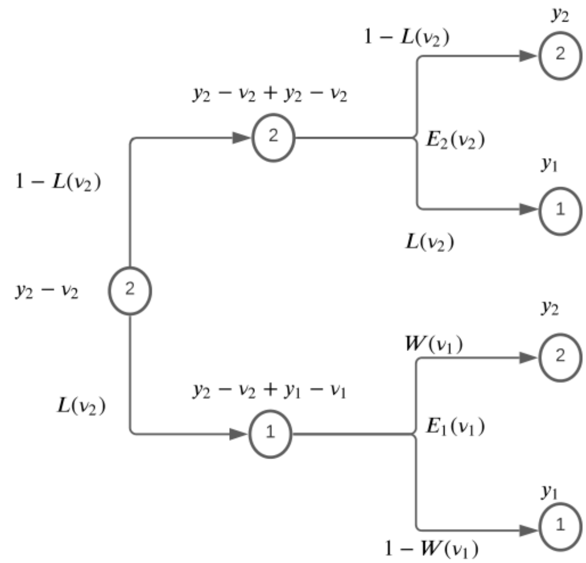

Figure 16: Two period choice for consumer 2

fact that the richer consumer absorbs (replicates) the choice made by poorer consumers as she is demoted to band 1 and thus the choice of the poorer band is also factored into her choice in the starting period. Similarly, a higher $\bar{\nu}_2$ might make staying in the poorer band more appealing for the consumer 1.

If the total assets acquired by the consumer may be considered the only notion of welfare in the economy, the above model also allows us to evaluate if the consumers are better off in the long-term with assets they accumulate with the choice of long-term $\bar{\nu}_1$ and $\bar{\nu}_2$. More specifically, if $\bar{\nu}_1$,$\bar{\nu}_2$ are selected by maximising a certain utility, the expected assets over the two periods for consumer 1 and 2 are simply

$$E(A_1) =W(\bar{\nu}_1)(y_1 - \bar{\nu}_1 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) + (1 - W(\bar{\nu}_1))(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1))$$

$$E(A_2) =L(\bar{\nu}_2)(y_2 - \bar{\nu}_2 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) + (1 - L(\bar{\nu}_2))(y_2 - \bar{\nu}_2 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2))$$

To recap, since A_T is always bounded for any general $T(\geq 2)$, a maximal $\bar{\nu}_1$ or $\bar{\nu}_2$ can always be selected (by consumers 1 and 2 respectively).

3.2.1 Population stability condition

The condition of population stability (see Equation 22) constraints the selection of $\bar{\nu}_1$ and $\bar{\nu}_2$ that is allowed in the short-term. More specifically, the conditions implies the following in a two-band economy,

$$W_1(\bar{\nu}_1) = L_2(\bar{\nu}_2)$$

The above relation between the selection $\bar{\nu}_1$ and $\bar{\nu}_2$ made by the consumer in the long-term (for the two-band economy) helps us define the functions $\phi(\cdot), \psi(\cdot)$ so that $\bar{\nu}_1 = \psi(\bar{\nu}_2) = W^{-1}(L(\bar{\nu}_2))$ and $\bar{\nu}_2 = \phi(\bar{\nu}_1) = L^{-1}(W(\bar{\nu}_1))$. This also means that the utilities u_1 and u_2 maximised by the consumer can be written in term of either $\bar{\nu}_1$ or $\bar{\nu}_2$. This is akin to the consumer 1 (or consumer 2) optimising her utility u_1 (or u_2) subject to the constraint $\bar{\nu}_2 = \phi(\bar{\nu}_1)$.

$$\begin{gathered}
u_1 \equiv u_1(\bar{\nu}_1, \bar{\nu}_2) = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) \\
+(1 - W(\bar{\nu}_1))u(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) \\
\Rightarrow u_1 = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \phi(\bar{\nu}_1) + W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2) \\
+(1 - W(\bar{\nu}_1))u(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1)
\end{gathered}$$

With $\bar{\nu}_1 = \psi(\bar{\nu}_2)$, the consumer 2 solves the equivalent problem,

$$\begin{gathered}
u_2 \equiv u_2(\bar{\nu}_1, \bar{\nu}_2) = L(\bar{\nu}_2)u(y_2 - \bar{\nu}_2 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) \\
+(1 - L(\bar{\nu}_2))u(y_2 - \bar{\nu}_2 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) \\
\Rightarrow u_2 = L(\bar{\nu}_2)u(y_2 - \bar{\nu}_2 + y_1 - \psi(\bar{\nu}_2) + (1 - L(\bar{\nu}_2))y_1 + L(\bar{\nu}_2)y_2) \\
+(1 - L(\bar{\nu}_2))u(y_2 - \bar{\nu}_2 + y_2 - \bar{\nu}_2 + (1 - L(\bar{\nu}_2))y_2 + L(\bar{\nu}_2)y_1)
\end{gathered}$$

Notice that as long as $\phi(\nu)$ and $\psi(\nu)$ are differentiable, the population condition ensures that $\frac{\partial u_2}{\partial \bar{\nu}_1} = \frac{\partial u_2}{\partial \bar{\nu}_2} = 0$ ($\because \frac{\partial u_2}{\partial \bar{\nu}_2} = 0 \Rightarrow \frac{\partial u_2}{\partial \bar{\nu}_1} = \frac{\partial u_2}{\partial \bar{\nu}_2}\frac{\partial \phi}{\partial \bar{\nu}_1} = 0$). For consumer 1, the first-order condition is

$$\frac{\partial u_1}{\partial \bar{\nu}_1} = \frac{\partial F_1}{\partial \bar{\nu}_1} + \frac{\partial F_2}{\partial \bar{\nu}_1} = 0$$

where

$$\begin{gathered}
F_1 = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \phi(\bar{\nu}_1) + W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2) \\
F_2 = (1 - W(\bar{\nu}_1))u(2y_1 - 2\bar{\nu}_1 + W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1)
\end{gathered}$$

$$\frac{\partial F_1}{\partial \bar{\nu}_1} = W'(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \phi(\bar{\nu}_1) + W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2) - W(\bar{\nu}_1)(1 + \phi'(\bar{\nu}_1) + W'(\bar{\nu}_1)y_2$$
$$- W'(\bar{\nu}_1)y_1)u'(y_1 - \bar{\nu}_1 + y_2 - \phi(\bar{\nu}_1) + W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2)$$

$$\frac{\partial F_2}{\partial \bar{\nu}_1} = (-W'(\bar{\nu}_1))u(2y_1 - 2\bar{\nu}_1 + W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1)$$
$$+ (1 - W(\bar{\nu}_1))(-2 + y_2W'(\bar{\nu}_1) - y_1W'(\bar{\nu}_1))u'(2y_1 - 2\bar{\nu}_1 + W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1)$$

While it is possible to proceed with the techniques used in Section 3.1 using a particular form of $\phi(.)$, we focus on specific forms of $W(\nu), L(\nu)$ for our further discussion. Instead of suggesting a functional form of $\phi(\nu)$ (or equivalently $\psi(\nu)$), we explore the characteristics of status competitions implied by the properties of particular forms of $W(\nu)$ and $L(\nu)$. These particular forms - along the utility $u(\Lambda) = \Gamma \times \Lambda^{\alpha}$ (Γ, α being constants while Λ is the asset accumulated) that we have used before - are used in essence to examine the risks shared between the bands as the income difference increases or decreases in a long-term equilibrium.

3.3 Particular mobility functions

The selection of $W(\nu)$ and $L(\nu)$ rests upon two properties that we have briefly discussed. First, the status competitions can never guarantee a reward to the next band i.e.$\nexists \nu$ such that $W(\nu) = 1$. Second, that any consumer with a higher ν should be rewarded with a higher probability than a consumer with a lower ν i.e. $\forall \nu_1 > \nu_2$ we have $W(\nu_1) > W(\nu_2)$ and equivalently $L(\nu_1) < L(\nu_2)$ with $\forall \nu_1 > \nu_2$.

With these specifications, we assume a logistic form for $W(\nu_1)$ as a general formulation

$$W(\nu) = \frac{1}{1 + e^{-\omega(\nu - \underline{\omega})}} \tag{26}$$

The above specification only considers $W(\nu)$ where $\frac{\partial W}{\partial \nu}$ is symmetrical around $\underline{\omega}$ i.e. the probability to rise to the next band rises and drops at the same rate around $\underline{\omega}$. The same applies to the equivalent definition for $L(\nu)$. When considering the population stability in band, the above specification translates into a simple linear relationship between the parameters that we discuss below. While a $\frac{\partial W}{\partial \nu}$ that is asymmetrical around $\underline{\omega}$ may provide a more general specification of $W(\nu)$ and $L(\nu)$, the results that we derive from the specification are independent of whether $\frac{\partial W}{\partial \nu}$ is symmetrical around $\underline{\omega}$ around or not.

