
# Effects of household asset holdings on child educational performance: Evidence from Tanzania

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## Abstract

*This paper estimates differentiated effects of household asset ownership on educational outcomes of children ages 6 and above in Tanzania. The paper contributes to the literature by providing a theoretical framework that portrays a mechanism for different assets to have differential effects on child education. We use data from Living Standard Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) in Tanzania which provides panel data on both household wellbeing and agricultural practices and resources. Use of the LSMS-ISA data allows us to disentangle the complicated relationship between child education and agricultural assets in ways which would not be possible using traditional cross-sectional surveys of either household wellbeing or farm practices. We use the Hausman-Taylor instrumental variable (HTIV) panel-data estimator to efficiently control for time-invariant variables omitted from our specifications while allowing us to identify the effects of fixed controls while correcting for the endogeneity of assets. We find that, controlling for household income, different asset types have opposing effects on child educational outcomes. Household durables and housing quality characteristics have positive effects but agricultural assets have adverse effects on highest grade completed and test scores. We demonstrate that the negative effect of agricultural assets emerges from higher opportunity cost of schooling and that the effect is more pronounced among boys and children from poor households, grain crop farmers, and rural residents.*



**JEL codes**: I25, J22, D13, O12

**Keywords**: asset ownership, child education, highest grade completed, test scores

## 1. Introduction

Most policy interventions aiming to improve livelihood and reduce poverty transfer economic resources. A growing body of literature indicates that such programs usually transfer income generating assets such as livestock or agricultural inputs, cash, or other in-kind physical assets. While a common form of asset transfer is livestock transfer, for example BRAC's Ultra-poor Program in Bangladesh (Das and Shams 2011), programs transferring agricultural inputs (Denning et al. 2009) and other in-kind physical assets have been increasingly popular and equally effective (Banerjee et al. 2015; Muralidharan and Prakash 2013). Other forms of interventions, such as cash transfer or training programs, which do not transfer assets directly do contribute to asset accumulation by increasing household income. Meanwhile, there is a strong current in the development literature advocating for cash transfers as superior to other asset transfers (Blattman and Niehaus 2014). Yet, most economic development programs may increase household asset holdings and assets can have multidimensional effects on household and individual well-being. Among other relationships, there is a growing interest in the effect of assets on child development outcomes (Lerman and McKernan 2013; Loke 2013).

A large body of evidence indicates that assets are a strong determinant of child educational outcomes (Deng et al. 2014; Chowa et al. 2013; Huang 2013; Huang 2011; Elliott, Destin and Friedline 2011; Kim and Sherraden 2011; Shanks 2007; Zhan and Sherraden 2003; Conley 2001), but much of the existing literature views the effect of assets as primarily operating through wealth effects. However, changes in the composition of asset holdings, apart from changing wealth, may affect child education in various ways. Agricultural assets might raise the returns to child labor, discouraging education investment, while other assets could raise the efficiencies of time spent studying (e.g. electricity, bicycle, and close source of water) and increase returns to schooling. An undifferentiated view of assets as a wealth indicator ignores the potential for different types of assets to have differential effects on child education. If there are heretofore unacknowledged differential effects across asset types, there could be scope to improve the design of asset transfer and public investment programs. While physical asset transfers may provide a practical approach for programs aiming to improve livelihood outcomes in the short run, some assets could influence the returns to child labor in ways that discourage investment in formal education and hurt longer term economic development.

The net effect of asset holdings on child education may depend on whether the return to child labor using the specific physical assets is higher than the expected return to schooling. If owning an asset increases the returns to child labor and therefore the opportunity cost of schooling, then an asset transfer could encourage parents to pull their children out of school for household or farm activities. The opportunity cost of schooling is high when assets are complements to child labor; while the expected return on schooling is low in communities where schools are of poor quality and for children who tend to perform poorly in school. For agrarian households, agricultural assets are complementary to child labor and may increase the opportunity cost of schooling. In contrast, assets like household durables and improved housing structures do not complement child labor and may in fact improve educational outcomes. The differential effects of assets also may vary with children's ability, gender, and household poverty. Children who perform poorly when in school are more likely to have lower returns to education and will be moved into household activities should assets increase the opportunity cost of schooling. Children who are doing better in school may not be pulled out because they have high expected returns to schooling. If farm assets grow in settings where boys are used more in agricultural operations, boys are more likely to be pulled out of school than girls. Similarly, when assets grow, poor children may suffer more as they have higher opportunity cost of schooling than rich children. The effect of assets on child education is governed by parental decisions and therefore parental education may also play a key role in the intensity of these effects. If this conceptual relationship between assets and child education persists, policies that transfer assets or help build assets may have unfavorable ramifications to child education. Therefore, the 'assets-child education' nexus deserves further scrutiny.

The conceptual framework considered in this paper provides intuitively appealing theoretical and empirical bases for expecting different assets to have differential effects on child education. We examine the relationship between assets and child labor drawing from the basic framework of the agricultural household models described in Singh, Squire and Strauss (1986). Showing the assets-child labor relation suffices under the assumption that child labor has a direct negative effect on child education. Unlike the theoretical exposition, our empirical approach estimates the effect of assets on child educational outcomes, directly. We perform our empirical

analysis using data from three waves of Tanzania National Panel Survey (NPS).[1] One complication in empirical approach is the potential endogeneity of assets, which the existing literature has not addressed (Lerman and McKernan 2013; Elliott et al. 2011). We correct for the potential endogeneity bias by using panel data estimators such as the Hausman-Taylor instrumental variable (HTIV) estimator for panel data. As opposed to the undifferentiated view of assets, we disentangle assets to three groups – household durables, agricultural assets, and housing quality characteristics – and estimate the effect of each asset type on child education. Our contribution to the literature is twofold. First, we establish a theoretical relation between different types of assets and child education under perfect and imperfect labor market conditions. Second, we establish a causal relationship between asset ownership and child education and demonstrate that different types of assets have differential effects on child education. We demonstrate that the negative effect of agricultural assets stems from higher opportunity cost of schooling and that the effect is more pronounced among boys and children from poor households, grain crop farmers, and rural residents.

## 2. Background

To the best of our knowledge, existing literature on the effects of assets on child education in developing countries is extremely limited (Elliott et al. 2011). A fairly large body of empirical studies examine the asset-child education association in developed countries but the vast majority of them estimated the effect of monetary value of assets rather than asset ownership. Many studies examine the question in the case of the United States using data from the Panel Study of Income Dynamics (PSID) and document a significant positive impact of asset holding on children's educational achievement (Elliott and Sherraden 2013; Loke 2013; Chowa et al. 2013; Huang 2013; Huang 2011; Shanks 2007; Zhan and Sherraden 2003; Conley 2001). Huang (2013) uses the PSID data to examine the effects of household assets (net worth) on transmission of parental abilities to child educational achievement and documents a positive causal relation. Conley (2001) also uses the PSID to investigate the effect of assets on children's post-secondary education and finds that children from asset rich households perform better in post-secondary education. Similarly, Kim and Sherraden (2011) assesses the effect of parental

[1] The Tanzania NPS is part of the LSMS-ISA program which aims to marry complex consumption-based household surveys with plot-crop detailed agricultural surveys. For more details on the LSMS-ISA, see: http://go.worldbank.org/BCLXW38HY0. The Tanzania NPS data, along with details on the sample and instrument design, are publicly available at: http://go.worldbank.org/OOLZL0UIR0.

asset holding ($ value) on educational attainment of high school and college students using data from the National Longitudinal Study of Youth 1979 and documents a positive relation between parental net worth and child education. In particular, homeownership and financial assets have positive causal relation with child educational attainment. Other researchers who examine the effect of assets on child education also find similar results but argue that the effect is more pronounced on early childhood (Huang 2011) and operates through mother's expectations of their children's educational achievement (Loke 2013).

Empirical evidence on the effects of asset ownership on child education in developing countries is limited. A recent study in China uses data from 2002 China Household Income Project and shows a significant causal relationship between assets (net worth and liquid assets) and educational attainment of children (Deng et al. 2014). Similar results are reported from Ghana where Chowa et al. (2013) uses baseline data from a field experiment among Ghanaian youth, Ghana Youth Save Experiment. In particular, their results indicate that youth from households that own at least one of the five key assets that are considered primary indicators of socioeconomic status – TV, refrigerators, electric iron, electric or gas stoves, and kerosene – outperformed the youth from control households in English test scores by at least one point. Despite some evidence of causal relation between assets and child education, confusions prevail as to what particular school outcomes to look at. Some studies measure child education with school enrollment (Filmer and Pritchett 2001) but others use test scores (Cockburn and Dostie 2007) or grade completed (Deng et al. 2014). Filmer and Pritchett (2001) examines the relationship between assets (net worth) and school enrolment and finds a wide gap in the school enrollment rate between rich and poor children in India. In particular, as the study reports, children from rich households are 31% more likely to be enrolled than children from poor households. Cockburn and Dostie (2007) investigates the relationship between time allocation and educational performance among Ethiopian children and reports a positive effect of having a close source of water on child education.

The scant body of empirical literature on child education-assets relationship also lacks a strong theoretical support. Cockburn and Dostie (2007) uses a variant of the agricultural household model and demonstrates that the effect of assets on child education varies with the type of assets. Cockburn and Dostie's point is that whenever expected return to schooling is less than return to child labor, providing households with more assets can have adverse effects on

child education because child labor demand increases with asset holdings. That child labor adversely affects child education is a common finding in the existing literature on this issue and enjoys strong theoretical and empirical support (Haile and Haile 2012; Basu, Das, and Datta 2010). As in Cockburn and Dostie (2007), Basu, Das and Dutta (2010) examines the effect of land holdings on child labor in rural India and discovers that when the labor market is missing, land holding size and child labor have an inverted U-shaped relationship. The main message from these studies is that when the labor market is complete, increase in household wealth decreases child labor and as a result child education improves. However, when the labor market is missing or imperfect, the effect of land holding on child labor (hence child education) is ambiguous. Basu and colleagues demonstrate that when the labor market is missing, the net effect of wealth (land) on child labor (education) depends on the specification of underlying utility and production functions.

