Effects of asset ownership on child health indicators and educational performance in Tanzania

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Abstract

Using a nationally representative data from 3 waves of Tanzania National Panel Survey (TZNPS), we estimate the effects of household asset ownership and community assets on educational and health outcomes of children. We start with a simple modification of the quantity-quality tradeoff model to show a theoretical relationship between assets and child outcomes. Empirically, using the panel data random effects models, we are able to establish a causal relationship between child wellbeing and asset ownership. After controlling for household income proxied by current consumption, we find that assets have significant effects on both educational and health outcomes of children. Although assets have positive effects on child health outcomes, effect on educational outcome is asset specific. Household and community assets have positive effects on child educational performance but agricultural assets have adverse effects.

JEL codes: I15, I25

Keywords: asset ownership, child outcomes, highest grade completed, test scores, stunting, underweight

1. Introduction

In recent years, policymakers have been interested in implementing child development programs through asset-based interventions rather than traditional income support models (Loke 2013). Assets are viewed as strategic tools for poverty alleviation as they can have multidimensional effects at the individual and household as well as at the community levels. In the last decade, empirical studies on the role of assets on child wellbeing and family's welfare have been growing. Several studies have identified a positive role of household assets (net worth) on children's educational outcomes (Elliott and Sherraden 2013; Huang 2011; Shanks 2007; Zhan and Sherraden 2003; Deng et al. 2014; Chowa et al. 2013; Kim and Sherraden 2011; Huang 2013; Conley 2001; Filmer and Pritchett 2001) but the evidence of asset effect on child health outcomes is rather limited (Shariff and Ahn, 1995; Chen and Li 2008; Huang 2011). Previous literature on asset effects on child education have almost always used data from developed countries and a vast majority of them estimated asset effects in conjunction with effects of mother's education. While a handful of studies used longitudinal data to estimate the asset effect on child education, to our knowledge, no previous study used longitudinal data to estimate the impact of asset ownership on child health outcomes. In this light, some researchers have reviewed the literature of asset effects on child wellbeing and identified a significant lack of rigorous empirical studies on the issue and called for further research covering variety of contexts and data (Elliot, Destine and Friedline, 2011). Similarly, in the past decade or so, policymakers also have a tremendous interest in the role of assets on individual wellbeing and household welfare (Lerman and McKernan 2013; Loke 2013).

One of the reasons that the asset-child wellbeing nexus has been of interest to researchers and policymakers is that child outcomes are largely dependent on household wealth or the diversity of resources families can make use of rather than a chunk of household income. For example, household and financial assets may reduce economic stress, provide an alternative source of income, and enable people to smooth their consumption. Similarly, public assets such as health services, drinking water, schools, and transportation facilities can have a direct impact on individual's wellbeing through various pathways. Unfortunately, the theoretical underpinnings of assets effects on child wellbeing is not well understood and empirical evidence of the asset effects on child outcomes is limited. In this study, we start with some key hypotheses proposed in the literature (Williams Shanks 2007) and test them empirically using a nationally representative data from Tanzania. In addition, we use a simple modification of the quantity-quality tradeoff model to show a theoretical connection between assets and child development outcomes.

There are four key hypotheses by which the assets-child development pathway is linked. First, assets are viewed as household wealth that provides economic stability through an alternative source of income as well as easier intergenerational transfers of parental property as bequest and gifts. Second, asset ownership decreases economic and psychological stress which may lead to good parenting and improved health condition. Third, parental behavior that leads to asset accumulation may also lead to high demand for child quality and vice versa. The fourth hypothesis which links public assets to individual welfare asserts that asset rich households tend to live in neighborhood where goods and services are nearby providing their children with better opportunities. Based on the four hypotheses, this study assesses the effect of asset holding at the household level and public assets on child health and educational outcomes. We focus on two health outcomes, Height-for-Age Z-scores (HAZ), and Weight-for-Age Z-scores (WAZ) and the educational outcomes include children's highest grade completed, and primary school leaving exam (PSLE) score. Although the four hypotheses can be tested separately, this study does not attempt to do so due to specific data requirements and other limitations. Instead, we try to identify the causal relationship between parental asset holdings and child wellbeing status by controlling for household consumption expenditure, parental abilities (proxied by maximum parent's education) and other covariates. We correct for potential bias from endogenous relation between parental ability (education) and asset ownership. To better understand the asset specific effects, we disentangle the assets to four key groups; household assets, agricultural assets, dwelling characteristics, and public assets and estimate their impact on child wellbeing.

2. Background

The empirical literature examining the effect of assets on children's educational outcomes have been focused mainly in developed country contexts. Many studies looked at the United States using data from the Panel Study of Income Dynamics (PSID) and documented a significant positive impact of asset holding on children's educational achievement (Elliott and Sherraden 2013; Huang 2011; Loke 2013; Shanks 2007; Zhan and Sherraden 2003; Chowa et al. 2013; Kim and Sherraden 2011; Huang 2013; Conley 2001). Deng et al. (2014) used data from 2002 China Household Income Project (CIHP) to show that differential assets (net worth and liquid assets) have significant effects on both boys' and girls' educational attainment. Similar results were evident in the United States as, using the PSID data, both Huang (2013) and Conely (2001) found positive effects of household assets (net worth) on transmission of parental abilities to child educational achievement and children's post-secondary education, respectively. The asset effects on educational outcomes were consistent for different age groups of children and young adults also (Kim and Sherraden, 2011). Other researchers who examined the asset effects on child education also found the similar results but argued that the asset effect is more pronounced on early childhood (Huang 2011) and the effect is operating through mother's expectations of their children's educational achievement (Loke 2013).

In developing country context, the literature on the effects of asset ownership on child educational outcomes is limited. Recently, Chowa et al. (2013) conducted a field experiment in

Ghanaian youth and found an evidence of asset effect on child educational outcomes. The results were based on five key assets that are considered primary indicators of socioeconomic status in Ghana; TV, refrigerators, electric iron, electric or gas stoves, kerosene stoves. Youth from households that own at least one of the five assets outperformed the youth from control households in English test scores by at least one more point. Cockburn and Dostie (2007) conducted another field experiment in Ethiopia and found that having near and close source of water contributes to better schooling outcomes. But, they noticed the asset effects on child outcomes are largely based on type of assets. Whenever expected return to schooling is less than return to child labor, providing households with more assets have adverse effects on child education as parents take their children out of school to work.

