Entrepreneurship and household food security in Malawi

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Abstract

This study assessed the heterogeneous impacts of entrepreneurship on food security in Malawi using modern growth theory that incorporates endogenous entrepreneurship assumptions. Using representative Living Standards Measurement Surveys' panel data collected in 2010, 2013 and 2016, the study isolates direct causal effects using propensity score and novel quantile regression techniques that adjust for sample selection bias as a specification error. Results generally indicate that entrepreneurship is lower but has been steadily increasing over the survey periods. The mechanisms driving entry into entrepreneurship were demographic factors such as education, marital status and household size. Results also indicate that entrepreneurship has positive impacts on the value, variety and quantity of food consumed. Further, results indicate that the poorest quantiles benefit from entrepreneurship the most as compared to other quantiles. More important, overall impacts were above 50% across all quantiles of income. The household specific and heterogeneous impacts imply that investing in entrepreneurship promotion is not only a good strategy for economic development but is also pro-poor.

Introduction

Entrepreneurship can be a catalyst for economic growth through innovation (Schumpeter, 1934; Anokhin and Schulze, 2009). While factors, such as choice, personal characteristics, success and failure, entry and exit mechanisms, that drive entrepreneurship have been widely studied in management literature (Mwatsika, 2015; Naudé, 2014), there is a huge disconnect on implications of entrpreneurship on welfare and economic growth (Naudé, 2010). While in the past development economics literature largely relegated entrepreneurship to management sciences, it is only recently that its formalization has taken root. Naudé (2010) pointed out that the main reasons for the disconnect between entrepreneurship in management sciences and in mainstream development economics has been that, in the past, entrepreneurship was vaguely defined to be incorporated into formal economic growth theories.

The second reason is that entrepreneurship has commonly been treated as a binding constraint to economic growth. However, recent advances in economic theory have made entrepreneurship tractable by formalizing it in modern economic growth theories (Gries and Naudé, 2010). Using such growth models has enabled development research evaluate the implications of venturing into entrepreneurship on the inequality (Kimhi, 2010), productivity (Audretsch et al., 2006), economic transformation (Gries and Naudé, 2010) and welfare (Tamvada, 2010; Henrekson, 2005; Otoo et al., 2011). However, most of the work has been concentrated in developed countries (*see* Chowdhury et al., 2019; Erken et al., 2018; Parker, 2018; Audretsch et al., 2006; Hamilton, 2000). Of the few studies conducted in developing countries, none have explored the implications of entrepreneurship on one important indicator of welfare, food security. In most African

countries, achieving food security is one of the key goals such that evaluating the impact of entrepreneurship on such indicators would be of much policy relevance.

In the belief that entrpreneurship would induce structural change in economic activities by creating more value added and, therefore, growth to achieve the Millennium Development Goals (MDGs) of ending poverty and hunger, the Malawi Government prioritized entrepreneurship. As a market oriented strategy to ensure that all individuals meaningfully participate in wealth creation and poverty reduction, the government invested approximately seven million US Dollars in development of technical, entrepreneurial and business management skills through various vocational training and all schools across the country between 2011 and 2016 (Government of Malawi, 2011).

The question of evaluating the effect of entrepreneurship on food security is complex because of several problems. First, the government prioritized strategy was nation wide and non-ignorable as opposed to randomized or sequential exposure. Thus, we can only observe compliance by individuals who became entrepreneurs. Second, entrepreneurs can be systematically different from non-entrepreneurs since we can not easily describe the mechanism and motivations that determine entry into entrepreneurship let alone simply attribute the effect to the government strategy. However, with a proper selection bias correction framework, we can conditionally assess the treatment effect of entrepreneurship on food security.