While Cockburn and Dostie (2007) and Basu et al. (2010) provide a theoretical understanding of household wealth (land holding in both cases) and child labor, they do not provide evidence on how other household assets affect child labor and child education. Basu and colleagues estimated the effect of land holdings only and Cockburn and Dostie (2011) did not specifically test the hypothesis that different asset groups have differential effects on child education. The present paper empirically tests whether different types of assets have differential effects on child education and whether the effect of labor complementary assets is negative. In so doing, we first examine the data to verify that agricultural asset holding predicts child labor in agriculture, in our sample. We estimate a probit regression of child labor on all three types of assets and other control covariates for each of the three waves of the Tanzania LSMS survey. The results indicate that agricultural assets increase the likelihood of child labor but household durables and housing quality assets either decrease or have no effect on child labor (Table A1 in Appendix). The rest of the analysis considers child labor as a potential mechanism for causal effect of assets on child education. Next, we provide a theoretical model to demonstrate the inherent relationship between child labor and household asset holdings.

## 3. Theory

Our theoretical exposition builds on the model of child labor and landholding presented in Basu et al. (2010) who adopted the framework of the agricultural household model from Sing, Squire, and Strauss (1986). We start with the basic structure as described in Basu et al. (2010)

and introduce an education production function which constrains the household's utility maximization problem. We consider two different scenarios under each of two labor market conditions; the perfect labor market and missing labor market. In one case, the household is constrained by an education production function and in the other case it is not. Our primary interest is in the interactions between assets and human capital investments in education and so in both cases we include education production functions. Nonetheless, for completeness, we summarize the results from all four cases – perfect and missing labor market with and without education production function – in Table 1. In this analysis, we first demonstrate the effect of asset holding on child labor and household consumption in the settings of a perfect labor market. We then switch to the case of missing labor markets. In either case, we explicitly assume that child labor adversely affects child educational outcomes. Therefore, our theoretical analysis portrays the effect of assets on child labor but does not attempt to find direct effects on child education.

*Basic structure*

Consider an economy where each household has one adult and one child. The adult always prefers to work and takes no leisure. The child either works or goes to school but takes no leisure. Suppose each household is endowed with the following utility function.

$$u = u(c, l) \qquad 1)$$

where *c* is the total consumption and $l \in [0,1]$ is child labor hours, 0 indicates no child labor and 1 indicates no school/study hours. Since the adult always prefers to work, the total labor supply of the household is always $1+l$. The aggregate consumption good *c* increases utility but labor accrues disutility. We assume that the utility function is smooth and quasi-concave and the following relationship holds: $u_c > 0, u_{cc} \leq 0, u_l < 0,$ and $u_{ll} \leq 0$. Similarly, we assume that the cross marginal utilities are negative; $u_{cl}, u_{lc} < 0$.[2] Each household faces a budget constraint, is engaged in some kind of household production activity, and owns agricultural assets (*K*) and

[2] These are a reasonable assumption because utility increases with consumption ($u_c > 0$) but at a decreasing rate ($u_{cc} < 0$) i.e. diminishing marginal utility. In case of labor, utility decreases with labor ($u_l < 0$) and it does so at an increasing rate ($u_{ll} < 0$). In other words, the marginal disutility from labor increases with additional labor. We also assume that the marginal utility of consumption decreases with additional labor i.e. $u_{cl}, u_{lc} < 0$.

non-agricultural assets (*A*). If a household has a school attending child, the household also faces an education production function, and is liable to the cost of schooling, $p_q$.

### 3.1. The Perfect labor market case

When a well-functioning labor market exists, household can supply labor to off-farm activities and hire labor to work on its farm. All households are price takers and hire in/out labor at a market wage rate, *w*. Following Basu et al. (2010), we assume that both adults and children earn exactly the same wage. Suppose each household faces a production function, $Q(L, K)$, and an education production function, $q(s, A, \theta)$[3], where $L$ is total labor used in household production, $K$ is household's agricultural asset holding, $s=1-l$ is total school/study hours, $A$ is household's non-agricultural asset holding which may directly affect child education, and θ denotes 'other factors' that affect child education. In this analysis, we suppress θ for simplicity. Both production functions are quasi-concave and therefore, $Q_L, Q_K > 0; Q_{LL} < 0; Q_{LK} > 0$ and $q_s, q_A > 0; q_{ss} < 0$ and $q_{sA} > 0$. The household's problem is:

$$\max_{c,l} \quad u(c, l) \quad \text{subject to}$$
$$Q = Q(L, K)$$
$$q = q(s, A) \text{ and}$$
$$c + p_q q = Q + y + w(H - L) \qquad (2)$$

where $Q$ is output produced, $q$ is children's educational outcomes, $p_q$ is unit cost of child education, $y$ is non-labor income, and $H = 1 + l$ is total labor supply of the household. Household supplies labor off-farm if $H > L$ and hires labor from outside if $H < L$. Since labor market is well-functioning and household can hire in/out labor as needed, production decision is separable from consumption decision. If a household possesses $K$ units of agricultural assets, it can earn a

[3] To the best of our knowledge, no previous studies introduced education production function in the settings of agricultural household model. Introducing education production function may make the model complicated but the added complications help us understand the potential effects of assets and tools that are not used in agricultural production and may have direct impact on child education. Models with child education functions are more realistic because most agricultural households these days face a decision of sending children to school or not, and this is increasingly so in developing countries.

profit of $\pi(w, K)$. Therefore, $c + p_q q = \pi(w, K) + wH$ + y. The household's problem simplifies to

$$u(c, l) - \lambda[c + p_q q - \pi(w, K) - w(1 + l) - y] \quad 3)$$

Rearranging the first order condition from equation (3) gives us the following expressions

i.) $\frac{u_l}{u_c} \equiv Z = -(p_q q_s + w)$

ii.) $c + p_q q = \pi(w, K) + w(1 + l) + y$

Totally differentiating the above expressions with respect to *K* and solving the resulting equations, we get

$$\frac{\delta l}{\delta K} = -\frac{z_c \pi_K}{z_c(p_q q_s + w) + (z_l - p_q q_{ss})} \text{ and } \frac{\delta c}{\delta K} = \frac{(z_l - p_q q_{ss})\pi_K}{z_c(p_q q_s + w) + (z_l - p_q q_{ss})}$$

By assumption, $\pi_K > 0, q_s > 0,$ and $q_{ss} < 0,$ and we can demonstrate that $z_c < 0, z_l < 0$.[4] Therefore, when the labor market is perfect, agricultural asset accumulation at the household level decreases child labor, i.e. $\frac{\delta l}{\delta K} < 0$ but increases household consumption i.e. $\frac{\delta c}{\delta K} > 0$. Similarly, differentiating expressions i.) and ii.) with respect to income *y* gives us the following conditions.

$$\frac{\delta l}{\delta y} = -\frac{z_c}{z_c w + z_l} < 0 \text{ and } \frac{\delta c}{\delta y} = \frac{z_l}{z_c w + z_l} > 0$$

This indicates that exogenous increase in income or assets unambiguously reduces (increases) child labor (consumption) when the labor market is perfect. This is consistent with previous findings that exogenous increase in land holdings decreases child labor when labor market is perfect (Basu et al. 2010 and Dostie and Cockburn 2007). However, further analysis shows that, unlike agricultural assets, increase in education-specific assets has negative effects on household

[4] We view this as a reasonable assumption because marginal rate of substitution between child labor and consumption may decrease with consumption, i.e. $z_c = \frac{\delta}{\delta c}\frac{u_l}{u_c} = \frac{u_{lc}u_c - u_l u_{cc}}{u_c^2} < 0$ because $u_c > 0, u_{lc} < 0$ and $u_l, u_{cc} < 0$, by assumption. Similarly, $z_l < 0$.

consumption ($\frac{\delta c}{\delta A} < 0$) and ambiguous effects on child labor.[5] Results imply that, when the labor market functions perfectly, the income effect on child labor is always negative but the effect of assets depends on asset types. Since assets are likely to affect household income, the net effect of increase in assets is ambiguous. The ambiguity gets more complicated when the labor market is missing. Next, we provide a detailed analysis of the case of missing labor market when households face both production functions.

### 3.2. The missing labor market case

In this case each household's consumption decisions are non-separable from production decisions. No outside labor is hired and no household labor is supplied to off-farm activities. Since the market wage does not exist, the household's problem in (2) is modified as

$$\max_{c,l} u(c,l) \text{ subject to}$$
$$Q = Q(L,K),$$
$$q = q(s,A) \text{ and } c + p_q q = Q + y \qquad 4)$$

Because of non-separability, the household's problem simplifies to

$$u(c,l) - \lambda[c + p_q q(s,A) - Q(L,K) - y] \qquad 5)$$

Solving the equation (5) gives us the following first order conditions (FOCs)

iii.) $\frac{u_l}{u_c} \equiv Z = -[p_q q_s + Q_L]$

iv.) $c + p_q q = Q + y$

Differentiating the first order conditions with respect to agricultural assets, *K*, we get

$$\frac{\delta l}{\delta K} = -\frac{Q_K z_c + Q_{LK}}{\alpha + \beta}$$

where $\alpha = z_c(p_q q_s + Q_L)$ and $\beta = (z_l - p_q q_{ss} + Q_{LL})$

[5] Differentiating conditions i) and ii) with respect to non-agricultural assets (A), we get, $\frac{\delta l}{\delta A} = \frac{z_c(p_q q_A) - p_q q_{SA}}{z_l(p_q q_s + w) + (z_e - p_q q_{ss})}$ and $\frac{\delta c}{\delta A} = \frac{p_q q_{SA}(p_q q_s + w) + p_q q_A(z_e - p_q q_{ss})}{z_l(p_q q_s + w) + (z_e - p_q q_{ss})}$, where $\frac{\delta c}{\delta A} > 0$ because both numerator and denominators are positive but $\frac{\delta l}{\delta A}$ can be negative or positive depending on the sign of numerator.