Causal relationships between assets and child health outcomes are as important as the asset-education relationship. Several studies have looked at the effect of household income on child health outcomes, but the effect of assets or net worth on child health outcomes has been largely overlooked. Shariff and Ahn (1995) examined how effects of maternal education on child anthropometry differ with certain asset ownership in Uganda. Although their findings suggest that mother's education has significant impact on child height-for-age z-scores and radio ownership has larger positive impacts among children of uneducated mothers, they did not look at the effects of asset ownership itself. Similarly, another study in Ugandan children found a negative association between child stunting and household asset index (Wamani et al. 2004). The study failed to establish a rigorous causal relationship between asset ownership and stunting but laid out a foundation for the causal relationship by demonstrating strong association of assets and child stunting among children from upper quintiles of asset index. Among other studies, Chen and Li (2009) used the Chinese data to show that mother's education serves as an important predictor of child health status even after controlling for household income and socioeconomic status. But, the study also does not look into the effects of socioeconomic status itself on child health outcomes. Recently, Huang (2011) used data from the PSID and found that when the value of net household wealth doubles, the chance of reporting excellent child health condition increases by 2%. This implies a larger marginal effect among households that start with low or no asset holding. Huang's findings that children from asset rich households were 16% more likely to visit doctors for general conditions but less likely to do so for psychological conditions and 17% less likely to be hospitalized imply a positive effects of assets on child health.

Apart from lack of strong theoretical foundation and rigorous empirical evidence, another problem in estimating asset-child outcome relation is the potential endogeneity of assets. A systematic review of literature revealed that only a few studies have attempted to control for the endogeneity of assets (Lerman and McKernan 2013; Elliott, Destin and Friedline 2011). Assets can be endogenous because parental ability serves as a predictor for both children's ability and household asset accumulation. In this light, this study contributes to the literature in two ways. First, we propose a theoretical linkage between assets and child quality outcomes. Then, we identify the true causal relationship between asset ownership and child development outcomes in a developing country context by controlling for household income and endogeneity of assets.

3. Theoretical Framework

The life cycle model provides the fundamental economic reasoning behind asset accumulation. Individuals tend to smooth consumption by borrowing when they are young, saving in middle age and dissaving when they get older. Parents, when they are in middle age, may save in the form of assets. Unlike income, assets are what people accumulate and hold over time. Assets not only provide a basis for future consumption, but also contribute to consumption and wellbeing over the life time. Asset accumulation helps people maintain their consumption level even in the event of economic shocks that lower income significantly (Sinai and Souleles 2005). On the other hand, asset poor families lack ability to borrow against future and are more likely to face credit constraints (Lerman and McKernan 2013). In essence, assets directly enter into the household utility maximization problem through the budget constraint. In addition, we propose that child quality is a function of household assets along with market purchased inputs and child health endowment. We demonstrate this relationship by using the famous quantity-quality (Q-Q) trade-off model first discussed in Becker and Lewis (1973).

In the Q-Q model, parents' utility is a function of the quantity and quality of children and household consumption. Parents maximize their utility subject to the household budget constraint and child quality production function. Child quality, in the Q-Q model, is a function of market inputs and the household's health endowment which is unobservable. Based on this framework, the Q-Q model predicts that any (exogenous) increase in fertility increases the shadow price of child quality, which decreases the relative price of child quantity and results in even higher demand of child quantity (Becker and Tomes 1976). Following Becker and Tomes, several researchers have tested the empirical validity of the original Q-Q model or some variant of the model. However, no attempt has been made to include assets in functional form of the model. We modify the Q-Q model in the following way to include the household's asset endowment and demonstrate its role in child quality measures such as education and health outcomes.

Let parent's utility be $U(q, c, n)$ where q is child quality, c is consumption, and n is number of children. Parents, or households for that matter, maximize $U(q, c, n)$ subject to the budget constraint and child quality production function.[1]

$\max_{q,c,n} U(q, c, n)$ subject to

$$p_c c + p_n n + p_z z\, n - r\, A = W \text{ and} \tag{1}$$

$$q = f(z, A, \theta)$$

where z is a vector of market purchased inputs related to child quality, A is household's asset endowment, θ is child health endowment at the household level[2], r is the rate of return on assets, p_c, p_n, p_z are the price of consumption, child quantity, and market inputs, and W is total household wealth including household income, and asset holdings. Without loss of generality, we assume that the production function is additively separable in two factors, factors controlled by household (assets and market purchased health inputs) and factors that are out of household's control (health endowment or inherited ability). So the production function takes the following form:

$$q = f(z, A, \theta) = a(z, A) + b(\theta)$$

The first order condition yields the following

1. $u_c = \lambda\, p_c = \lambda \Pi_c$
2. $u_n = \lambda(p_n + p_z z) = \lambda \Pi_n$
3. $u_q = \lambda p_z n \,\frac{\delta z}{\delta q} = \lambda p_z \frac{n}{\frac{\delta f(z,A,\theta)}{\delta z}} = \lambda p_z \frac{n}{\frac{\delta a(z,A)}{\delta z}} = \lambda \Pi_q$

Equilibrium conditions reveal that marginal utilities with respect to q, c, and n are equal to respective shadow prices and the shadow price of quality (quantity) is proportional to child quantity (quality) demand. In all cases, λ is the marginal utility of income. We assume that the marginal productivity of child quality increases in both asset endowment and market inputs i.e.

[1] As Becker and Tomes (1976) pointed out, child quality is partly controlled by household through expenditure on children. But, several other factors that are not controlled by household, such as inheritance, public investment, luck and other factors, also affect child quality.

[2] Health endowment at the household level means homogeneity of health endowment among all children. One can relax this assumption to allow for heterogeneous health endowments but Becker and Tomes (1976) indicated that the implication of Q-Q model does not change even with the relaxed assumption.