There are certain implications of the parameters for the nature of status competitions. First, the parameter ω determines how sharp the probability of promotion $W(\nu)$ would rise with ν. The plots of $W(\nu)$ defined in Equation 26 are shown in Figure 17. The parameter $\underline{\omega}$, on the other hand, represents whether a significant rise in probability occurs for a high ν (corresponding to a high $\underline{\omega}$) or relatively low ν (corresponding to a low $\underline{\omega}$). Roughly speaking, with $W(\nu)$ being the upward mobility in the two-consumer economy, ω is the degree of separation in bands imposed by the spending on ν. A high ω differentiates the outcome of those having low ν from those having higher ν more clearly. The parameter $\underline{\omega}$- on the other hand - is the minimum ν for there to be a probability of transition to the next income band. It thus represents the level of ν at which status competitions become significant in the economy. We focus on the $\underline{\omega}$ implied by long-term equilibria - since a high $\underline{\omega}$ means a higher ν required for mobility and a low $\underline{\omega}$ means low mobility. The plots for varying $\underline{\omega}$ are shown in Figure 18.

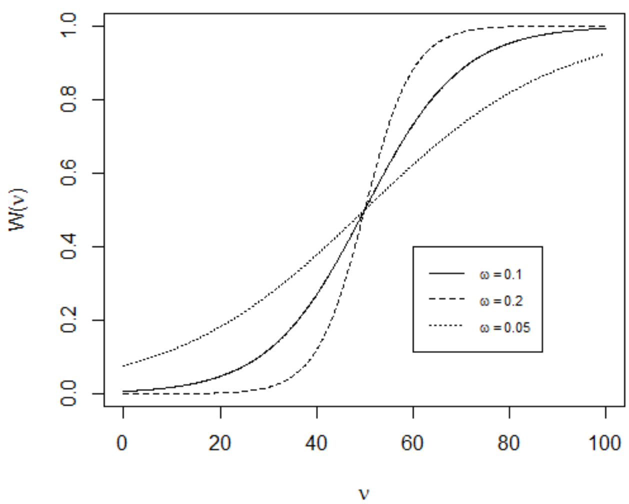

Figure 17: $W(\nu)$ parameter ω

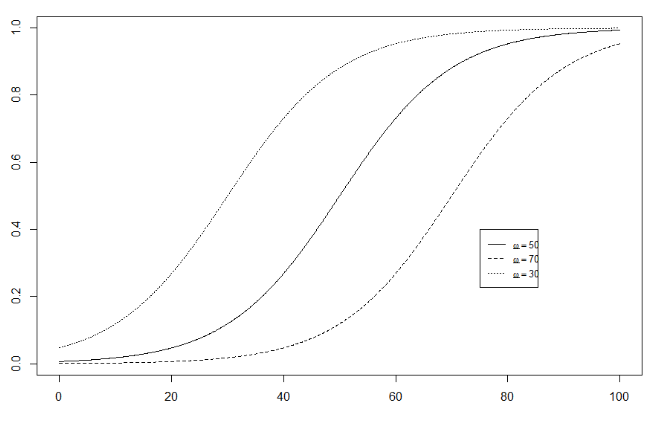

Figure 18: $W(\nu)$ parameter $\underline{\omega}$

Just as $W(\nu)$ represents the upward mobility, $1 - L(\nu)$ represents the security associated with the higher income band. The form of $L(\nu_2)$ with parameters λ, $\underline{\lambda}$ is as follows

$$L(\nu) = 1 - \frac{1}{1 + e^{-\lambda(\nu - \underline{\lambda})}} \tag{27}$$

Similar to the parameters ω and $\underline{\omega}$, the parameter λ separates winners and losers through $L(\nu)$ (see plots in Figure 19) and the level of ν where competitions become significant is driven by the parameter $\underline{\lambda}$ (see Plots in Figure 20). We use the constraints on this parameter to explain how status investments may rise or fall for a fixed set of λ and ω.

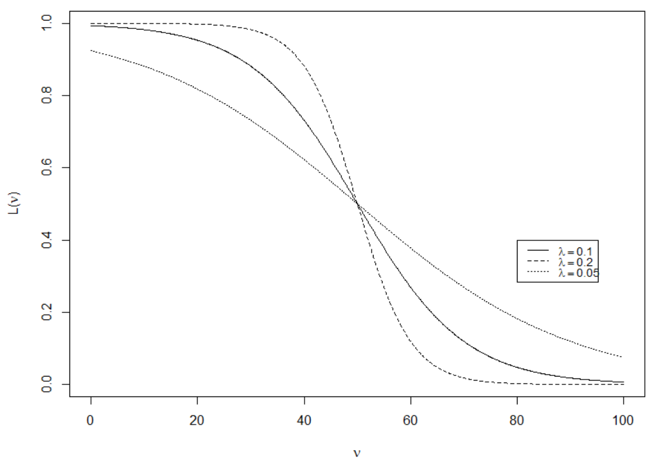

Figure 19: $L(\nu)$ parameter λ

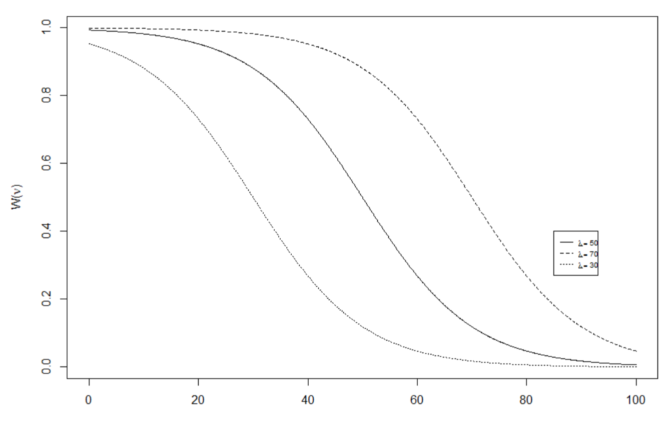

Figure 20: $L(\nu)$ parameter $\underline{\lambda}$

Notice that the optimisation of utility with the other consumer's choice fixed (i.e. optimisation of utility by choosing$\bar{\nu}_1$ for consumer 1 when $\bar{\nu}_2'$ is fixed or the optimisation of utility by choosing$\bar{\nu}_2$ by consumer 2 when $\bar{\nu}_1'$ is fixed) is not very different from the the optimisation in short-term. Given the particular forms of $W(\nu)$ and $L(\nu)$ in Equations 26 and 27 and a utility function $u(\Lambda)$ for assets Λ (in a particular time period), the Equations 24 and 25 can be rewritten so that the consumer 1 chooses a $\bar{\nu}_1$ to maximise the following utility for a $\bar{\nu}_2'$ chosen by consumer 2

$$u_1(\bar{\nu}_1, \bar{\nu}_2') = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \bar{\nu}_2' + E_2(\bar{\nu}_2')) + (1 - W(\bar{\nu}_1))u(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1))$$

Choosing $u(\Lambda) = \Gamma \cdot \Lambda^{\alpha}$(where α is a constant), the above can be written as

$$u_1(\bar{\nu}_1, \bar{\nu}_2') = \frac{\Gamma(y_1 + y_2 - \bar{\nu}_1 + E_2(\bar{\nu}_2') - \bar{\nu}_2')^{\alpha}}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} + \frac{\Gamma(2y_1 - 2\bar{\nu}_1 + E_1(\bar{\nu}_1))^{\alpha}}{1 + e^{\omega(\bar{\nu}_1 - \underline{\omega})}}$$

Similarly, the consumer 2 chooses $\bar{\nu}_2$ to maximise the following utility for a given $\bar{\nu}_1'$ chosen by consumer 1

$$u_2(\bar{\nu}_1', \bar{\nu}_2) = \frac{\Gamma(y_2 - \bar{\nu}_2 + y_1 - \bar{\nu}_1' + E_1(\bar{\nu}_1'))^{\alpha}}{1 + e^{\lambda(\bar{\nu}_2 - \underline{\lambda})}} + \frac{\Gamma(y_2 - \bar{\nu}_2 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2))^{\alpha}}{1 + e^{-\lambda(\bar{\nu}_2 - \underline{\lambda})}}$$

Defining $k_1 \equiv E_1(\bar{\nu}_1^*) - \bar{\nu}_1^*$ and $k_2 \equiv E_2(\bar{\nu}_2^*) - \bar{\nu}_2^*$ as the deviation from the expected of income from band-promotion (or demotion), we can also write

$$u_1(\bar{\nu}_1) = \frac{\Gamma(y_1 + y_2 - \bar{\nu}_1 + k_2)^{\alpha}}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} + \frac{\Gamma(2y_1 - 2\bar{\nu}_1 + E_1(\bar{\nu}_1))^{\alpha}}{1 + e^{\omega(\bar{\nu}_1 - \underline{\omega})}}$$

$$u_2(\bar{\nu}_2) = \frac{\Gamma(y_1 + y_2 - \bar{\nu}_2 + k_1)^{\alpha}}{1 + e^{\lambda(\bar{\nu}_2 - \underline{\lambda})}} + \frac{\Gamma(2y_2 - 2\bar{\nu}_2 + E_2(\bar{\nu}_2))^{\alpha}}{1 + e^{-\lambda(\bar{\nu}_2 - \underline{\lambda})}}$$