The numerator is always positive but the sign of denominator depends on the sign of the expression $\beta = z_l - p_q q_{ss} + Q_{LL}$. Since $Q_L, q_s > 0$ and $Q_{LL}, q_{ss} < 0$, we know that α > 0 and β is ambiguous. This implies that when the change in the marginal product of additional labor is very small (i.e. $Q_{LL} \approx 0$), child labor decreases with agricultural assets. However, when the change in the marginal product of labor outweighs the marginal value of additional school hours so that that (α +β) <0, then agricultural assets always increase child labor. The ambiguous effect of assets is further complicated because assets contribute to household income and the income effect on child labor may work on different direction than the direct effects of assets. To understand the income effect, we differentiate the FOCs with respect to non-labor income *y*; we get

$$\frac{\delta l}{\delta y} = -\frac{z_c}{\alpha + \beta}$$

Again, like agricultural assets, child labor decreases with income when the change in the marginal value product of child labor is smaller than the change in the marginal value product of school hours (i.e.$|Q_{LL}| < |p_q q_{ss}|$). When the change in the marginal product of labor increases with an additional unit of labor leading to (α + β) <0, higher income also may lead to higher demand of child labor. If the expected return to schooling is higher or the opportunity cost of schooling is lower, then increase in both agricultural asset holdings and non-labor income decrease child labor and improve child education. This is consistent with economic theory of factor productivity in that child labor increases when returns to labor is higher than expected return to schooling and child school hours increase when expected return to schooling is higher. Similar ambiguity prevails on the income effect on household consumption because $\frac{\delta c}{\delta y} = \frac{\beta}{\alpha + \beta}$ and household consumption goes up with income as long as the change in marginal value of child school hours is higher than the change in marginal product of child labor (i.e. β >0).

We summarize our theoretical results in Table 1. Results in case 1 and case 3 are essentially replication of Basu et al. (2010) and Dostie and Cockburn (2007) except that we use agricultural assets in general as opposed to use of land ownership as the only asset in these studies. Case 2 and case 4 are novel and more realistic in that they consider both household and education production functions and explicitly model the cost of education. Overall, the results

imply that, effects of exogenous increase in assets and income are clearly discernable when labor market is perfect. When no labor market exists and households have to make production and consumption decisions simultaneously, the effects of assets and income are more complicated to understand (Table 1). We resort to a rigorous empirical analysis to help unpack the ambiguous effect of assets and income on child education. In our empirical analysis, we are able to demonstrate that household income always has positive effect on child education and the effect of assets depends on asset types.

--Table 1 here --

The rest of the paper focuses on empirical analysis. First, we provide an overview of Tanzanian educational system followed by nature of the data and research method we employ. We then discuss our empirical findings before we make concluding remarks.

## 4. Tanzanian educational system

This analysis measures educational outcomes in the context of progression through the Tanzanian school system, represented in Figure 1. In Tanzania primary school consists grades 1 to 7 and marks its completion with a national level examination called primary school leaving exam (PSLE) at the end of the $7^{th}$ grade.

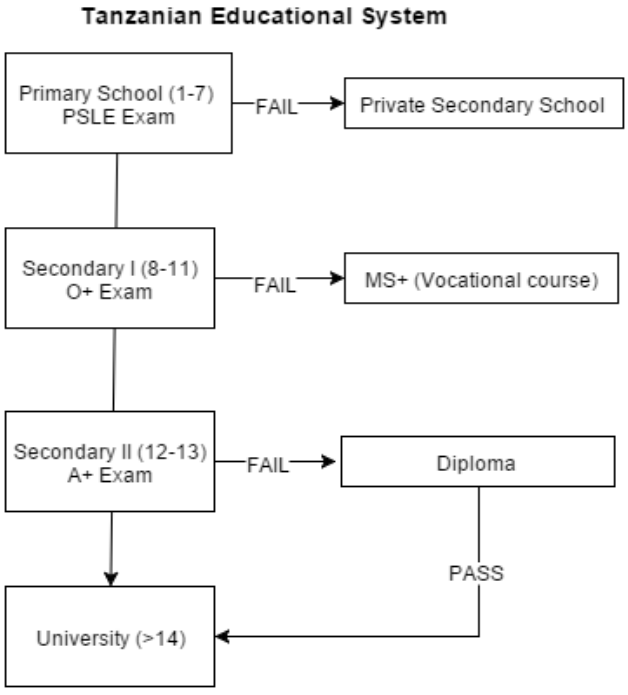


Figure 1. Educational system in Tanzania

A pass score in the PSLE test is required to proceed to government secondary school. Those who fail the PSLE test can either retake the exam, proceed to private secondary school, or end their formal education. The first tier of secondary school ends after four years of schooling with another national level examination called Form IV exam (FIVE), alternatively O+ exam, at the end of the $11^{th}$ grade. Students passing the FIVE test can proceed to the second tier of secondary school and those who fail the FIVE test can either retake the exam or enroll in vocational courses (MS+). After two years of schooling at the higher secondary level, students take yet another national level examination, Form VI exam (also called A+ exam) at the end of the $13^{th}$ grade. Students passing the A+ exam can directly go to university but those who fail the exam have to pass a diploma course before they can go to university. Secondary school with A+ exam in Tanzania is equivalent to high school in the United States.

## 5. Data and method

### 5.1. Asset variables

Assets are broadly defined and they include household durables, housing quality characteristics, and agricultural assets. Household durables include tools and equipment used in the household such as television, radio, cellphone, bicycle etc. Housing quality characteristics consist information about type of floor, roof, and wall materials, number of rooms, access to electricity, safe drinking water, toilet facility etc. Similarly, agricultural assets include farm tools, equipment, livestock, and livestock related assets. Since each asset group consists of several individual assets, we run into a problem of finding appropriate weight for each asset. Including individual assets as explanatory variables in the regression equation correctly assigns weights but may not be pragmatic because no individual assets can serve as a wealth measure. Several previous studies rely on the principal component approach which assigns weight to the components 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 Scott 2008; Vyas and Kumaranayake 2006; McKenzie 2005; Filmer and Pritchett 2001). We use the principal component approach to create asset indices for the three different asset types – household durable assets, agricultural assets, and housing quality characteristics. Table 2 presents a list of individual assets under each category with their scoring factors – weight that is used to calculate the first principal component. The first component accounts for more than 26% variation in each case. In this analysis we are interested on the effect of all three indexes –

household durable index, agricultural asset index, and housing quality index – on child education.

--Table 2 here---

Demographic variables included in the analysis as controls are both at individual level (age, age started school, number of siblings, and maximum parent's education) and household level (age, sex, and marital status of household head and logarithm of total consumption expenditure). Other controls include binary indicators for school in local community[6], rural vs urban household, economic shock in the last 12 months, and household's access to credit and saving facilities. Whenever outcome variable is at the household level, no individual level control variables are included in the model.

**5.2. Outcome variables**

Based on the educational system in Tanzania, outcomes of interest for this analysis are the highest grade completed, the proportion of children in the household who pass the PSLE (PSLE ratio), and the proportion of children who pass the FIVE (FIVE ratio). The highest grade completed is a count variable ranging from 1 to 25. A grade of 25 marks the end of advanced university degree (eg. a PhD in the United States). For the highest grade completed, only the individuals who are 6-18 in the first round are included in the analysis. Individuals who have never attended school are not included because both school outcome and school related explanatory variables are missing for them. Individuals with informal schooling like adult education and other skill development trainings also are excluded. Currents students are included with their highest grade completed calculated as their current grade minus one. As the results are conditional on attending school, inference from our empirical results on the effects of assets on highest grade completed should be taken with caution.

While the highest grade completed is measured over individuals, the two pass ratios are measured at the household level, but both of them are based on children's individual performance in national examinations. The exam scores are recorded as pass or fail and individuals who pass the exam once will never retake the exam. On average 65% of students pass the test in the first attempt and retake rate among failing students is very low. In particular, only about 13% of students failing in the first attempt pass the test in the second attempt. As a

[6] School in local community is coded 1 when the community has a primary school or a secondary school, or both, and 0 if no school.

result, students passing the exam in the first attempt are coded 1 in all waves and the majority of students failing in the first attempt are coded 0 in all waves. Since there is little to no variation in individuals' outcomes over time, we create a household-level measure of performance to capture the impact of assets on educational outcomes. The PSLE ratio is the number of children in the household who pass the PSLE over the total number of children aged 6 to 18 in the same household. Similarly, the FIVE ratio is the proportion of the number of youth in the household who passed the FIVE to the total number of adolescents of age 18 to 24 in the same household. As these proportions can represent performance of school age children at the household level only, using these ratios limits our ability to make inference about individual performance in the PSLE and FIVE exams.