$q_A > 0$ and $q_z > 0$. Sign of the cross marginal product (q_{Az}) is ambiguous and may dictate the net impact of asset endowment on the magnitude of the Q-Q trade off. Since assets and health inputs in the production function are not separable,

$$\frac{\delta}{\delta A}\left(\frac{\delta q}{\delta z}\right) = \frac{\delta}{\delta A}\left(\frac{\delta a(z,A)}{\delta z}\right) \neq 0$$

There are two possible cases.

1. Case i: $q_{Az} > 0$

We have

$$\Pi_q = p_z \frac{n}{\frac{\delta a(z,A)}{\delta z}}$$

Differentiating w.r.t. A,

$$\frac{\delta}{\delta A}\Pi_q = \frac{\frac{\delta}{\delta A}(p_z\, n)\,.\frac{\delta a(z,A)}{\delta z} - p_z n\,.\frac{\delta}{\delta A}\left[\frac{\delta a(z,A)}{\delta z}\right]}{\left[\frac{\delta\, a(z,A)}{\delta z}\right]^2}$$

$$\frac{\delta}{\delta A}\Pi_q = -\frac{p_z n\,.\frac{\delta}{\delta A}\left[\frac{\delta a(z,A)}{\delta z}\right]}{\left[\frac{\delta a(z,A)}{\delta z}\right]^2}$$

The denominator of the last expression is positive, and the numerator is positive by assumption. Consequently, $q_{Az} > 0$ implies that $\frac{\delta}{\delta A}\Pi_q < 0$. Thus, any exogenous increase in asset endowment leads to decreases in the shadow prices of child quality. Any decrease in the shadow price (Π_q) contributes to higher demand of child quality. In addition, the relative price of child quantity goes up adding to further increase in child quality demand.

2. Case ii. $q_{Az} < 0$

In this case, $q_{Az} < 0$ implies that $\frac{\delta}{\delta A}\Pi_q > 0$. Thus, any increase in asset holding increases the shadow price of child quality and reduces the demand of quality. Relative prices of child quantity decrease and the demand of number of children goes up.

In either case, it is implied that asset ownership can alter the child quantity-quality trade off and the net impact depends on specific assets. If $q_{Az} > 0$ holds true for asset X, then parents with higher ownership of X may demand more quality per child because $\frac{\Delta\pi_q}{\Delta n}$ decreases in X. The reverse is true if $q_{Az} < 0$. All in all, parents with higher asset endowments may behave differently than other parents and children's outcomes differ accordingly.

4. Data and Methods

4.1. Research Method

Child well-being is measured by health outcomes and educational achievement. Health outcomes of interest are the standardized scores for height and weight, HAZ, and WAZ, which are consistent with the WHO 2006 standard. No standardized scores are calculated for children more than 5 years old. The z-scores (z_i) are standardized using the mean ($\bar{h}_j$) and standard deviation (σ_j) of the reference group, $z_i = \frac{h_{ij} - \bar{h}_j}{\sigma_j}$. In regression framework, we use stunting (1 if HAZ <-1 and 0 else) and underweight (1 if WAZ <-1, 0 else) as primary health outcomes. Educational outcomes include the highest grade completed, and PSLE score for children aged 6 to18. The PSLE test is a national level examinations that is administered after grade 7 and students must pass it to go to the public secondary schools.

Assets are broadly defined and they include household assets, dwelling characteristics, agricultural assets, financial assets, and public assets. Household assets include tools and equipment used in the household such as television, radio, cellphone, bicycle, kitchen tools etc. Dwelling characteristics consist information about home ownership, type of floor, roof, and wall materials, number of rooms, dwelling tenure status etc. Similarly, agricultural assets include farm tools, livestock, and livestock related assets and financial assets include access to saving and credit services and loan. Finally, public assets include access to drinking water, schools, health centers, roads, markets and other public services. Since each asset group consists several individual assets, we run into a problem of finding appropriate weight for each asset. Including individual assets as explanatory variables in regression equation correctly assigns weights but it may not be pragmatic to do so because no individual assets can serve as wealth measure. Several researchers rely on the principal component approach which assigns weight to the components (assets) based on their variance. The first principal component is considered to serve as a proxy for socioeconomic status as it captures the largest variation in assets (Filmer and Pritchett 2001; McKenzie 2005; Vyas and Kumaranayake 2006; Filmer and Scott 2008). Following the literature, we use the principal component analysis approach to create asset indices for the four different asset types.[3] The first component accounts for more than 26% variation in each case. The research method identifies the effect of owning a particular group of assets by controlling for other asset holdings, household income, consumption, and other covariates.

4.2. Endogeneity of Assets

The causal effect of asset ownership on child outcomes may be seriously biased because of the endogeneity of assets. The endogeneity of assets may come from simultaneity, reverse causality or both. Simultaneity occurs when assets and the outcomes of interest cause each other. Similarly, reverse causality occurs when the outcome of interest causes asset growth. In addition, there could be systematic differences among people that lead some people to accumulate more assets than others. If we think of asset accumulation as a 'treatment', than selection into the treatment could be biased. In any case, the result is biased unless we take care of the factors that are correlated with both assets and the outcomes. We rule out the endogeneity resulting from simultaneity and reverse causality because child health outcomes and exam test scores may not directly lead to asset accumulation. We consider the systematic difference among people that leads to higher asset accumulation among certain groups as a potential source of endogeneity. Some explanatory variables may be correlated with the unobserved individual characteristics that affect our outcome of interest. We provide a potential source of this bias here.

Let's say child development indicators are determined by parental characteristics, household and community asset endowment, income, and children's individual characteristics.

Child outcomes = f(parental characteristics, assets, income, individual characteristics) + error

But we know that some parental characteristics are observed (eg. education) and others are not (eg. ability). Not only the observed parental characteristics but also the asset endowment may be correlated with the unobserved characteristics. We assume that these unobserved characteristics are time constant. Since the observed and unobserved variables are correlated and both affect child outcomes, the effect of observed variables on the outcomes may be biased unless we correct for the problem- endogeneity of assets and observed parental characteristics.

[3] Household asset index includes household items such as TV, radio, motorbikes, kitchen items, beds and other household durable. Agricultural asset index includes all farms tools and equipment, livestock and agricultural land. Dwelling index includes household characteristics, such as wall, roof, and floor materials, access to water, electricity at home, home ownership etc. Finally, community asset index includes access to public services such as hospitals, schools, water taps, type of services (government or private) and so on.