The functions $E_1(\bar{\nu}_1)$ and $E_2(\bar{\nu}_2)$ used above are set as follows using the specific forms of $u(\Lambda)$, $W(\nu)$ and $L(\nu)$. The selection of $\bar{\nu}_1$ by the consumer 1 based on ω, $\underline{\omega}$ is evidently symmetric to the selection of $\bar{\nu}_2$ based on λ, $\underline{\lambda}$ by the consumer 2.

$$\begin{aligned} E_1(\bar{\nu}_1) &= W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1 \\ &= \frac{y_2}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} + \frac{y_1}{1 + e^{\omega(\bar{\nu}_1 - \underline{\omega})}} \end{aligned}$$

$$\begin{aligned} E_2(\bar{\nu}_2) &= (1 - L(\bar{\nu}_2))y_2 + L(\bar{\nu}_2)y_1 \\ &= \frac{y_2}{1 + e^{-\lambda(\bar{\nu}_2 - \underline{\lambda})}} + \frac{y_1}{1 + e^{\lambda(\bar{\nu}_2 - \underline{\lambda})}} \end{aligned}$$

While an explicit solution of the first-order conditions for the above may be less trivial, it is easy to show numerically that higher income differences $y_2 - y_1$ increase both $\bar{\nu}_1$ and $\bar{\nu}_2$. Also, an increase in k_1 (i.e. less $E_1(\bar{\nu}_1^*) - \bar{\nu}_1^*$) decreases $\bar{\nu}_2$ while increasing k_2 (i.e. less $E_2(\bar{\nu}_2^*) - \bar{\nu}_2^*$) decreases $\bar{\nu}_1$.

As we now show, the increases in $\bar{\nu}_1$ and $\bar{\nu}_2$ are balanced by long-term consequences of population stability conditions. Such a long-term solution which accommodates the population stability can be assumed to imply a planner that directs the various selections $\{\bar{\nu}_1, \bar{\nu}_2\}$ implied by the above optimisation of above utilities. In other words, a combined utility $\mathscr{U}$ for both the consumers can be assumed to be maximised while the population stability conditions are implied. To explore a detailed numerical solution of the equilibrium, we therefore focus on a cooperative solution using a combined utility $\mathscr{U}$ for both the consumers.

The cooperative approach that we explain the effect of income differences $\Delta = y_2 - y_1$ with imposes two constraints on the set of parameters ω, $\underline{\omega}$, λ, $\underline{\lambda}$. First is the population stability condition with the specific forms of $W(\nu)$ and $L(\nu)$. More specifically, the population constraint $W(\nu_1^*) = L(\nu_2^*)$ implies a relationship between $\bar{\nu}_1$ and $\bar{\nu}_2$ as follows[34]

$$\omega(\bar{\nu}_1 - \underline{\omega}) + \lambda(\bar{\nu}_2 - \underline{\lambda}) = 0 \tag{28}$$

The second constraint is through a combined utility for the rich and poor consumers in the economy that we detail in Section 3.3.1. Since we have limited our attention to the growing economies where status competitions determine promotion more sharply than demotion, we focus only on cases where $\omega > \lambda$ ($\kappa > 1$) and assume that ω as well as λ are fixed for the rest of our discussion. With fixed ω and λ, the cooperative solution with the population stability constraint and the maximal combined utility is used to eliminate $\underline{\omega}$ and $\underline{\lambda}$. Before we detail this cooperative equilibrium, consider however the relationship between $\bar{\nu}_1$ and $\bar{\nu}_2$ which the population stability alone indicates.

Setting $\kappa \equiv \frac{\omega}{\lambda}$, we have $(\bar{\nu}_1 - \underline{\omega}) = -\kappa(\bar{\nu}_2 - \underline{\lambda})$ so that consumers must balance $\bar{\nu}_1$ and $\bar{\nu}_2$ on either side of $\underline{\omega}$ and $\underline{\lambda}$. Another way to interpret $\nu_1^* = \underline{\omega} - \kappa(\nu_2^* - \underline{\lambda})$ is that the poorer consumer's long-term expenditure towards status rises with the level at which upward transition becomes significant and falls with richer consumer's excessive spending. It is worth noting that the population stability condition is independent of any consumer utilities that the consumers use to make choices for $\bar{\nu}_1$ and $\bar{\nu}_2$ or whether one views the cooperative or Nash equilibrium as solutions.

The level at which upward transition becomes significant raises poor consumer's expenditure towards status is less surprising. What's more interesting is the withdrawal of the poorer consumer from the status competition due to a higher status investment by the richer consumer. The population constraint - under the assumption $\kappa > 1$ - readily provides

[34] $\frac{1}{1+e^{-\omega(\nu-\underline{\omega})}} + \frac{1}{1+e^{-\lambda(\nu-\underline{\lambda})}} = 1 \Rightarrow (1 + e^{-\omega(\nu-\underline{\omega})})(1 + e^{-\lambda(\nu-\underline{\lambda})}) = 1 + e^{-\omega(\nu-\underline{\omega})} + 1 + e^{-\lambda(\nu-\underline{\lambda})}$

the condition of withdrawal from status competitions for either of the consumers in the economy. More particularly, there would be no benefits to the consumer from expenditure towards status when either $\overline{\nu}_1 \to 0$ or $\overline{\nu}_2 \to 0$ is implied in the long-term. Since $\overline{\nu}_1$ and $\overline{\nu}_2$ are known in terms of $\underline{\lambda}$,$\underline{\omega}$ (ω,λ are already known and fixed) for given utilities, the condition $\frac{\underline{\omega}}{\kappa} + \overline{\lambda} = \overline{\nu}_2$ as $\overline{\nu}_1 \to 0$ sets the $\underline{\omega}$ for a given level of security $\underline{\lambda}$ that must exist for there to be a status competition with non-zero $\bar{\nu}_2$. In other words, for consumer 1 to participate in the status competition, the consumer 2 must choose $\overline{\nu}_2 < \frac{\underline{\omega}}{\kappa} + \underline{\lambda}$. Similarly, $\bar{\nu}_2 > 0$ implies $\bar{\nu}_1 < \kappa\underline{\lambda} + \underline{\omega}$ i.e. if the consumer 1 spends more than $\kappa\underline{\lambda} + \underline{\omega}$, the likelihood of her getting into the richer band is so high relative to the security offered to the consumer 2 through status competition that there would be no reason for any expenditure towards status for the richer consumer. Notice that these constraints indeed uphold for any utility maximised by the consumer. To explore the effect of income differences $\Delta = y_2 - y_1$ on the selection of $\bar{\nu}_1$ and $\bar{\nu}_2$ by the poor and rich consumers, we now explore a cooperative solution numerically for a given κ where both the population stability condition and a combined utility for the two consumers are considered.

3.3.1 Optimal utility for fixed ω and λ

With fixed values of ω and λ, the condition other than the population stability (see Equation 28.) that helps determine the remaining parameters $\underline{\omega}$ and $\underline{\lambda}$ is arrived at by viewing the selection of $\bar{\nu}_1, \bar{\nu}_2$ as a multi-objective optimisation so that an optimal pair $\{\bar{\nu}_1, \bar{\nu}_2\}$ is selected for the society comprising of two bands. In other words, the values for $\underline{\omega}$ and $\underline{\lambda}$ are implied by the population stability condition and the criterion for maximal consumer utilities - as the parameters $\underline{\omega}$ and $\underline{\lambda}$ (defined as the level of expenditure towards status at which promotion or demotion in the bands is of material significance) are eliminated after fixing ω and λ.