This paper, therefore, assesses the distributional impacts of entrepreneurship on household food and nutrition security. In particular, we examine implications of entry into entrepreneurial activities on food consumption, dietary diversity as incomes change. We also explore the mechanisms driving entry into entrepreneurship and food consumption expenditure patterns. So far, no study has been conducted to empirically assess whether the programme achieved its goals of increasing incomes and end hunger. Part of the problem is that it is ethically and politically difficult to randomize access to such resources mainly due to the self selecting nature of individuals getting into entrepreneurship. For those households that venture into entrepreneurial activities, there could potentially be general equilibrium effects at population level due to backward and forward linkages of multisectoral activities. This paper, therefore, assesses the distributional impacts of entrepreneurship on household real consumption expenditure, food and nutrition security. In particular, we examine whether entry into entrepreneurial activities leads to more diverse diets as incomes change. We also explore the mechanisms driving food consumption expenditure patterns among entrepreneur households between 2011 and 2016.

Our study contributes to literature by combining modern economic growth theory with endogenous entrepreneurship assumptions. We further empirically apply a novel quantile regression technique that adjusts for selection bias to a recent three wave panel Living Standards Measurement Survey (LSMS) from Malawi. Literature on off-farm entrepreneurship and welfare outcomes in African settings is scarce and this

study aims to bridge that gap.

The rest of the paper is structured as follows. The second section presents the methodology where the theoretical framework, identification strategy and data are presented. The third section presents results beginning with descriptive analysis, then explicitly modeling entry into entrepreneurship to isolate Malawian context specific drivers. Then propensity score analysis follows to balance the data and isolate treatment effects on the treated at household level. A quantile regression model adjusted for selection bias is presented to assess heterogeneous effects of entrepreneurship. Section four discusses the results using economic theory and recent literature to draw policy implications. Section five summarizes and concludes.

Methods

Theoretical framework

An equilibrium growth model with entrepreneurship

Table 1 summarizes key equations of the model. Our model starts with entrepreneurial firms in each of the sector s producing output Q using factors F using constant returns to scale, equation 1 in Table 1. Entrepreneurial and managerial ability are part and parcel of the factors F. The model takes productivity a as endogenous and subject to the entrepreneur's capabilities and endowments, such that it determines shares of production technologies. We assume that firms maximize profits in such a way that factor payments W are equal to production revenues. Labour l is unemployed and fully mobile in the agricultural sector while in non-agricultural sectors is fully employed and sector specific. That is, unskilled labour from agriculture can easily move across the sectors i.e. a smallholder farmer can easily move to be employed or start a business in another sector while it is difficult for architects or doctors to switch between sectors but they can produce other economic activities e.g. entrepreneurial firms within those sectors. Land n, and capital are fully employed and sector specific. The entrepreneurial firm face investment demands I – equation 4, Table 1.

Households in the model maximize a Ramsey type intertemporal utility function (Barro and Sala-i Martin, 2004) subject to a budget line in equation 3, Table 1. That is, households pool their resources and livelihood activities and maximize a common utility function in cooperation (Becker, 1974). We have not shown the temporal dimension in the equations for brevity. Of note, household income Y is a function of total returns W – equation 2 – from productive activities of the entrepreneurial firm since they are eventual owners of factors of production F. Further, households face consumption demands D such that they utilize their income Y to purchase commodities at given market prices P.

We further assume that product, labour, capital and land markets are in equilibrium – equations 7,8,9 in Table 1. We also assume that entrepreneurial firms engage in international trade and government collects revenue through various taxes and levies but to keep the model sufficiently simple we have abstracted from explicitly modeling such policy instruments. For details see (Lofgren et al., 2002; Pauw et al., 2011). Normally, due to the complexity of linkages in the model, the model is solved analytically. However, since we have explicitly shown how each of the equations are linked, it is easier to assess equation (3) econometrically and assume that the other linkages are implicitly controlled for.