### 5.3. Econometric model

Our empirical approach considers the missing labor market case explained in section 3.2 because our sample consists primarily of agricultural households in rural settings. As described in section 3.1, child educational performance ($q$) is determined by school hours ($s$), non-agricultural assets ($A$), and other factors ($\theta$). Assume that the other factors include parental characteristics, household income ($I$), and child's individual ability ($QC_u$) and school hours depends on agricultural assets ($K$), and household income. Parental characteristics consist of observed characters such as education ($QP_e$) and unobserved characters such as ability ($QP_u$). Conceptually, child education is a function of parental characteristics, income, assets, and child ability. That is,

$$q = QP_e + QP_u + QC_u + A + K + I + error \tag{6}$$

We know that certain parental characteristics such as hereditary trait and other abilities directly transmit to their children, i.e. $QC_u = f(QP_u) + error$. This implies that child education can be predicted by observed parental characteristics, child's ability, assets, and income.

$$q = QP_e + \widetilde{QC}_u + Z + I + error \tag{7}$$

where $\widetilde{QC}_u = QC_u + f^{-1}(QC_u)$ is unobserved ability that is both inherited from parents and specific to the individual child and $Z$ indicates all household assets. Since the parental ability is correlated with parental education and household asset accumulation, the unobserved child ability ($QC_u$) is also correlated with both of them i.e. $corr(QC_u, QP_e) \neq 0$ and $corr(QC_u, Z) \neq 0$. Since the observed and unobserved variables are correlated and affect child education, we face the problem of endogeneity. We assume that these unobserved characteristics are time invariant and address the endogeneity problem empirically using panel data. We start with the following simple model for panel data.

$$q_{it} = X_{it}\Pi + u_i + \varepsilon_{it} \quad (8)$$

where *i* indicates individual and *t* indicates time, or survey round. Thus, $q_{it}$ is child *i*'s education outcome at time *t*, $X_{it}$ is a vector of explanatory variables which includes individual characteristics, parental characteristics, income, assets and other relevant controls, Π is matrix of coefficient estimates, $u_i$ is a time invariant individual effect[7], and $\varepsilon_{it}$ is idiosyncratic error term. We know that $u_i$ consists of unobserved individual abilities which are correlated with both asset ownership and parental education. Estimating equation (8) with the random effects model yields inconsistent estimates because the 'zero correlation' assumption is clearly violated. The fixed effects model is consistent but it drops all time constant variables along with the individual effect ($u_i$). As all asset indexes are time varying, effect of asset endowment can be consistently estimated with the fixed effect model. But, we would like to estimate the effects of time constant variables like parent's education and gender which cannot be included in a fixed effects model. Hausman and Taylor (1981) proposed an instrumental variable estimator (hereafter referred to as HTIV) to address this endogeneity problem. Specifically, replace (8) with:

$$q_{it} = x_{1it}\alpha + x_{2it}\beta + z_{1i}\theta + z_{2i}\gamma + u_i + \varepsilon_{it} \quad (9)$$

where $x_{1it}$ is a vector of time-varying exogenous variables such as age and household size, $x_{2it}$ is a vector of time-varying endogenous variables such as assets, $z_{1i}$ is a vector of time invariant exogenous variables such as gender and age started school, and $z_{2i}$ is a vector of time invariant

[7] Note that $u_i$ in equation (8) is equivalent to $QC_u$ in equations (6) and (7).

endogenous variables such as maximum parent's education. We assume that the idiosyncratic error term is correlated with no explanatory variables but the unobserved specific effect is correlated with both time-varying endogenous variables ($x_{2it}$) and time constant endogenous variables ($z_{2i}$). That is,

i.) $E(u_i|x_{2it}) \neq 0, E(u_i|z_{2i}) \neq 0$

ii.) $E(u_i|x_{1it}) = 0,\ E(u_i|z_{1i}) = 0$ and $E(\varepsilon_{it}|x_{1it}, x_{2it}, z_{1i}, z_{2i}) = 0$

The model specification in equation (9) provides a required framework for the HTIV model if conditions (i) and (ii) are satisfied. The HTIV model relies on instruments but the instruments come from within the model. In equation (9), $z_{1i}$ serves as an instrument for itself, the within transformations $x_{1it} - \bar{x}_{1i}$ and $x_{2it} - \bar{x}_{2i}$ serve as valid instruments for $x_{1it}$ and $x_{2it}$, respectively and the between transformation $\bar{x}_{1i}$ serves as a valid instrument for $z_{2i}$. With the instruments in hand, the final estimation of equation (9) with the HTIV method requires a generalized least squares (GLS) transformation of all the variables.[8] Conceptually, first, equation (9) is estimated with the fixed effects model saving the residual. The residual is used to run a regression on $z_{1i}$ and $z_{2i}$ by using $x_{1it}$ and $z_{1i}$ as instruments. All variables in the model are then transformed by using the estimated variance from the residual regression. The transformed model is estimated by using $x_{1it} - \bar{x}_{1i}, x_{2it} - \bar{x}_{2i}, z_{1i}$ and $\bar{x}_{1i}$ as instruments.

$$\ddot{q}_{it} = \ddot{x}_{1it}\alpha_1 + \ddot{x}_{2it}\beta_1 + \ddot{z}_{1i}\theta_1 + \ddot{z}_{2i}\gamma_1 + \ddot{u}_i + \ddot{\varepsilon}_{it} \tag{10}$$

where the double dot sign (¨) indicates the GLS transformation as mentioned above. In practice, estimating equation (9) with the fixed effects model or the HTIV method both yield consistent estimates but, the later approach is more efficient and can estimate coefficient estimates on time constant variables as well (Baltagi, Bresson and Pirotte 2003; Hausman and Taylor 1981). For comparison purposes, we estimate equation (9) with three different panel data estimators – random effects model, fixed effects model, and the HTIV model but our preferred model is HTIV. Estimating equation (9) with the HTIV model is equivalent to estimating equation (10) with 2SLS method. The coefficients of interest are β and γ in equation (9) and $\beta_1$ and $\gamma_1$ in equation (10).

[8] In practice, estimating equation (10) with 2SLS is equivalent to estimating equation (9) with the STATA in-built command 'XTHTAYLOR'. In this analysis, we use the XTHTAYLOR command specifying asset indexes and max. parent's education as endogenous.

### 5.4. Data

We use the data from Tanzania LSMS, also called National Panel Survey (NPS). The NPS is a nationally representative survey that is implemented by the National Bureau of Statistics of Tanzania with technical support from the World Bank. 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 increase in the sample size is due to household splits. The NPS maintains a relatively low attrition rate (4.8%) at the household level across all 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 overall 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 (excluding live-in servants) are considered eligible. Households and individuals are tracked to new locations when necessary. In this study, we use a balanced sample from the three survey rounds. The panel contains 3088 households and 14,577 individuals. 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 and FIVE variables, we use a panel of households with children aged 6-18 and 18-24, respectively, during the respective waves.

## 6. Results

### 6.1. Summary statistics

Summary statistics are presented in Tables 3-5. All point estimates are weighted to allow inferences to the population of either individuals or households, depending on the variable. Point estimates are accompanied by standard errors and number of observations. Table 3 presents demographic characteristics of sample in the first and third NPS waves.

---Table 3 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 descriptive statistics for the second wave but use them in the regression analysis. The average age of the population is 22 years in baseline and 26 years in the third survey wave. The average household size is about 6 in both waves and the majority (53%) of the household members are female. Among other demographics, parental and household head's characteristics are very important for the analysis because effect of assets on child education mostly operates through parental decisions about

child labor, schooling, intra-household resource allocation, and divisions of work. Parental education is measured with 'maximum parent's education', the maximum level of father and mother's education. As a vast majority of parents in our sample are not current students, we keep parental education constant across waves. On average, both parents and household heads have attended primary school but about 20% of the heads are still illiterate. Other characteristics of household head includes age, gender, and marital status. In baseline, household heads are relatively young with the average age of 46 years, 80% households have a male head, and about 80% of heads are married. As household heads are changing over time (due to death, migration, marriage etc.) household head's characteristics such as gender, marital status, and literacy rate need not be constant across waves.

---Table 4 here---

Children's educational outcomes are summarized in Table 4. As educational outcomes are not available for children who have never attended school, both our summary statistics and empirical results are conditional on attending school. Among the three educational outcomes, highest grade completed is based on the panel of children 6 to18 years old during the first NPS wave. We track the cohort of 6 to 18 year old children in baseline to estimate the effect of assets on 'highest grade completed'. The average grade completed is 8 in the first wave and remains about the same in the third wave as well. This indicates that most children stopped going to school after the PSLE exam (grade 7) or they are pulled out of school. As the primary school leaving exam (PSLE) and Form IV exam (FIVE) data are not available for the first wave, we use the PSLE and FIVE data from the second and third NPS surveys only. We also present school characteristics and not surprisingly, majority of schools are public schools (92%) with less than 1% boarding schools and some religious or other schools in 2008. After 4 years, the proportion of public schools decreased to 89% with about 6% increase in boarding school.

Asset indexes[9] and access to credit and loan services are presented in Table 5. All asset indexes have mean close to zero and identical signs in both waves. All asset indexes are constructed using the principal component analysis method. The aggregated asset index consists 54 components but the disaggregated indexes – household durables, agricultural assets, and housing quality assets – consist 23, 17, and 14 components, respectively. Data indicate that more

[9] Since we calculate asset indexes at the household level, we assume that all children within a household have equal access to household assets.

than 90% households have access to school in village but only about 6% households have access to credit and saving services. The proportion of loan taking households increase from 6% in 2008 to 11% in 2012.