Without a loss of generality, $\underline{\lambda}$ is eliminated with the population stability condition in order for us to explain the sensitivity of status investments with respect to income difference $\Delta = y_2 - y_1$. $\underline{\omega}$ then corresponds to the maximal combined utility for the two consumers. This combined utility for the two consumers can be viewed as the Pareto-goal for the society comprising of rich and the poor consumers. A parameter β is used in this combined utility to controls for whether the Pareto goal relies more on the richer consumer than the poorer consumer. The parameter β could indicate how labour-intensive an economy may be or how segregated (in terms of the population) the rich and the poor are in the economy. For the purposes of our discussion, it suffices that a given long-term income difference $\Delta = y_2 - y_1$ corresponds to a particular $\underline{\omega}$ when a particular structure of the combined utility is known. Defining a general form of the combined (concave) utility - which is maximised collectively for the two consumer in the two bands - with parameter β that tilts society's combined utility in favour of the richer or poorer consumer, we have

$$\mathscr{U} = f(\beta, \bar{\nu}_1^*, \bar{\nu}_2^*) \tag{29}$$

Recall that the population stability condition $W(\bar{\nu}_1) = L(\bar{\nu}_2)$ provides the following relationship among $\lambda, \underline{\lambda}, \omega$ and $\underline{\omega}$

$$\omega(\bar{\nu}_1 - \underline{\omega}) + \lambda(\bar{\nu}_2 - \underline{\lambda}) = 0$$

As we have defined $\bar{\nu}_2 = \phi(\bar{\nu}_1)$ and $\bar{\nu}_1 = \psi(\bar{\nu}_2)$, we use above to write,

$$\begin{aligned}\psi(\bar{\nu}_2) &= \underline{\omega} - (\lambda/\omega)\bar{\nu}_2 + (\lambda/\omega)\underline{\lambda} \\ \phi(\bar{\nu}_1) &= \underline{\lambda} - (\omega/\lambda)\bar{\nu}_1 + (\omega/\lambda)\underline{\omega}\end{aligned}$$

The above definitions also imply that the utilities for the consumers can be written either in terms of $\bar{\nu}_1$ or $\bar{\nu}_2$. More particularly, if the selection for consumer 1 is represented with the function $G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, \Delta)$, then

$$\begin{aligned}\bar{\nu}_1^* &= G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, \Delta) \\ \bar{\nu}_2^* &= \phi(\bar{\nu}_1^*)\end{aligned} \tag{30}$$

The utility $\mathscr{U}$ is thus a function of $y_1, \Delta = y_2 - y_1$ and the parameters $\lambda, \underline{\lambda}, \omega, \underline{\omega}$

$$\mathscr{U} = f(\beta, G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, \Delta), \phi(G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, \Delta))$$

With a particular form of $\mathscr{U}$, a $\underline{\omega}$ can be obtained using numerical methods after eliminating $\underline{\lambda}$. While we pursue this approach in Section 3.3.2, we consider a solution with the total expenditure on status $\bar{\nu}_1^* + \bar{\nu}_2^*$ in the society - a concern that is of interest in its own right. Setting an upper bound ξ so that $\bar{\nu}_1^* + \bar{\nu}_2^* \leq \xi$ (i.e. $\xi - \bar{\nu}_1^* - \bar{\nu}_2^* \geq 0$), the above definition of $\bar{\nu}_2 = \phi(\bar{\nu}_1)$ leads to the following

$$\frac{\lambda\xi - \omega\underline{\omega} - \lambda\underline{\lambda}}{\lambda - \omega} - G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, y_2) \geq 0$$

The condition $\bar{\nu}_1^* + \bar{\nu}_2^* \leq \xi$ translates into the following upper bound for $\bar{\nu}_1$. With $\omega > \lambda$ (in a growing economy), it is thus evident that an increase in ξ decreases this bound on $\bar{\nu}_1$

$$\bar{\nu}_1 = G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, y_2) \leq \frac{\omega/\lambda\underline{\omega} - (\xi - \underline{\lambda})}{\omega/\lambda - 1}$$

Proceeding with first-order conditions under this constraint, the Lagrangian $L = \mathscr{U} + \mu(\frac{\lambda\xi - \omega\underline{\omega} - \underline{\lambda\lambda}}{\lambda - \omega} - G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, \Delta))$ leads to the following (Kuhn-Tucker) conditions for an interior solution (notice that all constraints being linear ensures that the following first-order-conditions is a necessary condition for local-minima - see Takayama (1993)) where μ is the Lagrangian multiplier for the constraint $\bar{\nu}_1^* + \bar{\nu}_2^* \leq \xi$.

$$\frac{\partial L}{\partial \underline{\lambda}} = \frac{\partial L}{\partial \underline{\omega}} = 0$$

and

$$\mu(\frac{\lambda\xi - \omega\underline{\omega} - \underline{\lambda\lambda}}{\lambda - \omega} - G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, y_2)) = 0$$

Two cases therefore arise

- Case I: $\frac{\lambda\xi - \omega\underline{\omega} - \underline{\lambda\lambda}}{\lambda - \omega} = G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, y_2)$ i.e. $\bar{\nu}_1^* + \bar{\nu}_2^* = \xi$ and $\mu > 0$.
- Case II: $\bar{\nu}_1^* + \bar{\nu}_2^* < \xi$ and $\mu = 0$ so that $\frac{\partial \mathscr{U}}{\partial \underline{\lambda}} = 0$ corresponds to the unconstrained maximum for $\mathscr{U}$ after $\bar{\omega}$ is eliminated using the population stability condition (see below for details).

In Case I, the condition $\bar{\nu}_1 + \bar{\nu}_2 = \xi$ (with $\mu \neq 0$) directly leads to a solution dependent on ξ

$$\bar{\nu}_1 = G(\lambda, \underline{\lambda}, \omega, \underline{\omega}, y_1, y_2) = \frac{\lambda\xi - \omega\underline{\omega} - \underline{\lambda\lambda}}{\lambda - \omega}$$

or,

$$\frac{\partial G}{\partial \xi} = \frac{1}{1 - \frac{\omega}{\lambda}}$$

As long as $\omega > \lambda$, an increase in ξ would decrease $\bar{\nu}_1$ and a decrease in ξ would increase $\bar{\nu}_1$. Finiteness constraints on $\bar{\nu}_1^* + \bar{\nu}_2^*$ therefore suppress the status investments for the poorer consumer. Further, as long as ξ is an increasing function of Δ i.e. increasing income difference between the two consumers always increases the constraint ξ, then $\omega > \lambda$ would mean that an increase in Δ would decrease $\bar{\nu}_1$ and a decrease in Δ would increase $\bar{\nu}_1$ since

$$\frac{\partial G}{\partial \Delta} = \frac{1}{1 - \frac{\omega}{\lambda}} \frac{\partial \xi}{\partial \Delta}$$

The results for Case II i.e. of local-maximisation of u_1, u_2 when ξ is high enough are less straightforward since both u_1, u_2 depend on $\phi(\nu), \psi(\nu)$ - whose specific forms have not been yet assumed in the solution. Considering a specific form for $u(A) = \Gamma \cdot A^{\alpha}$ and the population stability condition (see Appendix III), the three unknowns $\underline{\omega}$, $\underline{\lambda}$ and $\bar{\nu}_1$ (with fixed λ, ω) can be solved using the conditions $\frac{\partial u_1}{\partial \bar{\nu}_1} = 0$, $\frac{\partial u_2}{\partial \bar{\nu}_1} = 0$ and the optimisation of the combined utility $\mathscr{U}$ (see Equation 29). So long as the form of $\mathscr{U}$ ensures that the $\underline{\lambda}$ can be expressed as a concave function of $\underline{\omega}$, we can ascertain that a unique $\underline{\omega}$ would maximise the combined utility $\mathscr{U}$. Such a solution depends however on the particular form of combined utility $\mathscr{U}$. The form of a particular $\mathscr{U}$ i.e. the Pareto concern of how the asset utilities from poor and richer consumer are combined in a society thus form an important caveat for the effect of income differences on consumer selections $\bar{\nu}_1$ and $\bar{\nu}_2$. A simple setting of $\mathscr{U}(u_1, u_2) = \beta u_1 + (1-\beta) u_2$ where both consumers are better off with more assets (higher utilities from assets) - that we explore numerically in Section 3.3.2 - does not guarantee that the consumers would decrease status investments with lowering of income differences.

Notice that there are two factors in the cooperative solution with population stability that balance the increase in $\bar{\nu}_1$ and $\bar{\nu}_2$ in the long-run. First is that the poorer consumer eventually runs out of budget y_1 if the y_2 is a lot higher (i.e. when $\Delta = y_2 - y_1$ is very high) and exercises $\bar{\nu}_1 \to 0$ instead. Second is that the richer consumer withdraws with $\bar{\nu}_2 \to 0$ if the poorer consumer gets the promotion to a higher band very easily. Both of these both factors - are a result of the population stability condition and are thus independent of the combined utility $\mathscr{U}$. As these factors would continue to hold for a non-cooperative solution, we can argue that the above dynamics for the effect of $\Delta = y_2 - y_1$ on $\bar{\nu}_1$ and $\bar{\nu}_2$ in the long-run remain unchanged for a non-cooperative solution as well.

In summary, the goal of using the two conditions is to explore the effects of income difference $y_2 - y_1$ on status competitions while incorporating the changes in competitions that occur to rise or fall in income-differences in the long-term. With the parameters controlling a specific form of $W(\nu), L(\nu)$ endogenised within the equilibrium conditions, we are able to remedy the earlier issue with the short-term equilibrium that changes in income also change the competitions and $W(\nu), L(\nu)$ themselves. Unlike with the short-term equilibrium, in other words, the changes in $\Delta y = y_2 - y_1$ correspond to a different $W(\nu)$, $L(\nu)$ characterised by $\underline{\omega}$ and $\underline{\lambda}$. As we show with numerical methods, this relationship does not necessarily result in consumers always increasing $\bar{\nu}_1$, $\bar{\nu}_2$ in response to rise in income differences.