Table 1: Key Equations of the equilibrium growth model with entrepreneurship

Production function	$Q_s = a_s \cdot \pi_s \cdot \Pi_f F^{\delta_s}$	(1)
Factor payments	$W_f \cdot \Sigma_s \delta_{fs} \cdot P_s \cdot Q_s$	(2)
Household income	$Y_h = \sum_{fs} \theta_{hf} \cdot W_{f \cdot F_{fs}}$	(3)
Consumption demand	$P_s \cdot D_{hs} = \beta_{hs} \cdot (1 - v_h) \cdot Y_h$	(4)
Investment demand	$P_s \cdot I_s = \rho_s \cdot (\sum_h v_h \cdot Y_{ht})$	(5)
Product market equilibrium	$\sum_h D_{hs} + I_s = \sum Q_s$	(6)
Labour market equilibrium	$\sum_s F_{fs} = l - f$ where f is labour	(7
Capital market equilibrium	$F_{fs} = k_f$ where W_f is capital	(8)
Land market equilibrium	$F_{fs} = n_{fst} \lambda_{sf}$ where n is land	(9)
Subscripts	*Exogenous variables*	
f Factors of production	K Capital supply	
h Household groups	L Labour supply	
s Economic sectors	N Land supply	
Endogenous variables	*Exogenous parameters*	
B *cap* b Foreign savings balance	A Production Shift parameters	
F Factor demand quantity	B cap β Household budget share	
I Investment demand quantity	Θ Household share of factor income	
P Commodity price	P cap ρ Investment commodity expenditure share	
Q Output Quantity	Υ Household marginal propensity to save	
W Average factor returns		
Y Total household income		

Note: Adapted from Pauw et al. (2011)

Identification strategy

A counterfactual framework for entrepreneurship and welfare outcomes

The fundamental question of any causal analysis is to find out what would have happened to treated units had it been that they were not treated or what would have happened to control units had it been that they were treated. In our case, we would like to know what would have happened to entrepreneurs' welfare outcomes had it been that they were not entrepreneurs. On the other hand, we also examine what would have happened to non-entrepreneurs had it been that they had ventured into entrepreneurship. The key problem is that we can not observe both sides at the same time. We therefore have a missing data problem

which is known as the fundamental problem of causal inference (Guo and Fraser, 2010).

Our analysis attempts to use available data for entrepreneurs and non-entrepreneurs to ascribe welfare values for their counterfactual outcomes. Thus, if we assume a treatment variable W_i where $W_i = 1$ if an individual is an entrepreneur and $W_i = 0$ if the individual is not an entrepreneur. We also assume that there are two potential outcomes (Y_1, Y_0) for entrepreneurs and non-entrepreneurs and an actual measured outcome Y_i. Rubin (2005) presents the observed outcome as

$$Y_i = W_1 Y_{i1} + (1 - W_1) Y_{i0}. \tag{1}$$

where W_i acts as a switching variable. In order to make statements about causality, we cannot only use information about individuals who participated $Y_i 1 \cdot (W_i = 1)$ but we must also use information about individuals who did not participate $Y_i 0 \cdot (W_i = 0)$ and then eventually compare Y_{i1} and Y_{i0}. Therefore, to make a causal statement whether $W = 1$ causes Y_1, we must evaluate the evidence in the data on potential outcomes under $W = 1$ and $W = 0$. Thus, given an arbitrary cut off point p, where $Y_{i1} > p$ if $W_i = 1$ and $Y_{i0} < p$ if $W_i = 0$, we can deduce that $W_i = 1$ causes $Y_{i1} > p$ if after evaluating the evidence under $W_i = 0$, we find that indeed $Y_{i0} < 0$. Under an assumption of perfect randomization, where participants are randomly assigned $W = 1$ and non-participants $W = 0$, Hernan and Robins (2018); Guo and Fraser (2010) state that we can compare the average outcome under $W = 1$ and that under $W = 0$. The standard estimator for calculating treatment effect is,

$$\gamma = E(Y_1|W = 1) - E(Y_0|W = 0) \tag{2}$$

where E is an expectation operator and γ is the Average Treatment Effect (ATE) of participating in entrepreneurship. Thus, $E(Y_0|W = 0)$ represents a counterfactual for $E(Y_0|W = 1)$ and $E(Y_1|W = 1)$ represents the counterfactual when $E(Y_1|W = 0)$. In a perfectly randomized framework, an ordinary least squares regression can be used i.e.