---Table 5 here---

**6.2. Effects of assets on highest grade completed**

We use equation (9) to estimate the effects of assets on highest grade completed by children 6-18 years of age in round 1. In particular, equation 9 is estimated for two different model specifications using the random effects, fixed effects, and HTIV models. Both specifications are exactly the same in all but the endogenous time-varying variables. The first specification includes aggregated asset index as the only time-varying endogenous variable (Table 6) and the second specification includes all three sub-indexes (Table 7). Results in Table 8 and Table 9 also come from the second specification but several interaction terms are also included.[10] Standard errors are clustered at the household level in all regressions.

Tables are structured such that results in the first column are obtained from the random effects model which is inconsistent under conditions (i) and (ii) in section 5.3. Under the same conditions, results in the second and third columns are consistent as they are obtained from the fixed effects and HTIV models, respectively. Results in the third column are our preferred results because HTIV model is a more efficient estimator than the fixed effect model (Baltagi et al. 2003; Hausman and Taylor 1981). Efficiency gain is particularly important for our analysis because our data comes from a comprehensive nationally representative survey which is likely suffered from unforeseen measurement errors.

---Table 6 here---

Table 6 presents the effect of aggregated asset index on the highest grade completed by children. After controlling for the endogeneity, the aggregate wealth (assets) index has no effect but having a school in village positively affects child education. As expected, both household income and parental education help children achieve higher grades. In particular, about 5%

[10] The basic estimating equation in this case is specified as follows: $Qc_{it} = x_{1it}\alpha + x_{2it}\beta + z_{1i}\theta + z_{2i}\gamma + u_i + \varepsilon_{it}$ where
$Qc_{it}$= highest grade completed,
$x_{1it}$ = (household size, age, age of head, sex of head, marital status of head, number of children 0-18, and dummies for access to credit, rural residence, and economic shock),
$x_{2it}$ = (asset index or sub-indexes depending on specification),
$z_{1i}$ = (sex, age started school), and
$z_{2i}$ = max. parent's education

increase in total expenditure and increase in parental education by one more level (such as primary to secondary school) have identical effect on child education in that both help children complete one more grade. Results indicate that, after controlling for endogeneity by using the HTIV method, effect of maximum parent's education on children's highest grade completed gets more than 4 times bigger than it was with the random effects model. This implies the potential endogeneity of parental education and shows the importance of using HTIV method over the fixed effect model. Among other controls, having a male head of household adversely effects children's grade level but girls are more likely to attend higher grades than boys. The level of education increases with age but late school starters hurt their chances of achieving higher grades. Finally, household size has smaller but significant negative effect on child education suggesting any increase in household size reduces child education.

--Table 7 here--

In Table 7, we disaggregate assets to three different groups – household durables, agricultural assets, and housing quality assets. Although aggregated wealth index has no effect on child education (Table 6), household durables have positive effects and agricultural assets have negative effects on children's highest grade completed. As agricultural assets include farm tools and equipment, land, and livestock, owning more agricultural assets may increase the opportunity cost of schooling and lead to higher child labor demand which contributes to poor school performance or school dropout. Overall, the adverse effect of agricultural assets is more than offset by household durables as the later has about three times larger effect than agricultural assets. The estimated effects of other variables including access to school in village are qualitatively identical to the results in Table 6.

---Table 8 here---

The evidence of negative effects of agricultural assets on the grade level completed is particularly striking because it may change the traditional view of wealth effect on education. Agricultural assets (or any productive assets) are a form of wealth, but they may behave differently than durable assets in that the productive assets incur labor and other input cost to be operational. Ownership of productive assets may indicate wealth acquisition but it may increase the opportunity cost of schooling and child labor demand, especially among agrarian households which have no or limited access to labor market. Table 8 builds on Table 7 by adding an interaction of agricultural assets and a binary indicator for on-farm agricultural child labor. We

use the interaction term to examine how agricultural assets affect child education when children are involved in own-farm agricultural activities. Clearly, effects of household durables and agricultural assets are consistent with Table 7 and still have opposing effects on child education. The larger coefficient of the interaction between agricultural assets and child labor indicator suggests that when children are working as unpaid own-farm labor, acquisition of agricultural assets has larger negative effect on children's highest grade completed. For children not working in agriculture, agricultural assets still have adverse effects on their education but the effect is much smaller in magnitude and is more than offset by the positive effects of household durables. Housing quality index still has no effect on child education but having a school in village appears to have even stronger positive effects.

Results indicate that while the effect of aggregate wealth index on child education is statistically insignificant, disaggregating assets to different sub categories have significant differential effects. The evidence points that an undifferentiated view of assets is misleading. It also implies that the opportunity cost of schooling rises with agricultural assets presumably through an effect on child labor in farming (Table 8). That agricultural assets increase child labor in agriculture is a striking result for policy makers and planners and deserves further exploration. In Table 9, we explore the potential mechanism of the negative effect by including various interactions between agricultural asset index and several variables in four different categories – agricultural activities, gender, wealth, and other demographics. Among the variables being interacted with agricultural asset index, all but maximum parent's education are binary indicators. So, the net effect of agricultural assets should be calculated as a weighted average of the coefficients on agricultural asset index and the associated interaction terms.[11]

---Table 9 here---

Results in Table 9 indicate that children in grain crop producing household see adverse effects from agricultural assets but livestock keeper's children are not as much affected. Interaction between agricultural assets and child sex indicator shows that boys pose an amplifying effect on the net effect of agricultural assets as their education is adversely affected from any increase in household agricultural asset holding. This is consistent with anecdotal evidence from developing countries that boys are more likely to forgo school for household

[11] For example the net effect of agricultural assets on education of children from grain crop producing households would be $w_1(-.43) + w_2(-0.064)/(w_1 + w_2)$ where w1 and w2 are specific weights for agricultural assets index and grain crop dummy.

agricultural activities in comparison to girls who usually take care of household and kitchen activities. However, having a male household head helps mitigate the negative effect of agricultural assets on child education. One possible explanation is that when the household head is a working age male, the head is available to take care of most agricultural activities that otherwise would have to be done by the children.

We consider wealth as another potential source of variation. Landownership indicates richness and 'poor' indicates poverty at or below second quartile of total consumption expenditure. Providing agricultural assets to both wealthy (landowners) and poor people has tempering effect on the net effect of agricultural assets but the negative effect is amplified when agricultural assets are provided to poor grain crop farmers. The results make a perfect sense in that the opportunity cost of schooling may not increase with agricultural assets if the household is not farming regardless of wealth status. In contrast, children from poor agricultural households may find it worthwhile to work on farm instead of going to school.

The last 3 rows of Table 9 indicate that easy access to school and parental education both have tempering effects on the negative effect of agricultural assets but the effect is amplified for children residing in rural communities. For example, educated parents may see larger expected return from sending kids to school; so the opportunity cost of schooling is not as high for their children and it may reduce child labor in agriculture. Similarly, children who live nearby a school may work on farm in the weekends or off-hours in weekdays and still attend school in the daytime. This would lead to the tempering effect of 'school in village' even when child labor is employed in agriculture.

**6.3. Effects of assets on exam performance**

We know from the earlier discussion that agricultural assets have negative effects on highest grade completed and the negative effects largely stem from child labor in agriculture because most agricultural assets are complement to child labor. While the 'highest grade completed' provides a valid measurement of school enrollment and grade completion, it still does not provide a measurement of individual performance in specific exams. We use the PSLE ratio to examine the effects of assets on school age children's performance in the primary school leaving exam (Table 10). Similarly, FIVE ratio is used to assess the effects of assets on adolescent's performance in the form IV exam (Table 11). Both tables present results from two different model specifications, one specifies the aggregated asset index as the only time-varying

endogenous variable and other specifies the three sub-indexes. We still use the framework in equation (9) and estimate both specifications with the random effects, fixed effects, and HTIV models but the analysis is carried out at the household level in contrast to individual level analysis for the highest grade completed. While the variables of interest are still the same, the set of control covariates has been updated by deleting all individual level controls and adding some household level controls.[12] In Tables 10 and 11, coefficient estimates on 'Asset index' come from the first specification and rest of the variables are from the second specification. We suppress the full results from the first specification because all control variables are exactly the same in both specifications and the estimated coefficients on the control variables from one specification are not qualitatively different from the other. Full results from the first specification are presented in Appendix (Table A2-A3).

Table 10 presents the estimated effects of asset holdings on the PLSE ratio, proportion of school age children passing the PSLE exam. Results indicate that the aggregated asset index has positive effect on PSLE performance. It means that acquiring additional assets by households improves their children's performance in the PSLE exam. It also suggests that the proportion of PSLE pass children is significantly higher in asset rich households as compared to asset poor households.

---Table 10 here---

Results from the second specification, where the asset index is disaggregated to three sub-indexes, reveals that the positive effect of aggregated asset index mainly comes from ownership of household durables and housing quality assets. However, in contrast to the 'highest grade completed', PSLE performance is not affected by agricultural assets at all. These results are robust in that similar results hold for performance in the FIVE test as well. Results in Table 11 indicate that the aggregated wealth index has strong positive effect on FIVE ratio and, again, the positive effect comes from household durables and housing quality index while agricultural assets have no effect. This implies that the effect of agricultural assets is not homogenous among children from the same household. For example, children doing well in school may not be affected from agricultural assets as much because parents may perceive the expected returns to

[12] The new set of control variables include log(total expenditure), education of head, age of head, sex of head, marital status of head, household size, number of children, and binary indicators for access to credit, residence in mainland or Zanzibar, and economic shock. Note that max parent's education is replaced by education of head because max parent's education is not unique across households. Also, rural vs. urban indicator is replaced with mainland vs Zanzibar indicator.

additional education for them as higher than the return to their farm labor. Children performing poorly in school may be seen to have lower expected returns to education relative to the return to their labor. In other words, opportunity cost of schooling for high performing children may be not as high because opportunity cost is a ratio of return to child labor over expected return to formal education and the expected return from schooling is higher for high performing children.