3.3.2 A cooperative solution using Numerical methods

As we explain in Section 3.3.1, the investments towards future status $\bar{\nu}_1$ and $\bar{\nu}_2$ correspond to the maximal utility obtained by each consumer (as defined in Equation 30). With λ , ω fixed for a given set of incomes, y_1, y_2, the values of $\underline{\lambda}$ and $\underline{\omega}$ correspond to unique $\bar{\nu}_1$ and $\bar{\nu}_2$ - of which we're only interested in those that satisfy the long-term stability condition in

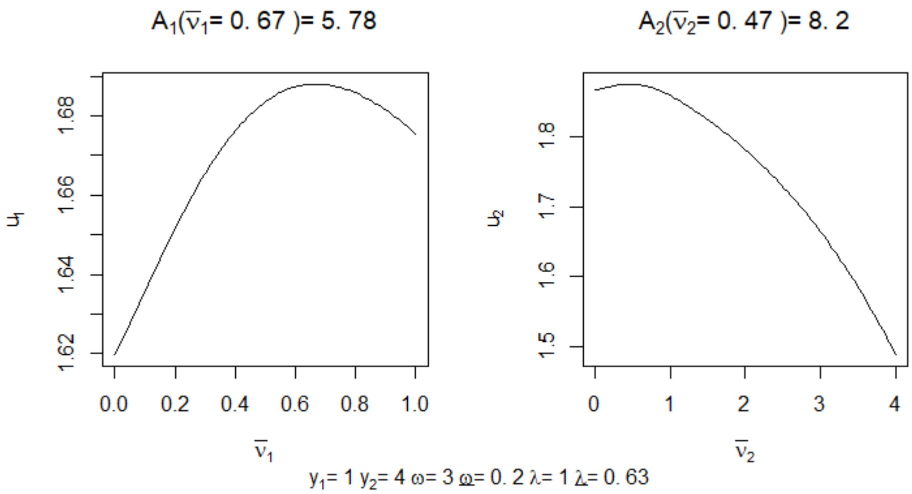

Figure 21: Selection of $\bar{\nu}_1$ and $\bar{\nu}_2$ for $u(A) = A^{1/3}$

Equation 28. For a given $\underline{\omega}$ that corresponds to a combined utility $\mathscr{U}$ (see Equation 29), we thus seek $\bar{\nu}_1$ and $\bar{\nu}_2$ numerically where $|\underline{\lambda} - (\omega/\lambda)\bar{\nu}_1 + (\omega/\lambda)\underline{\omega} - \bar{\nu}_2| \to 0$.

Given that the combined utility in Equation 29 corresponds to an optimal $\bar{\omega}$, we use $\bar{\omega}$ to explain how higher of lower $\underline{\omega}$ influences the equilibrium level selections of $\bar{\nu}_1$ and $\bar{\nu}_2$. To examine the effect of income differences $\Delta y = y_2 - y_1$ on $\bar{\nu}_1$, $\bar{\nu}_2$ as well as the asset accumulations $E(A_1), E(A_2)$, we rely on the numerical computation of $\underline{\omega}$ using the utility $u(A) = \Gamma \cdot A^{\alpha}$; $0 < \alpha < 1$ and $\mathscr{U}(u_1, u_2) = \beta u_1 + (1-\beta)u_2$. We observe that a higher $\bar{\omega}$ does cause the poorer consumer to withdraw from the competition so that $\bar{\nu}_1 \to 0$ while $\bar{\nu}_2 > 0$. Similarly, a lower $\bar{\omega}$ causes the richer consumer to withdraw from the status competition so that $\bar{\nu}_1 > 0$ and $\bar{\nu}_2 \to 0$. More particularly, a lower $\bar{\omega}$ creates the incentive for the consumer 1 to participate in the status investments and a certain range of $\underline{\omega}$ makes it worthwhile for both the consumers to have non-zero status investments ($\bar{\nu}_1 > 0$ and $\bar{\nu}_2 > 0$). However, both extremely low and high values of $\bar{\omega}$ force a withdrawal. An extremely low $\bar{\omega}$ makes the promotion extremely easy and causes the consumer 2 to withdraw i.e. reduce $\bar{\nu}_2 \to 0$. This is because the richer consumer would no longer be concerned with demotion if the opportunities to rise to the richer position are plenty. Similarly, an extremely high $\underline{\omega}$ causes the (poorer) consumer 1 to withdraw due to the constraint $\bar{\nu}_1 < y_1$.

It is also evident from the numerical methods that a widening of income differences would result in a higher expenditure $\bar{\nu}_1$ from consumer 1 if the consumer 2 withdraws from the competition. This is because the benefits from higher investments into status are higher if the other consumer does not participate. The plots in Figure 21 demonstrate the selection of $\bar{\nu}_1$ and $\bar{\nu}_2$ maximising the utilities for a given set of $y_1, y_2, \omega, \lambda$. The changed consumer selections $\bar{\nu}_1$ and $\bar{\nu}_2$ for a higher income differences (while maintaining the same $\underline{\omega}$) are shown in Figure 22.

The changes in $\bar{\nu}_1$ and $\bar{\nu}_2$ with respect to changes in $\Delta = y_2 - y_1$ are shown in Figure 23. As the figure shows, the very low values of $\underline{\omega}$ only make the status competition lucrative for the

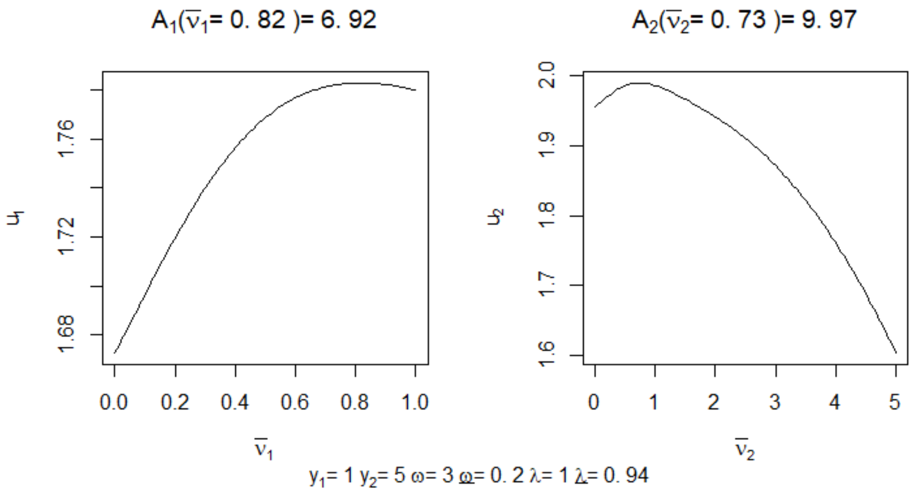

Figure 22: Selection of $\bar{\nu}_1$ and $\bar{\nu}_2$ for $u(A) = A^{1/3}$ with a higher income (same $\underline{\omega}$)

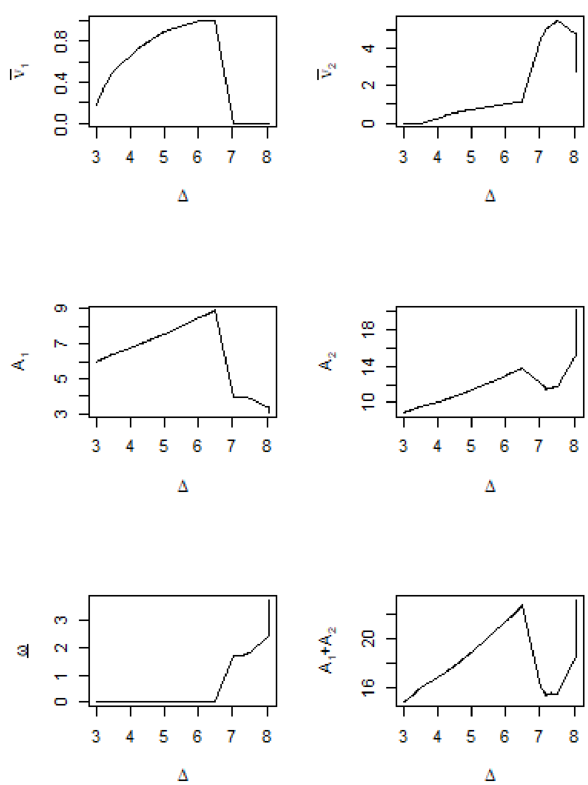

Figure 23: Changes in$\bar{\nu}_1$, $\bar{\nu}_2$, A_1,A_2 implied with the utility ordering$\mathscr{U}(u_1, u_2) = \beta u_1 + (1-\beta)u_2$