$$Y_i = \alpha + \gamma W_i + \epsilon \tag{3}$$

where α is a regression constant representing the average effect when $W_i = 0$, τ is the ATE and ϵ is a regression error term (White, 2006). When the assignment mechanism to participant and non-participant status is not randomized, that is if either individuals self-select or there appears to be another mechanism, then the latter and the former do not represent the counterfactuals. Thus, $E(Y_0|W = 0) \neq E(Y_0|W = 1)$ and $E(Y_1|W = 1) \neq E(Y_1|W = 0)$. Estimation of effects using τ in equations 2 and 3 would lead to biased

estimators i.e. effects that are influenced by outliers. However, given a number of assumption, it is possible to estimate causal effects using the Rubin counterfactual framework.

In order to estimate the effects, we first assume that conditional on observable control variables X, assignment to participation and non-participation is independent of the potential outcomes $(Y_1, Y-0) \perp W|X$. Thus, we assume that given the control variables, the selection mechanism into entrepreneurship is independent of the welfare outcomes. this is known as the conditional independence assumption (CIA) (Huber and Melly, 2015; Guo and Fraser, 2010; Rosenbaum, 1984). To check the validity off this assumption, we conduct a bivariate comparison of control variables using student's t-tests for continuous variables and chi-square tests for categorical variables. If the control variables are statistically different between the participants and non-participants, then the correlation is non-zero, $\rho(W, X) \neq 0$ and CIA is violated.

Second we assume that the value of the outcome Y_i for individual i with participation status W_i will not change regardless of the procedure used to assign the participation status and the participation status of other individuals. This is called the Stable Unit Treatment Value Assumption (SUTVA) (Rubin, 2005). During the assessment, it helps rule out interactions among individuals and general equilibrium effects.

Third, $w \perp \epsilon|X$: we assume that the participation status is independent of the error term given the control variables . In this assumption, we assume that our selection mechanism has been adequately modeled such that there are no confounding nor omitted variables and that there are no measurement errors. Thus, all relevant drivers of selection into entrepreneurship have been thoroughly accounted for.

Fourth, $X \perp \epsilon$: we assume that the control variables are not correlated with the error term. This assumption rules out that some of the explanatory variables are independent variables in themselves.

Fifth, $X \perp W$: we assume that the treatment status is independent of the explanatory variables. This rules out perfect collinearity in our model which would prevent the model from achieving rank conditions.

Sixth, $\epsilon \sim$ i.i.d, $N(0, 1)$: we assume that the error term is independent and identically distributed with mean 0 and standard deviation of 1.

Adjustments to counterfactual assumptions and estimation

At the administrative level, the government strategy and efforts to encourage participation in entrepreneurship for economic development does not discriminate no assigns participation status randomly. On the contrary, individuals self select into program. Thus the randomization assumption is violated and we only observe voluntary compliance into entrepreneurship $W_1 = 1$. Therefore, the effect we measure is a form of intent to treat.

Since we have three time periods, we also have a problem of time varying treatment effects. To illustrate, taking 2010 as time 0, we can have $2^3 = 8$ treatment situations. For example, it is possible, where $W = 1$ is

represented by 1 otherwise 0, to have a universal set of

$$\mathbb{U} = \{(1,1,1),(0,1,1),(0,0,1),(1,0,0),(1,1,0),(0,1,0),(1,0,1),(0,0,0)\}$$

of the static treatment situation. In this case, a an individual drawn randomly from the population has a one in eight chance of being found in one of the participation situations. Following Hernan and Robins (2018), we invoke the full sequential exchangeability also known as the joint independence assumption that, given the participation history $a \in \mathbb{U}$ of the household in 2010, 2013 and 2016, i.e. $t = 0, 1, 2$ and a vector of control variables, the participation into entrepreneurship is independent of the welfare outcomes. That is

$$(Y^a, X^a) \perp W_t | W_{k-1}, X_t \quad \forall k = 0, 1, 2 \quad \text{and} \quad a \in \mathbb{U}. \tag{4}$$