---Table 11 here---

Household consumption expenditure has a strong positive effect on PSLE and FIVE ratios, suggesting positive income effect on child education. Similarly, household head's education has a positive effect on both ratios. Specifically, having a household head with one more level of education contributes to 7% increase in the ratio of PSLE pass children and 9% increase in the ratio of FIVE pass children. Unlike the 'highest grade completed' having a school in local community has no effect on performance on either exam. An implication is that students who are doing well and still in school may find it worthwhile to travel to nearby community for schooling but, students who are not doing well may drop out when school is far away.

## 7. Conclusion

A large body of empirical evidence indicates that household wealth helps improve child education (Deng et al. 2014; Chowa et al. 2013; Huang 2013; Elliott, Destin and Friedline 2011; Kim and Sherraden 2011; Shanks 2007; Zhan and Sherraden 2003; Conley 2001). Despite the positive effect of household wealth, there is extremely limited empirical evidence on how different components of the wealth (i.e. different assets) contribute to child education after controlling for household income. In this paper we developed a simple theoretical model that explains as to how different types of assets can have differential effects on child education. Our model predicts, when labor market is perfect, increase in assets contributes to child education, but when labor market is missing, the effect of assets can go either way depending on asset types and other conditions. Under the assumption of missing labor market, our empirical results confirmed the theoretical findings and revealed that different assets have differential effects on child education presumably through child labor.

We showed that agricultural assets have adverse effect on the highest grade completed but have no effect on performance in the primary school leaving exam and the form IV exam.

This implies that agricultural assets may increase the opportunity cost of schooling for children but the increment may not be homogenous among siblings or other children in the same household. For children who are doing well in school, the opportunity cost of schooling is warranted because they have higher expected return from education than other children. As child schooling largely depends on parental decision about when and which child to send to school, parents may choose to take the low performing children out of school and invest more in 'good' children's education. This is likely the case in many developing countries and it certainly leads to negative effect of agricultural assets on grade completed or school enrollment but no effect on school performance because children who are still in school are not affected by household's endowment of agricultural assets. That agricultural assets have negative effects on child education because they are labor using technology and increase opportunity cost of schooling is well justified with the evidence of larger negative effect of agricultural assets for children working in household agricultural activities. Our finding that the negative effects of agricultural assets is amplified for all boys or children of grain crop farmers, poor children, and rural children but mitigated when the household head is male, there is a school in the village, and household owns land also backs up the evidence that the negative effect of agricultural assets operates through child labor in agriculture.

Household durable assets such as radio, TV, bicycle etc. have positive effects on both 'grade completed' and exam performance for children of age 6-18 and youth of age 18-24. Unlike agricultural assets, household durables are not labor using technology and they are unlikely to increase the opportunity cost of schooling. Instead, a large endowment of household durables is perceived as household wealth or higher socioeconomic status that contributes to better education for children via wealth effect. In addition, household durables may provide enhanced economic security and reduced economic stress among parents and that usually leads to better child education through good parenting. Housing quality assets have no effect on 'grade completed' but positive effect on both PSLE and FIVE test performances. This indicates that having access to facilities like electricity, safe drinking water, and good quality home may not increase 'grade completed' or school enrollment but it helps improve test performance for children who are still in school. It could be that the positive effect of housing quality index is a part of wealth effect on child education. Some assets such as access to electricity, safe drinking water, and good toilet facility may have a direct effect on child education as electricity helps

study and safe water and good toilet improve child health which may improve school performance.

Results imply that even though assets serve as a good predictor of child educational performance, asset based interventions that capitalize in agricultural assets may not be favorable for child education. From policy perspective, if child education is an intended goal of the intervention, transferring agricultural assets or other resources to build agricultural asset holding may not yield the desired result. In the context of Tanzania, program interventions that transfer livestock or help increase livestock herd size may be favorable for child education than providing other agricultural assets to grain crop growers, poor farmers, and households in rural areas. Our other findings imply that, despite the potential negative effect of agricultural assets on child education, there may be ways to transfer/help accumulate agricultural assets without compromising child education. Since the negative effect of agricultural assets essentially boils down to child labor in agriculture, asset based intervention conditional on 'no child labor in agriculture' policy may help increase household welfare without hurting child education; although implementing such a policy may be extremely difficult. Another implication of our findings is that transferring agricultural assets in combination with awareness training or adult education to parents, or establishing a public school in the target community also may help mitigate the potential adverse effects of agricultural assets on child education. In addition, asset transfer programs conditional on sending children to school may be another alternative.

Programs that help accumulate household durables or improve housing quality characteristics contribute to child education and therefore may be incorporated in policy interventions aiming to improve both household welfare and child education. Although policy interventions that transfer household durables or housing quality assets are rare, empirical findings in this study suggest that interventions that combine agricultural asset transfers with household durables or housing quality assets may contribute to household socioeconomic status as well as temper the potential negative effect of agricultural assets on child education. Since we control for household income, our findings should still hold regardless of the level of household income. One caveat is that this study does not consider the threshold level of income or asset holding above which change in asset ownership may have no effect on child education. In other words, if the demand for child education is inelastic to the opportunity cost of schooling, which may be the case for wealthy people, then our findings may not hold anymore. Otherwise, the

effect of assets on child outcomes are based on type of assets and policy interventions that help accumulate assets or directly transfer assets should be implemented with caution.

Overall, the key implication of this study is that assets are an important element of social policies that focus on improving both household and individual welfare. The traditional method of considering all assets under household's possession as an aggregated measure of household wealth may be misleading because different type of assets have differential effects on child education and this may be true for other outcomes too. The evidence that, even after controlling for household income, asset ownership has a significant causal impact on child education and the impact differs by the type of assets is a novel finding and deserves further exploration. If similar findings hold for other countries and contexts, it should help researchers and policymakers to design asset based interventions or all other policy interventions that help accumulate assets in a more meaningful way.

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**Tables**

Table 1. Effects of exogenous increase in assets and income on child labor and household consumption

| | Perfect labor market | | | | No labor market | | | |
|---|---|---|---|---|---|---|---|---|
| | Case 1 | | Case 2 | | Case 3 | | Case 4 | |
| | *l* | *c* | *l* | *c* | *l* | *c* | *l* | *c* |
| Agricultural Assets (K) | -ve | +ve | -ve | +ve | ± | ± | ± | ± |
| Assets specific to child education (A) | . | . | ± | -ve | . | . | ± | ± |
| Income (y) | -ve | +ve | -ve | +ve | ± | ± | ± | ± |
| Education production function (q) | No | | Yes | | No | | Yes | |

Notes. *l* indicates child labor, and *c* indicates household consumption. Similarly, -ve, +ve, and ±, indicate negative, positive, and ambiguous effects of assets or income, respectively, on child labor and household consumption.

Table 2. Scoring factors and summary statistics of household durable assets

| Household durables | Scoring factors | Agricultural assets | Scoring factors | Housing quality characteristics | Scoring factors |
|---|---|---|---|---|---|
| Radios | 0.154 | Hoes | 0.016 | Own dwelling (1=Yes 0=No) | -0.262 |
| TVs | 0.362 | Spraying machines | 0.085 | Rent dwelling (1=Yes 0=No) | 0.264 |
| Telephones (landline) | 0.137 | Water pumps | 0.149 | House wall (1=cement/concrete/stones, 0=else) | 0.345 |
| Telephones (mobile) | 0.314 | Reapers | 0.273 | House roof (1=metal sheets 0=else) | 0.257 |
| Refrigerators | 0.336 | Tractors | 0.294 | House floor (1=concrete/cement/tiles 0=else) | 0.352 |
| Sewing machines | 0.212 | Trailers | 0.288 | Number of rooms (=1 if 3 or more 0=else) | 0.004 |
| Video/DVDs | 0.20 | Ploughs | 0.102 | Safe water (1=boiled/bottled/treated 0=else) | 0.197 |
| Computers | 0.021 | Harrows | 0.313 | Water source (1=protected, 0=open source) | 0.242 |
| Irons (charcoal/electric) | 0.291 | Milking machines | 0.395 | Water hauling time (1=less than average 0=else) | 0.054 |
| Electric/gas stoves | 0.27 | Harvesters/threshers | 0.395 | Access to toilet (1=Yes 0=No) | -0.207 |
| Other Stoves | 0.246 | Hand milling machines | 0.298 | Toilet type (1=modern, 0=Vault/Pit) | 0.152 |
| Water heaters | 0.229 | Coffee pulping machines | 0.254 | Electricity (1=Yes 0=No) | 0.363 |
| Cassette players | 0.101 | Fertilizer distributors | 0.381 | Fuel source (1=electricity/gas/generator/solar,0=else) | 0.362 |
| Music systems | 0.146 | Livestock | 0.034 | Cooking fuel (1=firewood 0=else) | -0.352 |
| Cars | 0.225 | Poultries | 0.011 | | |
| Motor cycles | 0.135 | Donkeys | 0.064 | | |
| Carts | 0.10 | Plots | 0.017 | | |
| Bicycles | 0.057 | Outboard engines | 0.035 | | |
| Wheel barrows | 0.063 | Land owned(1=Yes 0=No) | -0.006 | | |
| Boats/canoes | 0.026 | Land rented(1=Yes 0=No) | -0.003 | | |
| Houses | -0.036 | Land shared(1=Yes 0=No) | -0.001 | | |
| Fan/ACs | 0.315 | Land free(1=Yes 0=No) | -0.008 | | |
| Dish antennas | 0.20 | | | | |
| *Observations* | 3088 | | 3088 | | 3088 |