poorer consumer. However, there is only a certain level of $\Delta \equiv y_2 - y_1$ until which high income differences encourage only consumer 1 to increase $\bar{\nu}_1$ - a level after which both consumers participate so that $\bar{\nu}_1 > 0$ and $\bar{\nu}_2 > 0$. When $\underline{\omega}$ rises by as much that the poorer consumer is no longer able to afford raising $\bar{\nu}_1$, the optimal choice for consumer 1 is to reduce $\bar{\nu}_1 \to 0$ - thus letting consumer 2 pay for the high security implied by high $\bar{\omega}$. In other words, an extremely large change in income differences reverses the withdrawal among the consumers - since a shift from low-income differences to high income-differences (through lowering of y_1 or increase in y_2) causes the poorer consumer to no longer view any benefit from the status investment - a situation where any further rise in income differences only increases the investment $\bar{\nu}_2$ for consumer 2. Likewise, a shift from high-income differences to largely-similar income-differences would mean that the richer consumer no longer sees any benefit from participating in the status competition - thus setting $\bar{\nu}_2$ to zero. Therefore, the lower differences in income - which is used to accumulate assets in the long-term - are as undesirable for the richer consumer as higher differences in income are for the poorer consumer. A widening in income-differences increases $\bar{\nu}_1$ and $\bar{\nu}_2$ - only until it becomes so high $\bar{\nu}_1$ is reduced to zero by the consumer 1. Similarly, a lowering of income differences decreases $\bar{\nu}_1$ and $\bar{\nu}_2$ until the incomes are so equal that $\bar{\nu}_2$ is reduced to zero.

The equilibrium levels of asset accumulations also correspond to the choices $\bar{\nu}_1$ and $\bar{\nu}_2$. An equilibrium with high $\bar{\nu}_1$ and $\bar{\nu}_2$ does not necessarily mean lower asset accumulations - since status investments also contribute to asset accumulation through social promotion in the model. The total asset accumulations implied by the selections $\bar{\nu}_1$ and $\bar{\nu}_2$ in Figures 21 and 22 demonstrate that A_1, A_2 rise with rise in $\Delta = y_2 - y_1$ if $\underline{\omega}$ remains the same. With changes in $\underline{\omega}$, the total assets decline for the poorer consumer on withdrawal (i.e. when $\bar{\nu}_1 \to 0$) and they rise for consumer 2 with rise in income difference. As the plots in Figure 23 show, a high $A_1 + A_2$ is achieved when all of the poorer consumer's disposable income y_1 is spent towards status investments. The withdrawal from status investments lowers the total accumulation $A_1 + A_2$ until the point when changes in income difference Δ become so high that all gains through status investments only benefit the richer consumer. The result that total assets are higher either when status investments are at highest possible values for the poor consumer or when they benefit only the richer consumer in the long-term does confirm the intuition as well.

4 Conclusions

We had set ourselves to find how income inequality could influence status consumption as investments in an economy. Interpreting status consumption as investments or efforts spent towards economic status, we use a two-band economy under the conditions of population stability and a known ordering of asset utilities for consumers to argue that a rise in income inequalities need not always raise status consumption in the long-term.

The conditions that population stability must prevail in a long-term equilibrium of income bands and that there exists a known ordering for asset utilities for the rich and poor consumer - together imply that the expenditure towards status for the poorer (richer) consumer need not rise (fall) with increase in income differences since withdrawal of either the rich or the poor consumer. This is because an increase (decrease) in income inequalities can drive an increase (decrease) in status investments only as long as the poorer (richer) consumer does not withdraw from the status game - finding it no longer lucrative for positional improvement in the game. Thus, while it is tempting to argue using the short-term equilibrium conditions that wider income differences make status competitions more stringent and the expenditure towards status higher (lower) for the poorer (richer) consumer, the long-term equilibrium - under conditions of population stability and a known order of asset utilities for the rich and the poor consumer - imply a different dynamics where wide income differences could reduce expenditure towards status by making promotion difficult (for the poor consumers) or security cheaper (for the richer consumers). This also means that the combined asset accumulations for the rich and the poor consumer - might either rise or fall with higher income inequality.

There are two important caveats to the above result that we must also highlight. First is that the cooperative solution rests on a certain ordering of combined utility for rich and poor consumers. Second is that a risk with the accumulated wealth is necessary for there to be a status competition at all - one that promises income opportunities and securities to the respective positions in a finite-bands setting. In other words, an inequality in bands cannot maintain a steady state competition without an inherent risk that sets an upper bound on wealth accumulation for the richer consumer.

In applications where consumer welfare follows from status investments such as education, the above model can be used to explain how constraints on resources in an economy with income segregation may limit the participation of poorer consumers despite an increase in opportunities for income mobility. The consideration of positional concerns of the economy in the model demonstrates how long-term constraints due to finite resources could lower the participation for investments such as education simply because the differences in socioeconomic positions must also be maintained.

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APPENDIX I

We know that for $y'(t) = a(t)y(t) + b(t)$ and $y(t_0) = y_0$ we have the solution

$$y(t) = y_0 e^{A(t)} + e^{A(t)} \int_{t_0}^{t} e^{-A(s)} b(s) ds \tag{31}$$

Here, $A(t) = \int_{t_0}^{t} a(s)ds$.
Given $u(A) = \Gamma A^{\alpha}$, we have

$$\begin{aligned} &W(\nu)u_2(A + y_1 - \nu + y_2) + (1 - W(\nu))u_1(A + y_1 - \nu + y_1) \\ &= W(\nu)\Gamma(A + y_1 - \nu + y_2)^{\alpha} + (1 - W(\nu))\Gamma(A + y_1 - \nu + y_1)^{\alpha} \end{aligned}$$

We rewrite the function $f(\nu)$ which is to be maximised by choosing $M_1 = A + y_1 + y_1$and $M_2 = A + y_1 + y_2$.

$$\begin{aligned} f(\nu) &= W(\nu)(\Gamma(A + y_1 - \nu + y_2)^{\alpha} - \Gamma(A + y_1 - \nu + y_1)^{\alpha}) + \Gamma(A + y_1 - \nu + y_1)^{\alpha} \\ &\Rightarrow f(\nu) = W(\nu)(\Gamma(M_2 - \nu)^{\alpha} - \Gamma(M_1 - \nu)^{\alpha}) + \Gamma(M_1 - \nu)^{\alpha} \end{aligned}$$

The derivative $f'(\nu)$

$$\begin{aligned} f'(\nu) = &(\Gamma(M_2 - \nu)^{\alpha} - \Gamma(M_1 - \nu)^{\alpha})W'(\nu) \\ &+ W(\nu)(\alpha\Gamma(M_1 - \nu)^{\alpha-1} - \alpha\Gamma(M_2 - \nu)^{\alpha-1}) - \alpha\Gamma(M_1 - \nu)^{\alpha-1} \end{aligned}$$

The first order condition $f'(\nu)$ implies

$$\begin{aligned} f'(\nu) = 0 \Rightarrow &(\Gamma(M_2 - \nu)^{\alpha} - \Gamma(M_1 - \nu)^{\alpha})W'(\nu) \\ &= W(\nu)(\alpha\Gamma(M_2 - \nu)^{\alpha-1} - \alpha\Gamma(M_1 - \nu)^{\alpha-1}) + \alpha\Gamma(M_1 - \nu)^{\alpha-1} \end{aligned}$$

$$W'(\nu) = \alpha W(\nu) \frac{(M_2 - \nu)^{\alpha-1} - (M_1 - \nu)^{\alpha-1}}{(M_2 - \nu)^{\alpha} - (M_1 - \nu)^{\alpha}} + \frac{\alpha(M_1 - \nu)^{\alpha-1}}{(M_2 - \nu)^{\alpha} - (M_1 - \nu)^{\alpha}}$$

The characteristic function $A(t) = \int a(s)ds$ in the Equation 31 corresponds to the following (notice that this is defined only as long as $(M_1 - \nu)^{\alpha} \neq (M_2 - \nu)^{\alpha}$)

$$\int a(s)ds = -log(\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha) + C$$

Writing $D = log(\Gamma_1(M_1)^\alpha - \Gamma_2(M_2)^\alpha)$ we have

$$\begin{aligned} A(\nu) = \int_0^\nu a(s)ds &= -log(\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha) - (-log(\Gamma(M_1)^\alpha - \Gamma(M_2)^\alpha)) \\ &= log(\Gamma(M_1)^\alpha - \Gamma(M_2)^\alpha) - log(\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha) \\ &= D - log(\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha) \end{aligned}$$

Thus,

$$A(\nu) = D - log(\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha)$$

and,

$$e^{-A(s)} = e^{log(\Gamma(M_1 - s)^\alpha - \Gamma(M_2 - s)^\alpha) - D} = e^{-D}(\Gamma(M_1 - s)^\alpha - \Gamma(M_2 - s)^\alpha)$$