4.3. Econometric model

In the literature, the causal effect of asset holding on certain outcomes are studied by using ordinary least squares (OLS) method, logit, probit, generalized linear model (GLM), hierarchical regression, instrumental variable (IV) method, simultaneous equation model (SEM), and fixed effect (FE) models. The first five methods cannot correct for endogeneity in assets because they control only for what is observed and directly included in the model. The latter 3 methods-IV, SEM, and FE- can take care of unobservables and hence the endogeneity problem. In this study, we start with the following simple model for panel data.

$$q_{it} = X_{it}\beta + u_i + \varepsilon_{it} \qquad (2)$$

where q_{it} is a child health or education outcome, X_{it} is a vector of explanatory variables which includes individual characteristics, parental characteristics, income, assets and other relevant controls, and u_i is a time invariant individual effect. The fixed effect model is inappropriate because asset accumulation is assumed to be correlated with the unobserved parent's ability, which is correlated with children's ability thus confounding the asset effect. The random effect model also may yield biased estimates because the unobserved effect that is correlated with some observed variables is now a part of the error term. We use the Hausman-Taylor Instrumental Variable (HTIV) approach to address this problem. Let's rewrite the estimating equation as follows:

$$q_{it} = x_{1it}\beta_1 + x_{2it}\beta_2 + z_{1i}\alpha_1 + z_{2i}\alpha_2 + u_i + \varepsilon_{it} \qquad (3)$$

where

x_{1it} is time-varying exogenous variables such as age, household size etc.

x_{2it} is time-varying endogenous variables such as asset endowment

z_{1i} is time invariant exogenous variables such as sex

z_{2i} is time invariant endogenous variables such as parent's education

We assume that the idiosyncratic error term is uncorrelated with all variables but the unobserved specific effect is correlated with x_{2it} and z_{2i}. That is $E(u_i, x_{2it}) \neq 0, E(u_i, z_{2i}) \neq 0$ but $E(u_i, x_{1it}) = 0$ and $E(u_i, z_{1i}) = 0$. This method, developed by (Hausman and Taylor 1981), produces unbiased estimates but needs some unique instruments. One of the advantages of this method is that instruments are easy to find. In fact, z_{1i} serves as instruments for itself because it is time-invariant and exogenous. $x_{1it} - \bar{x}_{1i}$ and $x_{2it} - \bar{x}_{2i}$ are valid instruments for x_{1it} and x_{2it}, respectively and $\bar{x}_{1i}$ serves as a valid instrument for z_{2i}.

4.4. Data

We use the data from the National Panel Survey (NPS) of Tanzania. The NPS is a nationally representative survey that is jointly implemented by the World Bank and the National Bureau of Statistics of Tanzania. The NPS uses four key domains of sampling; mainland rural, mainland urban, Dar es Salaam, and Zanzibar. It includes 3 survey rounds with 3265 households in the baseline (2008/09), 3924 households in the second wave (2010/11), and 5015 households in the third wave (2012/13). The growth in the number of households is due to household splits. The NPS maintains a relatively small attrition rate (4.8%) over the three waves of the survey. Number of observations at the individual level increased from 16,709 in the baseline to 20,599 and 25,412 in the second and third waves, respectively. The attrition rate at the individual level is 7.5%. In all the survey rounds, the NPS follows the same households and eligible members of the households. All household members of age 15 or older but the live-in servants are considered eligible. Households and individuals are tracked to new locations when necessary. In this study, we use a panel data from the three survey rounds. The panel contains 3088 observations at the household level and 14,577 observations at the individual level. For child health outcomes, we use a panel of children 0-5 years of age during all three waves. For the highest grade completed, we use a panel of children who have ever attended school and are 6-18 years old during the first wave. Similarly, for the PSLE variable, we use a panel of children who ae 6-18 years old during the first wave and have taken PSLE test at least once.

5. Summary statistics

Summary statistics are presented in Table 1-3. All summary statistics are based on the observations that made to the panel or participated in all three rounds. Point estimates are nationally representative as they are population weighted. Household demographic characteristics are presented in Table 1.

---Table 1 here---

The first half of the table presents statistics from NPS wave 1 (2008/09) and the second half presents NPS wave 3 (2012/13) statistics. We do not present statistics for the second wave but use them in the analysis to follow. On average, Tanzanian households have about 6 members both in 2008 and 2012. Although, majority of the household members are female (52%), most household have a male head (80%) of about 46 years old in 2008. After 4 years, there is a 2% increase in female headed households in 2012. A significant majority of household heads are married (82%) and literate (79%) in 2008 with a small decrease in both statistics in 2012. Household heads have about 9 years of schooling, which translates to primary school grade 7 in Tanzanian educational system. Despite a high literacy rate of household heads, the maximum parent's education[4] is primary level or lower and the average age of children first starting primary school is still 8 years, a figure higher than the average for most African countries (7 years). In general, the population is younger with the average age of 22 years in 2008.

---Table 2 here---

Table 2 presents summary statistics on child health and educational outcomes related variables. On average, height-for-age z-scores (HAZ) increased from -1.57 in 2008 to -1.39 in 2012, but the weight-for-age z-scores (WAZ) decreased from -0.72 in 2008 to -0.95 in 2012. This is also evident from the kernel density graphs in Figures 1 and 2. Using HAZ and WAZ scores, we constructed indicators for children's stunting and underweight status. A child is considered stunted if HAZ is less than -1, and underweight if WAZ is less than -1. On average, 71% children were stunted in 2008 and about 66% in 2012 suggesting an improved health status. In contrast, percentage of underweight children increased from 44% in 2008 to 48% in 2012.