Accordingly, the full sequential exchangeability assumption represents all counterfactuals of the participation status across the three time periods. Bang and Robins (2005) provided doubly robust estimators to assess treatment effects. We will use the doubly robust estimated to draw inference at individual level.

There is also a possibility that effects of participation could vary across individuals such that the average treatment effect could not be truly representative. For example, effects of participating into entrepreneurship could be larger for poorest households as compared to richest households. To account for this variation in effects, we use conditional quantile regression models. Using conditional quantile regression models allows us compute quantile specific treatment effects. In this case, given control variables X, we can express equation 3 as

$$Q_\tau(Y_i|W, X) = X'\beta + W'\gamma + F^{-1}(\epsilon) \tag{5}$$

where Q_τ is a quantile analogue of the expectation operator E for quantile τ; β is a vector of unknown parameters to be estimated and $F^{-1}(\epsilon)$ is the probability distribution of the error term ϵ (Cameron and Trivedi, 2010; Angrist and Pischke, 2013). Therefore,

$$\gamma_\tau = Q_\tau(Y_{i1}|W = 1, X) - Q_\tau(Y_{i0}|W = 0, X) \tag{6}$$

is the Quantile Treatment Effect (QTE). Equation 6 is difficult to estimate in the presence of self selection. Abadie et al. (2002) developed an instrumental variable estimator for QTE equation 6 where in the presence

of a suitable instrument for W, say Z, the QTE can be identified as

$$(\gamma, \beta) = \arg\min E\{\rho_\tau(Y_i - aW_i - X_i'b)|W_i = 1\} - E\{\kappa_i\rho_\tau(Y_i - aW_i - X_i'b)|W_i = 0\} \tag{7}$$

where

$$\kappa_i = 1 - \frac{W_i(1 - Z_i)}{1 - P(Z_i = 1)|X_i} - \frac{(1 - W_i)Z_i}{P(Z = 1)|X_i}$$

; where Z_i is a dummy instrumental variable (Angrist and Pischke, 2013). However, since not only one instrument affects W but a vector of variables and the difficulty of finding a suitable instrument of entrepreneurship, it is proper to explicitly model the selection mechanism using propensity scores (Heckman, 1977). We, accordingly, model the selection mechanism using a distribution function of the percentile error in the food security outcome equation and the error in the entrepreneurship participation decision using Arellano and Bonhomme (2017) framework with an adjustment for the extended treatment effects model (Heckman, 1977; Maddala, 1983). Distributional parameters are estimated by a rotated check function method of moments minimization. Thus, estimates across the percentiles are corrected for selection bias. The extension of the quantile sample selection model to a generalized treatment effects model presents a novel methodological contribution of out study. Thus, the estimated model is

$$Q^S(\tau, Z) = X'\beta(\tau^*(Z)) \tag{8}$$

where Y_{it} is the outcome of interest for household i at time t (household real consumption expenditure, value of food consumption, dietary variety and nutrient intake per capita). The quantity $\tau^*(Z) = G^{-1}(\tau, \Phi(Z'\gamma); \rho)$ where Z is a vector of all relevant explanatory variables such that $X \subset Z$ and $W \subset Z$. $p(Z) = \Phi(Z'\gamma)$ is the propensity score and $V(\Phi(\eta))$ is the rank of unobservable scalar $\eta \sim U(0, 1) \perp Z$ and $\Phi(\cdot)$ is a normal conditional distribution function (CDF). $(U, V) \sim$ bivariate Gaussian copula with a correlation coefficient $\rho \perp Z$ and τ is the percentile in question $\tau \in (0, 1)$. Thus, $G(\tau, p; \rho)$ and S means conditional on selection Arellano and Bonhomme (2017).