Notes. All asset variables are in count, unless otherwise indicated. Asset indexes calculated by using binary indicators of asset ownership are not qualitatively different from the indexes resulting from count variables. Scoring factor is the weight that is used to calculate the first principal component. The first component explains 26% of the variance in durable assets

Table 3: Demographic Characteristics

| | NPS Wave 1 (2008/09) | | | NPS Wave 3 (2012/13) | | |
|---|---|---|---|---|---|---|
| | Mean | SE | N | Mean | SE | N |
| Age | 22.4 | 0.16 | 14577 | 26.2 | 0.16 | 14577 |
| Household size | 6.34 | 0.026 | 14577 | 6.33 | 0.027 | 14577 |
| Gender (1=male,0=female) | 0.48 | 0.004 | 14577 | 0.48 | 0.004 | 14577 |
| Age started school† | 8.07 | 0.021 | 9659 | 8.07 | 0.021 | 9659 |
| Maximum parent's education‡ | 2.63 | 0.011 | 14210 | 2.63 | 0.011 | 14210 |
| Annual consumption, real (million TSZ) | 2.89 | 0.023 | 14577 | 4.28 | 0.033 | 14482 |
| *Household head* | | | | | | |
| Age | 45.9 | 0.12 | 14577 | 47.7 | 0.12 | 14576 |
| Gender (1=male, 0= female) | 0.80 | 0.003 | 14577 | 0.78 | 0.003 | 14577 |
| Literacy rate | 0.79 | 0.003 | 14353 | 0.77 | 0.003 | 14496 |
| Education level (grade) | 2.30 | 0.009 | 14574 | 2.30 | 0.009 | 14574 |
| Marital status (1= married, 0 else) | 0.82 | 0.003 | 14577 | 0.78 | 0.003 | 14577 |

Notes. Point estimates are population weighted means. Standard errors are in the column next to the point estimates. Total disposable income and expenditure are in Tanzanian Shilling (TSZ).

†Number of observations of 'age started school' is much smaller than other variables because about 35% of the population has never attended school

‡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 4: Child educational outcomes and school characteristics

| | NPS Wave 1 (2008/09)† | | | NPS Wave 3 (2012/13) | | |
|---|---|---|---|---|---|---|
| | Mean | SE | N | Mean | SE | N |
| *Educational outcomes* | | | | | | |
| Highest grade completed | 8.08 | 4.13 | 10568 | 8.34 | 4.33 | 11389 |
| PSLE pass ratio‡ | 0.19 | 0.005 | 2906 | 0.24 | 0.006 | 2906 |
| FIVE pass ratio | 0.11 | 0.005 | 2769 | 0.13 | 0.006 | 2722 |
| *School characteristics* | | | | | | |
| School type (1=public, 0=private) | .92 | .26 | 4417 | .89 | .301 | 4275 |
| Boarding school (1= yes, 0= no) | .009 | .091 | 4417 | .072 | .26 | 4275 |
| Meals provided in school (1= yes, 0= no) | .038 | .19 | 4417 | .071 | .26 | 4275 |

Notes. Point estimates are population weighted means. Standard errors are in the column next to the point estimates.

†The PSLE and FIVE ratios are based on the data from NPS wave 2 (2010/11).

‡Primary school leaving exam (PSLE) and Form IV exam (FIVE) are national level examinations after grades 7 and 11, respectively. The PSLE and FIVE ratios are the proportions of children passing the PSLE and FIVE tests to total children of ages 6-18 and 16-24, respectively.

Table 5: Asset indexes and access to loan and credit services

| | NPS Wave 1 (2008/09) | | NPS Wave 2 (2008/09) | |
|---|---|---|---|---|
| | Mean | SE | Mean | SE |
| Asset index† | -0.69 | 0.053 | -0.75 | 0.052 |
| Household durable index | -0.32 | 0.035 | -0.30 | 0.038 |
| Agri. asset index | 0.019 | 0.043 | 0.095 | 0.024 |
| Housing quality index | -0.45 | 0.038 | -0.53 | 0.036 |
| School in village | 0.89 | 0.006 | 0.96 | 0.003 |
| Membership in credit group (1=yes, 0=no) | 0.054 | 0.004 | 0.060 | 0.004 |
| Loan, last 12 months (1=yes, 0=no) | 0.065 | 0.004 | 0.11 | 0.006 |
| Observations | 3088 | | 3088 | |

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

†Aggregated asset index consist of 54 components, and three sub-indexes – household durable index, agri. asset index, and housing quality index – consist 23, 17, and 14 components, respectively.

Table 6. Effect of asset ownership on children's educational achievement in Tanzania

| | Dep variable: Highest grade completed | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.27*** | 0.16*** | 0.22*** |
| | (0.034) | (0.040) | (0.035) |
| Asset index | 0.068*** | -0.020 | -0.010 |
| | (0.010) | (0.015) | (0.013) |
| School in village (1=yes,0=no) | 0.12*** | 0.016 | 0.11** |
| | (0.045) | (0.050) | (0.045) |
| Max. parent's education | 0.22*** | _ | 0.94*** |
| | (0.025) | | (0.080) |
| Gender (1=male,0=female) | -0.28*** | _ | -0.30*** |
| | (0.052) | | (0.060) |
| Head's gender (1=male, 0=female) | -0.22*** | -0.29*** | 0.0070 |
| | (0.079) | (0.112) | (0.056) |
| Age (years) | 0.82*** | 0.83*** | 0.82*** |
| | (0.008) | (0.010) | (0.007) |
| Age started school | -0.46*** | _ | -0.41*** |
| | (0.025) | | (0.025) |
| Household size | -0.063*** | -0.067*** | -0.063*** |
| | (0.014) | (0.017) | (0.013) |
| Observations | 11711 | 11711 | 11711 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. Results are based on panel of children who have attended school and were 6 to 18 years old in 2008. Results are presented for key variables only, estimated model includes additional variables:

Table 7. Effect of asset ownership on children's educational achievement in Tanzania

| | Dependent variable: Highest grade completed | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.23*** | 0.14*** | 0.20*** |
| | (0.034) | (0.041) | (0.036) |
| Household durable index | 0.072*** | 0.02 | 0.028** |
| | (0.014) | (0.016) | (0.014) |
| Agri. asset index | -0.0076** | -0.0099** | -0.01** |
| | (0.0036) | (0.0042) | (0.0043) |
| Housing quality index | 0.064*** | -0.016 | -0.006 |
| | (0.0170) | (0.0226) | (0.0193) |
| School in village (1=yes,0=no) | 0.12*** | 0.019 | 0.11** |
| | (0.045) | (0.050) | (0.045) |
| Max. parent's education | 0.20*** | _ | 0.87*** |
| | (0.0247) | | (0.0784) |
| Gender (1=male,0=female) | -0.28*** | _ | -0.29*** |
| | (0.0520) | | (0.059) |
| Head's gender (1=male, 0=female) | -0.23*** | -0.30*** | -0.19** |
| | (0.0794) | (0.112) | (0.079) |
| Age (years) | 0.82*** | 0.83*** | 0.82*** |
| | (0.008) | (0.010) | (0.0064) |
| Age started school | -0.46*** | _ | -0.41*** |
| | (0.0246) | | (0.025) |
| Household size | -0.069*** | -0.069*** | -0.068*** |
| | (0.014) | (0.017) | (0.013) |
| Observations | 11711 | 11711 | 11711 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. Results are based on panel of children who have ever attended school and were 6 to 18 years old in 2008. Results are presented for key variables only, estimated model includes more variables.

Table 8. Effect of agricultural assets and agricultural child labor on educational achievement

| | Dep variable: Highest grade | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.23*** | 0.14*** | 0.19*** |
| | (0.034) | (0.041) | (0.036) |
| Household durable index | 0.072*** | 0.020 | 0.026* |
| | (0.014) | (0.016) | (0.014) |
| Agri. asset index | -0.006 | -0.008* | -0.008* |
| | (0.004) | (0.004) | (0.004) |
| Ag. assets * Ag child labor (1=yes,0=no) | -0.028 | -0.027 | -0.029* |
| | (0.019) | (0.020) | (0.017) |
| Housing quality index | 0.061*** | -0.016 | -0.004 |
| | (0.017) | (0.022) | (0.019) |
| School in village (1=yes,0=no) | 0.17*** | 0.26*** | 0.29*** |
| | (0.065) | (0.089) | (0.075) |
| Max. parent's education | 0.205*** | _ | 0.927*** |
| | (0.025) | | (0.079) |
| Gender (1=male,0=female) | -0.283*** | _ | -0.297*** |
| | (0.052) | | (0.059) |
| Age (years) | 0.817*** | 0.828*** | 0.816*** |
| | (0.008) | (0.010) | (0.006) |
| Age started school | -0.454*** | _ | -0.403*** |
| | (0.025) | | (0.025) |
| Observations | 11711 | 11711 | 11711 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. Results are based on panel of children who have ever attended school and were 6 to 18 years old in 2008. Results are presented for key variables only, estimated model includes more variables.