---Figures 1 and 2 here---

Children's educational outcomes are summarized in Table 2 and depicted in Figures 3 and 4. While health outcomes are calculated for children 5 or younger, educational outcomes are calculated for children 6 to18 years old during the first NPS wave. To estimate the asset effects on educational outcomes, we track the cohort of 6 to 18 years old children in NPS 2008. As the primary school leaving exam (PSLE) data are not available for the first wave, we use the PSLE data from the last two NPS surveys. Among those who appeared in the PSLE examination, 32% passed the exam in 2010 while the pass rate was slightly improved in 2012 (36%). As a consequence, the highest grade completed by children who have ever attended school is primary or lower. We also present school characteristics and not surprisingly, majority of schools are public schools (92%) with about 3% boarding schools and some religious or other schools in 2008. After 4 years, proportion of public schools decreased to 89% with an increase in boarding

[4] Maximum parent's education is the maximum level of education of father or mother. This is coded as follows: 1=no education, 2= primary not finished, 3=primary finished, 4= secondary not finished, 5= secondary finished, and 6= higher than secondary.

school (7%). Despite a significant majority of schools being public or government funded, only about 3% children got some kind of meals at schools in 2008 but it was improved to 7% in 2012.

---Figure 3 and 4 here---

Asset indexes[5] and access to credit and loan services are presented in Table 3. All asset indexes have mean close to zero and identical signs in both waves except for community index. Data indicate that only a small portion of households have access to credit and saving services. The proportion of household with a membership in credit and saving groups is surprisingly low (~5%) in both waves with an increase in the proportion of loan taking households from 6% in 2008 to 11% in 2012.

6. Preliminary Results

Our empirical results are based on equation (5) that we estimate using two different panel data model; random effects (RE)[6], and Hausman-Taylor instrumental variable (HTIV) method.

$$q_i = \alpha_0 + \beta_0 x_{10} + \beta_1 x_{11} + \beta_2 x_{12} + \beta_3 x_{13} + \beta_4 x_{14} + \beta_5 x_{15} + \beta_6 x_{16} + \Pi X + \varepsilon_{it} \quad (4)$$

where q_i is outcome of interest, x_{10} is log of total consumption expenditure, $x_{11}$is household asset index, $x_{12}$is dwelling asset index, x_{13} is agricultural asset index, x_{14} is community asset index, x_{15} is credit group dummy (1 if member), and x_{16} is loan dummy (1 if took loan).

Coefficients of interest are $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5,$ and β_6. Π is a matrix of slope coefficients associated with the vector of control covariates, X. The control covariates include household head's education, age, gender, and marital status, household size, rural dummy, employment dummy, gender and age of child in month, school characteristics, and maximum parent's education. For the HTIV method, household asset index, agricultural asset index, and dwelling asset index are considered time-varying endogenous, parent's education is time-invariant endogenous, gender is time invariant exogenous and rest of the variables are considered time-varying exogenous. First, we run the random effect model without asset variables, and we run full models using both the random and HTIV methods. Below, we discuss the results on child educational outcomes, highest grade completed and PSLE test score, followed by the results on child health outcomes, stunting and underweight.

[5] Since we calculate asset indexes at the household level, we assume that all children within a household have equal access to household assets. Similarly, for community assets, all children within a community are assumed to have equal access to public assets.

[6] First, we estimated equation (5) with the fixed effects and random effects models. As Hausman specification test on the random and fixed effect specifications concludes in favor of the random effect model, we don't present results from the fixed effects estimation.

6.1. Educational outcomes

The PSLE test score are a binary variable that takes a value of 1 if a child has passed the PSLE exam. PSLE scores are calculated for children who are 6 to 18 years old during the second NPS wave and successfully resurveyed in the third wave. Children's 'highest grade' is the highest grade level completed by children who are in 6 to 18 age group during the first NPS wave and successfully resurveyed in all follow up rounds. In Table 4, we present the results of assets endowment on children's educational attainment.

---Table 4 here---

Results in the first two columns are estimated using the random effects model and the HTIV result are in the third column. When assets are not included in the regression specification, consumption expenditure has the largest impact on children's education. When assets are included, the magnitude of expenditure effect decreases as it disperses to asset (wealth) effects. As one would expect, household assets, community assets, and dwelling assets have positive impact and agricultural assets have negative impact on the children's highest grade completed. It suggests that having more agricultural assets may increase the opportunity cost of schooling as easy access to farm equipment and tools can increase return to child labor. When the potential endogeneity of assets and parental education is corrected for, small significant effects of dwelling and public assets disappear but financial assets appear to have positive impacts on education and the magnitude of parental education increases heavily. This suggests the potential endogeneity of parental education.

Table 5 presents the effects of assets on the PSLE test score. Results indicate that children from household with higher endowment of improved dwelling features are more likely to pass the test as children from households with a large endowment of agricultural assets are less likely to pass the exam. While children from communities with easier access to school and other public facilities are also more likely to perform better in the test, household durable assets have no impact at all. Unlike the effects on children's educational attainment (highest completed grade), consumption expenditure has no effect on the PSLE pass rate but parental education still has the largest impact on children's likelihood to pass the PSLE test. As boys are more likely to pass the exam, late school starter of any gender are less likely to perform well.

---Table 5 here---

6.2. Health outcomes

Results on child height indicator, stunting, are presented in Table 6. Household consumption expenditure has significant negative (positive) impact on child stunting (height) but the effect vanishes when assets are included in the model and the endogeneity of assets is controlled for. Ownership of household durable assets and agricultural assets significantly reduces the prevalence of child stunting but dwelling characteristics and community index have no such effects. While parental education has no impact at all, Tanzanian boys are more likely to suffer stunting. Irrespective of child sex, older children are at higher risk of stunting than younger children.

---Table 6---

Table 7 presents the results on effects of assets on prevalence of underweight among children 5 or younger. Results indicate that asset effects on underweight are more or less consistent with the effects on child stunting. All but agricultural assets has a positive (negative) impact on children's standardized weight-for-age (underweight). Again, the positive impact of consumption expenditure on the prevalence of underweight vanishes when assets are included in the model. Although parental education still have no effects at all, boys of any age (0-5) and older children of any sex are more likely to suffer underweight.