Therefore,

$$e^{A(\nu)} = \frac{e^D}{\Gamma(M_1 - \nu)^\alpha - \Gamma(M_2 - \nu)^\alpha}$$

Now

$$\begin{aligned} \int_{\nu_0}^\nu e^{-A(s)} b(s)ds &= \int_{\nu_0}^\nu e^{-D}(\Gamma(M_1 - s)^\alpha - \Gamma(M_2 - s)^\alpha) \times \frac{\alpha(M_1 - s)^{\alpha-1}}{(M_2 - s)^\alpha - (M_1 - s)^\alpha} \\ &= -\alpha e^{-D}\Gamma \int_{\nu_0}^\nu (M_1 - s)^{\alpha-1} \end{aligned}$$

The integration of the last term is

$$\int_{\nu_0}^\nu (M_1 - s)^{\alpha-1} = -\frac{1}{\alpha}(M_1 - s)^\alpha|_{\nu_0}^\nu = -\frac{1}{\alpha}((M_1 - \nu)^\alpha - (M_1 - \nu_0)^\alpha)$$

Therefore,

$$\int_{\nu_0}^{\nu} e^{-A(s)} b(s) ds = -\alpha e^{-D} \Gamma(-\frac{1}{\alpha}((M_1-\nu)^\alpha - (M_1-\nu_0)^\alpha)) = \frac{\Gamma((M_1-\nu)^\alpha - (M_1-\nu_0)^\alpha)}{e^D}$$

and

$$\begin{aligned} W(\nu) &= W(\nu_0)e^{A(\nu)} + e^{A(\nu)} \int_{\nu_0}^{\nu} e^{-A(s)} b(s) ds \\ &= \frac{W(\nu_0)({M_2}^\alpha - {M_1}^\alpha)}{(M_2-\nu)^\alpha - (M_1-\nu)^\alpha} + \frac{(M_1-\nu_0)^\alpha - (M_1-\nu)^\alpha}{(M_2-\nu)^\alpha - (M_1-\nu)^\alpha} \end{aligned} \tag{32}$$

Equivalently for the $L(\nu)$, we have

$$L'(\nu) = L(\nu)\alpha \frac{(M_1-\nu)^{\alpha-1} - (M_2-\nu)^{\alpha-1}}{(M_1-\nu)^\alpha - (M_2-\nu)^\alpha} + \frac{\alpha(M_2-\nu)^{\alpha-1}}{(M_1-\nu)^\alpha - (M_2-\nu)^\alpha}$$

Again, the characteristic function is as follows

$$A(\nu) = D - log(\Gamma(M_1-\nu)^\alpha - \Gamma(M_2-\nu)^\alpha)$$

Therefore,

$$e^{A(\nu)} = \frac{e^D}{\Gamma(M_1-\nu)^\alpha - \Gamma(M_2-\nu)^\alpha}$$

Further,

$$\begin{aligned} \int_{\nu_0}^{\nu} e^{-A(s)} b(s) ds &= \int_{\nu_0}^{\nu} e^{-D}(\Gamma(M_1-s)^\alpha - \Gamma(M_2-s)^\alpha) \times \frac{\alpha(M_2-s)^{\alpha-1}}{(M_1-s)^\alpha - (M_2-s)^\alpha} \\ &= -\alpha e^{-D} \Gamma \int_{\nu_0}^{\nu} (M_2-s)^{\alpha-1} \end{aligned}$$

The integration of the last term is

$$\int_{\nu_0}^{\nu} (M_2-s)^{\alpha-1} = -\frac{1}{\alpha}(M_2-s)^\alpha |_{\nu_0}^{\nu} = -\frac{1}{\alpha}((M_2-\nu)^\alpha - (M_2-\nu_0)^\alpha)$$

Therefore,

$$\int_{\nu_0}^{\nu} e^{-A(s)} b(s) ds = \frac{\Gamma((M_2-\nu)^\alpha - (M_2-\nu_0)^\alpha)}{e^D}$$

The solution for $L(\nu)$ is therefore

$$L(\nu) = \frac{L(\nu_0)((M_1)^\alpha - (M_2)^\alpha)}{(M_1-\nu)^\alpha - (M_2-\nu)^\alpha} + \frac{(M_2-\nu)^\alpha - (M_2-\nu_0)^\alpha}{(M_1-\nu)^\alpha - (M_2-\nu)^\alpha}$$

APPENDIX II

The proof to demonstrate the lack of feasible non-constant $W(\nu)$, $L(\nu)$ that lead to stable asset-values in an economy with different income bands uses a general cost-function associated with the level of assets A. This function $c(A)$ is used to explain how consumers in the long-term equilibrium may balance future expected income with the costs imposed by the current assets. In empirical terms, this may correspond to expected expenditure required to maintain a certain level of wealth - including any maintenance fees, interest on loan, club memberships etc. that are associated with a certain level of wealth. We also define a net asset value function based on the general cost-function $c(A)$ that represents the net value of assets after adjusting for asset-costs

$$\pi(A) = A - c(A) \tag{33}$$

Note that even if the consumer were allowed to use leverage (credit) by choosing costs higher than she can afford, the liquidity concerns would ensure that $\nu_1 < y_1$ and $y_2 < \nu_2$. We now state the proof that no $W(\nu), L(\nu)$ would result in stable asset allows under no-risk and under population stability conditions.

Theorem. *There exist no $\pi(A)$ and non-constant $W_1(\nu)$,$L_2(\nu)$ for the long-term equilibrium satisfying the population constraint for asset accumulations under no risk.*

Proof. The proof is stated for two bands and can be generalised for higher number of bands. Notice that the population-stability constraint for the two band-economy means the following condition for $W({}^t\nu_1)$ and $L({}^t\nu_2)$ where ${}^t\nu_1$, ${}^t\nu_2$ are the expenditure towards status values selected by the consumer in band 1 and 2 at period t respectively

$$W({}^t\nu_1) = L({}^t\nu_2) \tag{34}$$

Next, the long-term equilibrium implies a stability of asset levels so that no more long-term asset-value is added to the consumer's assets as she chooses the equilibrium ${}^t\nu_1$ (consumer 1) or ${}^t\nu_2$ (consumer 2). Thus, with ${}^tA_1, {}^tA_2$ as the asset values at time t and the net asset value function $\pi(A)$ in equilibrium (see Equation 33), the assets would stabilise at ${}^tA_1$ for consumer 1 and ${}^tA_2$ for consumer 2 in the long-term equilibrium only as long as the following quantity tends to zero for the consumer 1 (as non-zero increments prevent stability of asset-values)

$$W({}^t\nu_1)\pi({}^tA_1 - {}^t\nu_1 + y_2) + (1 - W({}^t\nu_1))\pi({}^tA_1 - {}^t\nu_1 + y_1) \to 0$$

$$W_1({}^t\nu_1) = \frac{1}{1 - \frac{\pi({}^tA_1 - {}^t\nu_1 + y_2)}{\pi({}^tA_1 - {}^t\nu_1 + y_1)}} \tag{35}$$

The above condition implies that the consumer balances her expected future income with the costs on her assets. The net asset value from being either in band 1 or band 2 would be balanced by the expected returns the consumer 1 gets from putting up ν_1 towards status competitions. Since the probability $W_1(\nu)$ must be positive and less than unity, the ratio $\frac{\pi({}^tA_1 - {}^t\nu_1 + y_2)}{\pi({}^tA_1 - {}^t\nu_1 + y_1)}$ must be less than zero. In other words, the consumer in band 1 must move from a negative net asset-value to a positive asset value in band 2 (or vice versa). Similarly, for the consumer in band 2, the following quantity must amount to zero in the long-term equilibrium

$$L_2({}^t\nu_2)\pi({}^tA_2 - {}^t\nu_2 + y_1) + (1 - L_2({}^t\nu_2))\pi({}^tA_2 - {}^t\nu_2 + y_2) \to 0$$

$$L({}^t\nu_2) = \frac{1}{1 - \frac{\pi({}^tA_2 - {}^t\nu_2 + y_1)}{\pi({}^tA_2 - {}^t\nu_2 + y_2)}} \tag{36}$$

Above ensures that the expected loss from being in band 1 is balanced by the security provided by $1 - L_2(\nu_2)$. For consumer 2, $\frac{\pi({}^tA_2 - {}^t\nu_2 + y_1)}{\pi({}^tA_2 - {}^t\nu_2 + y_2)}$ must also be less than zero when she moves from a negative net asset value in band 2 to a positive net asset-value in 1 (or vice versa).