Table 9. Effect of agricultural asset ownership on child education under various conditions

| | Dependent variable: Highest grade completed | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.22*** | 0.14*** | 0.21*** |
| | (0.034) | (0.041) | (0.036) |
| Household durable index | 0.07*** | 0.017 | 0.025* |
| | (0.014) | (0.0160) | (0.0137) |
| Agri. asset index | -0.34*** | -0.44*** | -0.43*** |
| | (0.0984) | (0.103) | (0.0894) |
| *Agricultural activities:* | | | |
| Ag. assets * Grain crop | -0.061*** | -0.061** | -0.064*** |
| | (0.0216) | (0.0242) | (0.0196) |
| Ag. assets * Large ruminant | 0.028 | 0.032 | 0.027 |
| | (0.0448) | (0.0454) | (0.0457) |
| *Gender:* | | | |
| Ag assets * Boys | -0.017*** | -0.016** | -0.016** |
| | (0.006) | (0.008) | (0.008) |
| Ag assets * Male head | 0.16** | 0.13** | 0.19*** |
| | (0.064) | (0.061) | (0.0544) |
| *Wealth:* | | | |
| Ag. assets * Land ownership | 0.19*** | 0.18*** | 0.20*** |
| | (0.0434) | (0.0407) | (0.041) |
| Ag. assets * Poor | 0.21*** | 0.19*** | 0.25*** |
| | (0.0661) | (0.0629) | (0.0578) |
| Ag. assets * Poor * Grain crop | -0.15** | -0.11 | -0.15** |
| | (0.0763) | (0.0746) | (0.0743) |
| *Other demographics:* | | | |
| Ag assets * School in village | 0.070 | 0.20*** | 0.13*** |
| | (0.0554) | (0.068) | (0.0463) |
| Ag. assets * Parent education | 0.018** | 0.018** | 0.018** |
| | (0.0076) | (0.008) | (0.008) |
| Ag. assets * Rural | -0.12*** | -0.12** | -0.12*** |
| | (0.043) | (0.049) | (0.039) |
| Observations | 11711 | 11711 | 11711 |

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

Table 10. Effect of asset ownership on Primary School Leaving Exam (PSLE) performance

| | Dependent variable: PSLE pass ratio | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.040*** | 0.027*** | 0.026*** |
| | (0.007) | (0.009) | (0.008) |
| Asset index† | 0.015*** | 0.014** | 0.017*** |
| | (0.002) | (0.005) | (0.004) |
| Household durable index | 0.0066** | 0.0065 | 0.0071* |
| | (0.0028) | (0.0047) | (0.0037) |
| Agri. asset index | 0.0023*** | 0.0012 | 0.0008 |
| | (0.0009) | (0.0009) | (0.0017) |
| Housing quality index | 0.018*** | 0.0074 | 0.013** |
| | (0.0034) | (0.0066) | (0.0049) |
| School in village | 0.006 | 0.011 | 0.008 |
| | (0.009) | (0.012) | (0.009) |
| Head: education | 0.035*** | _ | 0.071*** |
| | (0.0048) | | (0.0138) |
| Head: age | 0.0026*** | 0.0008 | 0.0029*** |
| | (0.0003) | (0.0009) | (0.0003) |
| Head: Gender (1=male, 0=female) | 0.012 | 0.038 | 0.0029 |
| | (0.0175) | (0.0318) | (0.0159) |
| Household size | -0.022*** | 0.0024 | -0.019*** |
| | (0.0026) | (0.0040) | (0.0028) |
| Observations | 5709 | 5709 | 5709 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. As the dependent variable is in the household level, no individual child characteristics are included in the model.

†Asset index comes from the first model specification which includes aggregated asset index. We suppress the full results from the first model specification because all other variables are exactly the same and the estimated effects of other variables are not qualitatively different from the results when assets are disaggregated.

Table 11. Effect of asset ownership on Form IV Exam (FIVE) performance

| | Dependent variable: FIVE pass ratio | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.029*** | 0.024*** | 0.027*** |
| | (0.006) | (0.008) | (0.008) |
| Asset index† | 0.018*** | 0.016*** | 0.019*** |
| | (0.002) | (0.005) | (0.003) |
| Household durable index | 0.012*** | 0.0073* | 0.0095*** |
| | (0.003) | (0.004) | (0.003) |
| Agri. asset index | 0.0001 | -0.0012 | -0.0017 |
| | (0.0009) | (0.0017) | (0.0016) |
| Housing quality index | 0.013*** | 0.011** | 0.012** |
| | (0.0029) | (0.0054) | (0.0046) |
| School in village | 0.0034 | 0.0074 | 0.0073 |
| | (0.0084) | (0.0114) | (0.0078) |
| Head: education | 0.053*** | _ | 0.090*** |
| | (0.00466) | | (0.0129) |
| Head: age | 0.0010*** | -0.0005 | 0.0015*** |
| | (0.0002) | (0.0007) | (0.0003) |
| Head: Gender (1=male, 0=female) | 0.011 | 0.013 | 0.0008 |
| | (0.0151) | (0.0294) | (0.0136) |
| Household size | -0.0074*** | 0.0015 | -0.0057*** |
| | (0.0014) | (0.0031) | (0.0018) |
| Observations | 5375 | 5375 | 5375 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. As the dependent variable is in the household level, no individual child characteristics are included in the model.

†Asset index comes from the first model specification which includes aggregated asset index. We suppress the full results from the first model specification because all other variables are exactly the same and the estimated effects of other variables are not qualitatively different from the results when assets are disaggregated.

## Appendix

Table A1. Likelihood of child labor on own-farm agricultural activities

| | NPS Survey Waves | | |
|---|---|---|---|
| | Wave 1 | Wave 2 | Wave 3 |
| Log(Total expenditure) | 0.19*** | 0.010 | 0.0017 |
| | (0.0530) | (0.0532) | (0.0507) |
| Household durable index | -0.049* | -0.022 | -0.028 |
| | (0.0252) | (0.0288) | (0.0196) |
| Agri. asset index | 0.018*** | 0.0034 | 0.036*** |
| | (0.0054) | (0.0047) | (0.012) |
| Max. parent's education | -0.034 | -0.13*** | -0.052** |
| | (0.0258) | (0.0265) | (0.025) |
| Household size | -0.0077 | -0.0013 | -0.011 |
| | (0.0073) | (0.0059) | (0.0074) |
| Gender (1=male,0=female) | 0.21*** | 0.15*** | 0.14*** |
| | (0.0511) | (0.0492) | (0.0481) |
| Age (years) | 0.12*** | 0.072*** | 0.058*** |
| | (0.0078) | (0.0072) | (0.007) |
| Head: age | 0.0013 | 0.00092 | -0.0030 |
| | (0.0021) | (0.0019) | (0.0018) |
| Head: gender (1=male, 0=female) | -0.20*** | -0.079 | -0.019 |
| | (0.064) | (0.063) | (0.0593) |
| Rural (1=rural, 0=urban) | 0.23*** | 0.37*** | 0.21*** |
| | (0.087) | (0.077) | (0.067) |
| Negative [economic] shock | -0.10* | 0.12** | 0.22*** |
| | (0.0518) | (0.0504) | (0.0492) |
| Farming households | 0.93*** | 0.82*** | 0.62*** |
| | (0.136) | (0.112) | (0.090) |
| Livestock keeping households | 0.26*** | 0.42*** | 0.62*** |
| | (0.0676) | (0.0676) | (0.0574) |
| Observations | 4007 | 4003 | 4005 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$. Dependent variable is child labor in agriculture (1= yes, 0 = no) and the results are obtained from simple probit model.

Table A2. Effect of asset ownership on primary school leaving exam performance

| | Dependent variable: PSLE pass ratio | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.041*** | 0.027*** | 0.025*** |
| | (0.0068) | (0.0086) | (0.0083) |
| Asset index | 0.015*** | 0.014** | 0.017*** |
| | (0.002) | (0.005) | (0.004) |
| School in village | 0.0064 | 0.012 | 0.011 |
| | (0.0094) | (0.012) | (0.009) |
| Head: education | 0.035*** | _ | 0.060*** |
| | (0.0048) | | (0.0141) |
| Head: age | 0.0027*** | 0.001 | 0.003*** |
| | (0.0004) | (0.0009) | (0.0003) |
| Head: Gender (1=male, 0=female) | 0.015 | 0.038 | 0.0072 |
| | (0.0175) | (0.0319) | (0.0159) |
| Household size | -0.022*** | 0.0032 | -0.019*** |
| | (0.0026) | (0.004) | (0.0028) |
| Observations | 5709 | 5709 | 5709 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$.

Table A3. Effect of asset ownership on Form IV Exam (FIVE) performance

| | Dependent variable: FIVE pass ratio | | |
|---|---|---|---|
| | RE | FE | HTIV |
| Log(Total expenditure) | 0.031*** | 0.024*** | 0.025*** |
| | (0.00600) | (0.00764) | (0.00804) |
| Asset index | 0.018*** | 0.016*** | 0.019*** |
| | (0.00215) | (0.00464) | (0.00336) |
| School in village | 0.0055 | 0.0081 | 0.014* |
| | (0.00839) | (0.0114) | (0.00803) |
| Head: education | 0.053*** | _ | 0.081*** |
| | (0.00458) | | (0.0129) |
| Head: age | 0.0013*** | -0.00032 | 0.0017*** |
| | (0.000240) | (0.000665) | (0.000300) |
| Head: Gender (1=male, 0=female) | 0.013 | 0.014 | 0.0031 |
| | (0.0150) | (0.0292) | (0.0136) |
| Household size | -0.0065*** | 0.0021 | -0.0040** |
| | (0.00139) | (0.00307) | (0.00186) |
| Observations | 5375 | 5375 | 5375 |

Notes. Standard errors are in parentheses. Significance level: * $p < .10$, ** $p < .05$, *** $p < .01$.