---Table 7 here---

7. Conclusion

Results imply that asset holding at both household and community levels have a causal relationship with child health and educational outcomes. While the impact on educational outcomes is more pronounced, assets serve as a good predictor of child health outcomes, even after controlling for household income and parental abilities. The negative impact of agricultural assets on educational attainment of children implies that asset based interventions that capitalize in agricultural assets may not be favorable for child education. In contrast, agricultural and household durable assets have positive effects on both height and weight indicators. This suggests that ownership of agricultural assets adversely effects child outcomes of working age children only because when household has large endowment of agricultural assets, parents are likely to use their children for agricultural activities. In terms of the Q-Q model, the results imply that household asset endowment plays an important role in the Quantity-Quality trade-off but the net effect depends on the type of assets. While households with larger endowment of agricultural assets may demand more children, households with large endowment of durable assets and households residing in a well-developed community may invest more on child quality.

Overall, the results imply that assets are an important element of social policies that focus on individual and public welfare program. As the asset effect on child outcomes are based on type of assets, policy intervention that helps build up asset endowment should implement with caution. Policies that combine asset transfers with the traditional income support model may be more effective than the income support model alone.

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Tables

Table 1: Demographic Characteristics

	NPS Wave 1 (2008/09)			NPS Wave 3 (2012/13)		
	Mean	SD	N	Mean	SD	N
Household						
Age	22.39	18.92	14577	26.43	19.04	14577
Household size	6.34	3.14	14577	6.33	3.205	14577
Gender (1=male,0=female)	.48	.49	14577	.48	.49	14577
Age started school	8.067	2.079	9659	7.84	1.91	11376
Maximum parent's education*	2.63	1.25	14210	2.63	1.25	14210
Member employed (1=yes, 0=no)	.37	.48	14577	.43	0.49	14577
Total disposable income (TSZ)	4365707	$3.8x10^7$	13528	8769645	$2x10^8$	12228
Annual consumption, real (TSZ)	2889574	2770323	14577	4279580	3911291	14482
Household head						
Age	45.91	14.31	14577	47.75	14.45	14576
Literacy rate	.79	.405	14353	.77	.42	14496
Education level (grade)	8.33	5.11	14210	8.33	5.11	14210
Gender (1=male, 0= female)	.802	.39	14577	.78	.42	14577
Marital status (1= married, 0 else)	.82	.386	14577	.78	.41	14577

Notes. Point estimates are population weighted means. Standard deviations are in the column next to the point estimates. Total disposable income and expenditure are in Tanzanian Shilling (TSZ).
*Maximum parent's education is maximum education level of father or mother. It is coded as follows: 1= no education, 2= primary not finished, 3= primary, 4= secondary not finished, 5= secondary, and 6= higher than secondary.

Table 2: Child health and educational outcomes and school characteristics

	NPS Wave 1 (2008/09)			NPS Wave 3 (2012/13)		
	Mean	SD	N	Mean	SD	N
Health outcomes						
Height for age z-scores (HAZ)	-1.57	2.65	2227	-1.39	1.12	489
Weight for age z-scores (WAZ)	-.72	2.40	2227	-.95	.88	489
Stunted (1 if HAZ< -1, 0 else)	.71	.45	2227	.66	.47	489
Under weight (1 if WAZ<-1, 0 else)	.44	.49	2227	.49	.50	489
Educational outcomes						
Passed PSLE (1= yes, 0= no)	.32	.47	5816	.36	.48	6606
Highest grade completed	8.08	4.13	10568	8.34	4.33	11389
School characteristics						
Meals provided in school (1= yes, 0= no)	.038	.19	4417	.071	.26	4275
Boarding school (1= yes, 0= no)	.009	.091	4417	.072	.26	4275
School type (1=public, 0=private	.92	.26	4417	.89	.301	4275

Notes. Point estimates are population weighted means. Standard deviations are in the column next to the point estimates. HAZ and WAZ are calculated for children aged 5 or under. Calculations are consistent with WHO 2006 growth standard. The primary school leaving exam (PSLE) is a national level examination in Tanzania. PSLE data in the table is for 2010 as it is not available for 2008. Number of observations for each variable is based on the number of individuals who made to all three survey rounds.

Table 3: Asset indices and access to loan and credit services

	NPS Wave 1 (2008/09)		NPS Wave 2 (2008/09)	
	Mean	SD	Mean	SD
Household asset index	-.324	1.950	-.303	2.089
Agri. asset index	.019	2.376	.179	1.417
Dwelling index	-.452	2.086	-.526	2.014
Community asset index	-.182	1.553	.021	1.875
Membership in credit group (1=yes, 0=no)	.054	.227	.060	.238
Loan, last 12 months (1=yes, 0=no)	.065	.246	.111	.314
Observations	3088		3088	

Notes. Point estimates are population weighted means. Standard deviations are in the column next to the point estimates. All asset indices are constructed using the Principal Component Analysis (PCA) method.

Table 4: Effect of asset ownership on children's educational achievement in Tanzania

	Dependent variable: Highest grade completed		
	RE	RE	HTIV
Household asset index		0.086***	0.040***
		(0.0135)	(0.0137)
Agri. asset index		-0.012***	-0.014***
		(0.00359)	(0.00437)
Dwelling Index		0.066***	-0.018
		(0.0169)	(0.0193)
Community asset index		0.017*	0.0041
		(0.00985)	(0.00965)
Log(Total expenditure)	0.33***	0.23***	0.16***
	(0.0321)	(0.0341)	(0.0349)
Loan, last 12 months (1=yes)	0.081	0.078	0.091*
	(0.0516)	(0.0531)	(0.0503)
Max. parent's education	0.24***	0.19***	1.09***
	(0.0217)	(0.0244)	(0.0727)
Gender (1=male,0=female)	-0.31***	-0.29***	-0.32***
	(0.0479)	(0.0497)	(0.0618)
Age started school	-0.39***	-0.36***	-0.28***
	(0.0155)	(0.0154)	(0.0135)
Observations	12011	12008	12008

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$
Result is based on a panel of Tanzanian children who have ever attended school and were 6 to 18 years old in 2008.