As ${}^tA_1$ and ${}^tA_2$ stabilise in the long-term we drop the subscript t to write ${}^tA_1 \to A_1^*$ and ${}^tA_2 \to A_2^*$. Similarly, we write ${}^t\nu_1 \to \nu_1^*$and ${}^t\nu_2 \to \nu_2^*$. Combining the population stability condition in Equation 34 with the long-term asset stability conditions in Equations 35 and 36 we can write

$$\frac{\pi(A_1^* - \nu_1^* + y_2)}{\pi(A_1^* - \nu_1^* + y_1)} = \frac{\pi(A_2^* - \nu_2^* + y_1)}{\pi(A_2^* - \nu_2^* + y_2)} < 0 \tag{37}$$

As long as status competition is feasible for consumer 1, she should see an increase in the long-term net asset value by being in band 2. The possibility of moving from band 1 to band 2 only to observe the net asset value decline is ruled out because higher income bands are also meant to have a higher asset reference. Any peer effects associated with the assets would ensure a higher asset (comparative) reference in the higher asset-band. Thus while the consumer in band 1 cannot afford to have a decline in net asset value if she moves to the next band, the consumer in the rich band might accept a poorer band with a net increase in asset value. This implies that the the net asset-value function must be concave (see Figure 24).

However, the long-term equilibrium also ensures that the consumer arriving from the different band gathers no more assets than other consumers in the same band. Thus, we also have

$$\pi(A_1^* - \nu_1^* + y_2) = \pi(A_2^* - \nu_2^* + y_2)$$
$$\pi(A_2^* - \nu_2^* + y_1) = \pi(A_1^* - \nu_1^* + y_1) \tag{38}$$

Due to Equation 37 and 38, an equilibrium is implied only if

$$\pi(A_1^* + y_1 - \nu_1^*) + \pi(A_2^* + y_2 - \nu_2^*) = 0$$

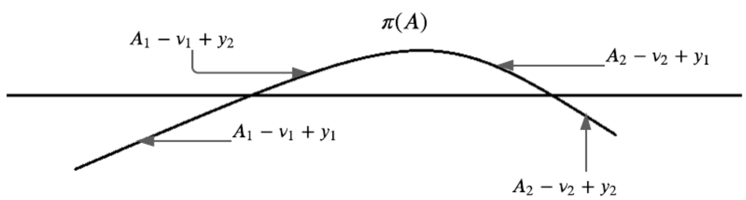

Figure 24: Asset value function necessitated by the long-term equilibrium

Thus, the consumer must see no net gain on average from participating in the status competition for ${}^tA_1$ and ${}^tA_2$ to have stable A_1^*, A_2^*. The population constraint therefore implies that $W(\nu_1^*) = L(\nu_2^*) = \frac{1}{2}$ as the only possible equilibrium when no new asset value is added by participation in status competitions. $\square$

APPENDIX III

To express the consumer utilities u_1, u_2 in terms of $\bar{\nu}_1$(or equivalently in terms of $\bar{\nu}_2$) with the specific forms of $W(\nu), L(\nu)$ defined in Section 3.3 and $u(A) = \Gamma A^\alpha$, we consider first that

$$E_1(\bar{\nu}_1) = W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1 = L(\bar{\nu}_2)y_2 + (1 - L(\bar{\nu}_2))y_1$$

$$E_2(\bar{\nu}_2) = W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2 = (1 - L(\bar{\nu}_2))y_2 + L(\bar{\nu}_2)y_1$$

u_1 can now be written in terms of $\bar{\nu}_1$ using $\bar{\nu}_2 = \phi(\bar{\nu}_1)$ as follows

$$\begin{gathered} u_1 = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \bar{\nu}_2 + E_2(\bar{\nu}_2)) + (1 - W(\bar{\nu}_1))u(y_1 - \bar{\nu}_1 + y_1 - \bar{\nu}_1 + E_1(\bar{\nu}_1)) \\ \Rightarrow u_1 = W(\bar{\nu}_1)u(y_1 - \bar{\nu}_1 + y_2 - \phi(\bar{\nu}_1) + W(\bar{\nu}_1)y_1 + (1 - W(\bar{\nu}_1))y_2) \\ +(1 - W(\bar{\nu}_1))u(2(y_1 - \bar{\nu}_1) + W(\bar{\nu}_1)y_2 + (1 - W(\bar{\nu}_1))y_1) \end{gathered}$$

With the utility function $u(A) = \Gamma A^\alpha$ and the specific forms for $W(\nu)$ and $L(\nu)$, u_1 and u_2 are thus

$$\begin{gathered} u_1 = \Gamma(3y_1 - 2\bar{\nu}_1 + \frac{\Delta}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha \\ + \frac{\Gamma(3y_1 - \bar{\nu}_1 + 2\Delta - \underline{\lambda} + (\omega/\lambda)\bar{\nu}_1 - (\omega/\lambda)\underline{\omega} - \frac{\Delta}{1+e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} \\ - \frac{\Gamma(3y_1 - 2\bar{\nu}_1 + \frac{\Delta}{1+e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} \end{gathered}$$

$$\begin{gathered} u_2 = \frac{\Gamma(3y_1 + \Delta - \underline{\lambda} + (\omega/\lambda)\bar{\nu}_1 - (\omega/\lambda)\underline{\omega} - \bar{\nu}_1 + \frac{\Delta}{1+e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} \\ - \frac{\Gamma(3y_1 + 3\Delta - 2\underline{\lambda} + (2\omega/\lambda)\bar{\nu}_1 - (2\omega/\lambda)\underline{\omega} - \frac{\Delta}{1+e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}} \\ + \Gamma(3y_1 + 3\Delta - 2\underline{\lambda} + (2\omega/\lambda)\bar{\nu}_1 - (2\omega/\lambda)\underline{\omega} - \frac{\Delta}{1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}})^\alpha \end{gathered}$$

The derivatives to be used for the first-order conditions are (setting $F \equiv 1 + e^{-\omega(\bar{\nu}_1 - \underline{\omega})}$)

$$\frac{\partial u_1}{\partial \bar{\nu}_1} = \frac{1}{F}\{\alpha\Gamma \times (-\frac{\Delta\omega(F-1)}{F^2} + \frac{\omega}{\lambda} - 1)(2\Delta - \underline{\lambda} - \frac{\omega\underline{\omega}}{\lambda} - \frac{\Delta}{F} + \frac{\omega\bar{\nu}_1}{\lambda} - \bar{\nu}_1 + 3y_1)^{\alpha-1}$$
$$- \alpha\Gamma \times (\frac{\Delta\omega(F-1)}{F^2} - 2)(\frac{\Delta}{F} - 2\bar{\nu}_1 + 3y_1)^{\alpha-1}\}$$
$$+ \frac{\omega(F-1)}{F^2}\{\Gamma \times (2\Delta - \underline{\lambda} - \frac{\omega\underline{\omega}}{\lambda} - \frac{\Delta}{F} + \frac{\omega}{\lambda}\bar{\nu}_1 - \bar{\nu}_1 + 3y_1)^{\alpha} - \Gamma \times (\frac{\Delta}{F} - 2\bar{\nu}_1 + 3y_1)^{\alpha}\}$$
$$+ \alpha\Gamma \times (\frac{\Delta\omega(F-1)}{F^2} - 2)(\frac{\Delta}{F} - 2\bar{\nu}_1 + 3y_1)^{\alpha-1}$$

$$\frac{\partial u_2}{\partial \bar{\nu}_1} = \frac{1}{F}\{\alpha\Gamma \times (\frac{\Delta\omega(F-1)}{F^2} + \frac{\omega}{\lambda} - 1)(\Delta - \underline{\lambda} + \frac{\Delta}{F} + \frac{\omega(\bar{\nu}_1 - \underline{\omega})}{\lambda} - \bar{\nu}_1 + 3y_1)^{\alpha-1}$$
$$- \alpha\Gamma \times (\frac{2\omega}{\lambda} - \frac{\Delta\omega(F-1)}{F^2})(3\Delta - 2\underline{\lambda} - \frac{\Delta}{F} + \frac{2\omega(\bar{\nu}_1 - \underline{\omega})}{\lambda} + 3y_1)^{\alpha-1}\}$$
$$+ \frac{\omega(F-1)}{F^2}\{\Gamma \times (\Delta - \underline{\lambda} + \frac{\Delta}{F} + \frac{\omega(\bar{\nu}_1 - \underline{\omega})}{\lambda} - \bar{\nu}_1 + 3y_1)^{\alpha}$$
$$- \Gamma \times (3\Delta - 2\underline{\lambda} - \frac{\Delta}{F} + \frac{2\omega(\bar{\nu}_1 - \underline{\omega})}{\lambda} + 3y_1)^{\alpha}\}$$
$$+ \alpha\Gamma \times (\frac{2\omega}{\lambda} - \frac{\Delta\omega(F-1)}{F^2})(3\Delta - 2\underline{\lambda} - \frac{\Delta}{F} + \frac{2\omega(\bar{\nu}_1 - \underline{\omega})}{\lambda} + 3y_1)^{\alpha-1}$$

Above only have $\underline{\lambda}$ and $\underline{\omega}$ as unknowns - one of which can be eliminated using the population condition - leaving the other unknown determined using the combined utility function.