Table 5. Effect of asset ownership on children's educational achievement in Tanzania

	Dependent variable: Passed PSLE test (1=yes, 0=no)		
	RE	RE	HTIV
Household asset index		0.0040	0.00047
		(0.00368)	(0.00456)
Agri. asset index		-0.0042	-0.0040*
		(0.00344)	(0.00240)
Dwelling Index		0.018***	-0.0029
		(0.00603)	(0.00697)
Community asset index		0.0098***	0.0066*
		(0.00307)	(0.00349)
Log(Total expenditure)	0.013	0.0050	-0.014
	(0.0132)	(0.0142)	(0.0147)
Loan, last 12 months (1=yes, 0=no)	-0.0084	0.0020	-0.0015
	(0.0176)	(0.0171)	(0.0172)
Max. parent's education	0.056***	0.063***	0.22***
	(0.00814)	(0.00928)	(0.0262)
Gender (1=male, 0=female)	0.066***	0.092***	0.100***
	(0.0210)	(0.0233)	(0.0261)
Age started school	-0.020***	-0.015**	-0.0071
	(0.00687)	(0.00712)	(0.00609)
Observations	2649	2647	2647

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$
Results are based on a panel of children age 18 or under in 2008/09 and have taken the PSLE test at least once.
Results are presented for key variables only, estimated model includes more variables.

Table 6: Effect of asset ownership on stunting among children 5 or under

	Dependent variable: Stunting (1 if HAZ <-1, 0 else)		
	RE	RE	HTIV
Household asset index		-0.019**	-0.029**
		(0.00880)	(0.0142)
Agri. asset index		-0.027***	-0.027***
		(0.00647)	(0.00970)
Dwelling Index		-0.0038	0.0026
		(0.0130)	(0.0178)
Community index		0.0030	0.0033
		(0.00737)	(0.00773)
Log(Total expenditure)	-0.088***	-0.057**	-0.046
	(0.0236)	(0.0250)	(0.0296)
Loan, last 12 months (1=yes, 0=no)	-0.022	-0.012	-0.011
	(0.0432)	(0.0431)	(0.0430)
Max. parent's education	0.00029	0.010	0.0029
	(0.0140)	(0.0149)	(0.0451)
Gender (1=male,0=female)	0.12***	0.12***	0.12***
	(0.0301)	(0.0298)	(0.0307)
Age (months)	0.0034***	0.0033***	0.0033***
	(0.0006)	(0.0006)	(0.0006)
Observations	1378	1378	1378

Notes. Standard errors in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$
Results are based on panel of children age 5 or under in all 3 NPS waves. Results are presented for key variables only, estimated model includes more variables.

Table 7. Effect of asset ownership on underweight among children of age 5 or under

	Dependent variable: underweight (1 if WHZ <-1, 0 else)		
	RE	RE	HTIV
Household asset index		-0.0097	-0.015
		(0.00904)	(0.0138)
Agri. asset index		-0.0099	-0.016*
		(0.00692)	(0.00938)
Dwelling Index		-0.016	-0.020
		(0.0123)	(0.0174)
Community index		0.011	0.011
		(0.00783)	(0.00786)
Log(Total expenditure)	-0.073***	-0.054**	-0.029
	(0.0238)	(0.0262)	(0.0292)
Loan, last 12 months (1=yes, 0=no)	-0.039	-0.032	-0.030
	(0.0399)	(0.0400)	(0.0428)
Max. parent's education	-0.0021	0.0098	-0.0036
	(0.0137)	(0.0151)	(0.0464)
Gender (1=male,0=female)	0.078**	0.080**	0.081**
	(0.0325)	(0.0323)	(0.0341)
Age (months)	0.0057***	0.0055***	0.0053***
	(0.000619)	(0.000625)	(0.000606)
Observations	1378	1378	1378

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$
Results are based on panel of children age 5 or under in all 3 NPS waves. Results are presented for key variables only, estimated model includes more variables.

Figures

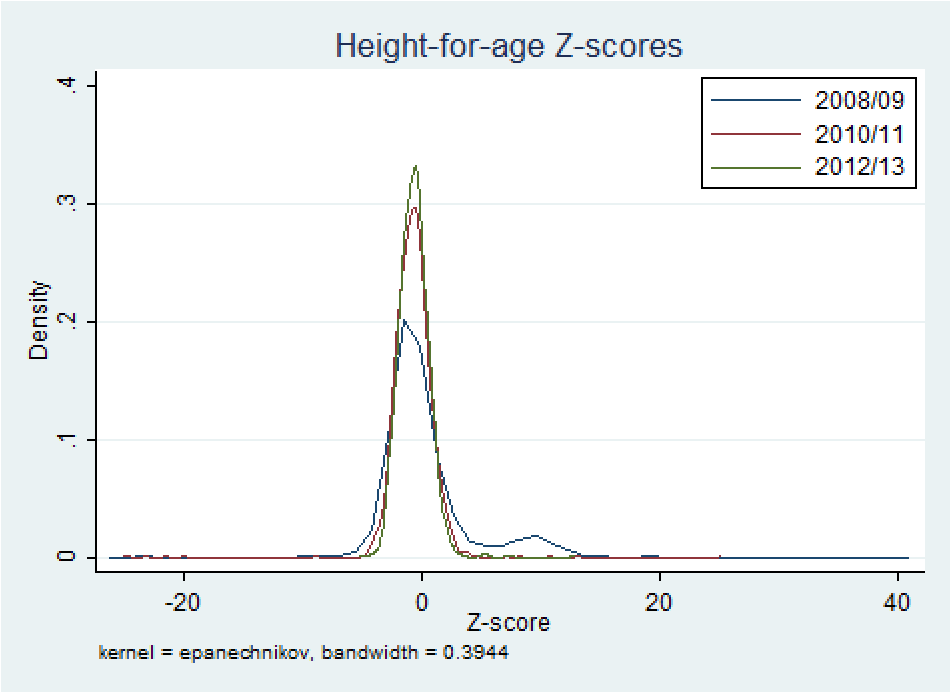

Figure 1: Height-for-age Z-scores for children 5 or younger

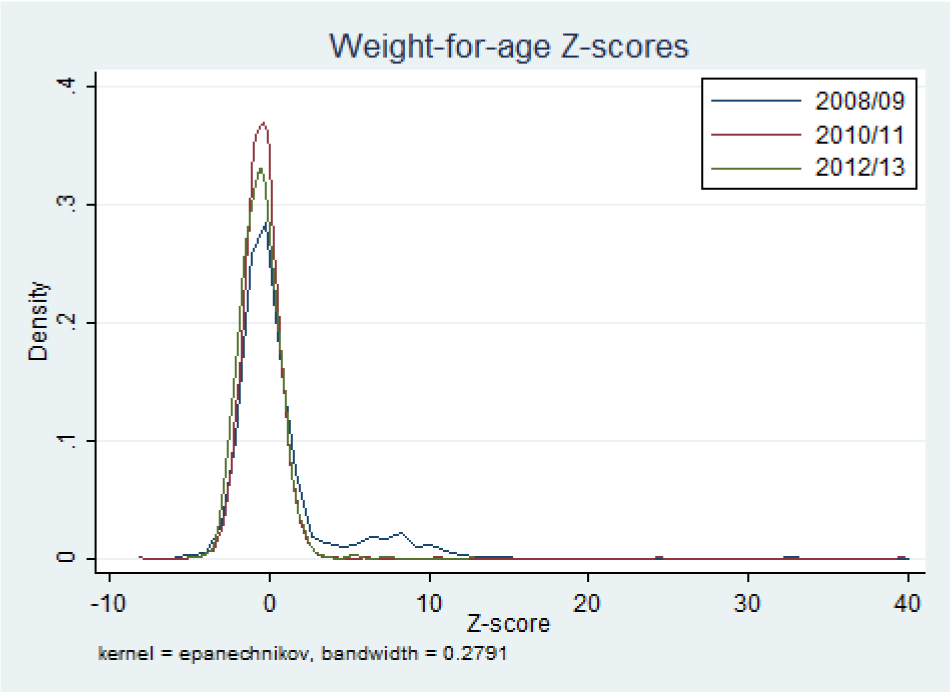

Figure 2: Weight-for-age Z-scores for children 5 or younger

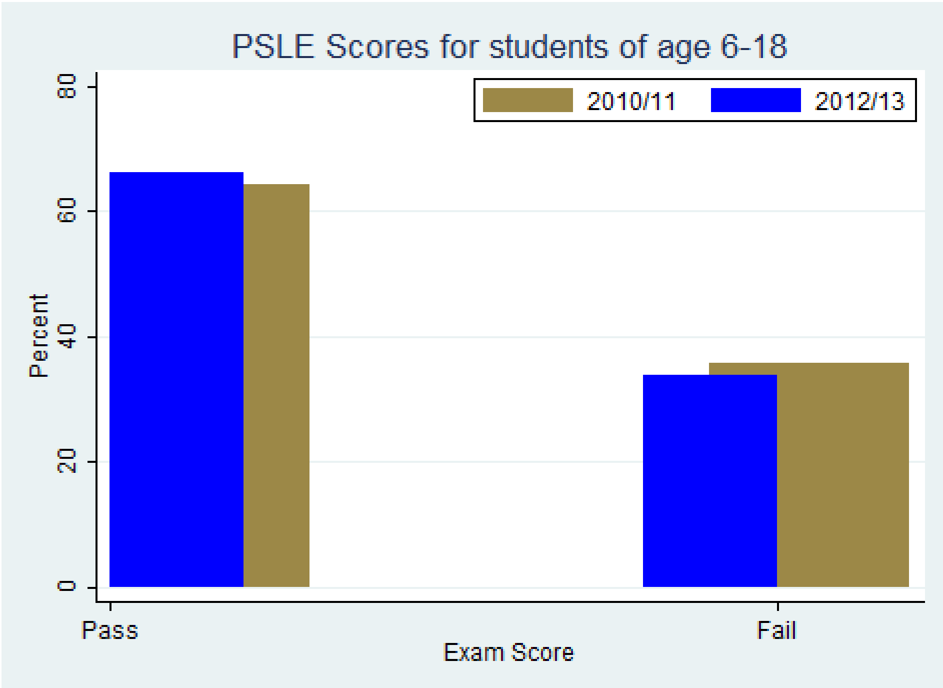

Figure 3: Primary school leaving exam (PSLE) scores for children 18 or younger

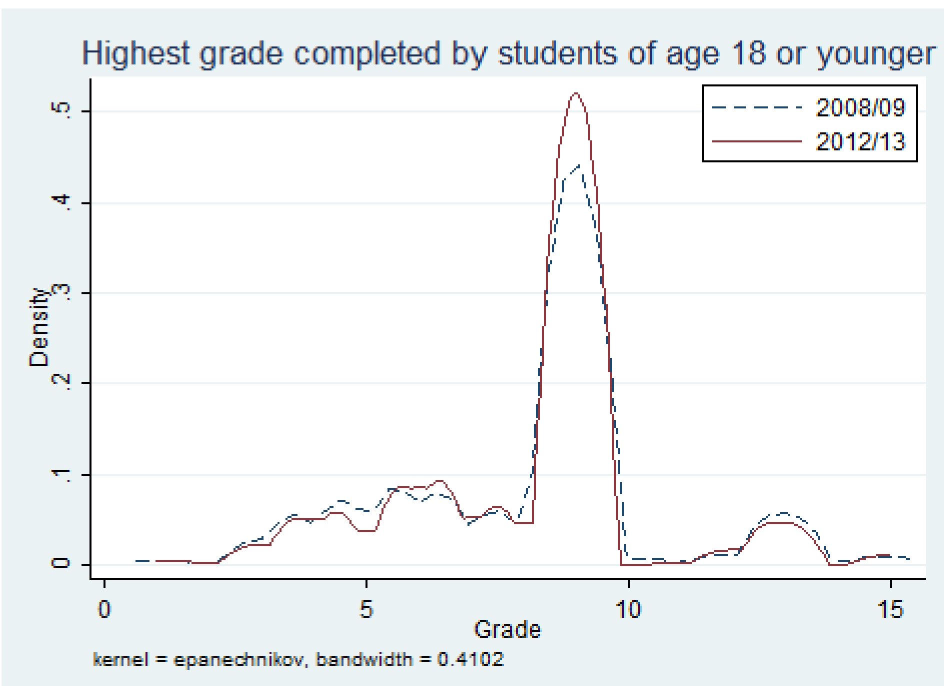

Figure 4: Highest grade completed by children 18 or younger