Data

We use a panel of Integrated Household Surveys (IHS) from Malawi conducted between 2010, 2013 and 2016. The IHS is part of the World Bank's Living Standards Measurement Surveys which are designed to collect socioeconomic characteristics of households in order to aid in policy design and evaluation. Use of the IHS to explore effects of entrepreneurship on food security contributes to a robust discussion on evidence based development policy design.

The longitudinal data, collected before the policy agenda was introduced and also collected after at the end of the MGDS II time period enables us obtain characteristics of individuals who entered into entrepreneurship and those that did not and further evaluate whether the program had impact along a distribution of households in the country.

The data has household, agriculture, and community modules that are particularly relevant to the study. From the household questionnaire, we obtained a roster of household characteristics such as household size, sex, age, marital status and education composition of members. We obtained food consumption information, such as amount of food consumed in the past seven days and expenditure levels if any from the household questionnaire. Due to home production and consumption aspects of households, some households reported consumption but no expenditure. In that case, a nearest neighbour's unit cost was computed and was triangulated using a community market questionnaire. A key assumption in imputing the zero expenditures from their nearest neighbours when the household had actually consumed a food item is that at community level, food markets are perfectly competitive and that the marginal cost of producing food at household level is equal to the prevailing market price. When the value of the food items consumed is calculated, we aggregated the expenditures to come up with the value of food consumed. From the aggregated food expenditure, we calculate budget shares as expenditure on a food item divided by total food expenditure. We also computed total household expenditure by including non-food items. When the food expenditure and non-food expenditure is combined, we can calculate total household expenditure per capita. Using the total household expenditure per capita, we can descriptively calculate Engel curves for participants and non-participants such that $w_i = \log Y_i'\alpha + \upsilon_i$, where w_i is the budget share for food commodity i and $\log Y_i$ is the logarithm of total household expenditure per capita, α is the expenditure elasticity of commodity i and υ_i is the error term (Banks et al., 1997).

Using the FAO's food composition table for use in Africa, nutrient composition of the food items consumed at household level was computed at and converted to per capita levels per day. We computed energy (kcal), protein (g), at (g), carbohydrate (g), Calcium Ca (mg), Phosphorus P (mg) , iron Fe(mg), retinol (μg), β-carotene μg, thiamene (μg), riboflavin (μg), niacin (μg) and ascorbic acid (μg). We use energy consumed as a dependent variable for food security and present the other variables

We calculate a Berry index of dietary variety as function of shares $s_i = q_i/Q$ of actual quantities of food consumed where q_i is the quantity of the commodity i consumed and $Q = \sum q_i$. Hence the Berry index is calculated as $BI = 1 - \sum_i s_i$. The BI lies between 0 and $1 - 1/n$ such that as the number of food items increases, the index approaches 1. The quantity $1 - 1/n$ describes a case where an individual household consumes equal shares of each commodity (Drescher et al., 2007). In a Malawian setting, where there are high poverty levels, this situation cannot happen. According to Timmer et al. (1983), poor people allocate

most of their expenditure to starchy foods. Malawi's diets are also predominantly starch based (Verduzco-Gallo et al., 2014). As a robustness check of the Berry index, we also compute an entropy index of dietary diversity as $E = \sum_{i=1}^{n} s_i \log(1/s_i)$ where a more diversified diet will lead to a higher E (Liu et al., 2014).

Some drivers of food security are whether a household is agricultural or not. To determine whether a household is agricultural or not, we used the agricultural household questionnaire and examined whether a household cultivated a non-zero amount of land during the rainy and dry season. Most agricultural activities are rain fed and to a certain extent some households practice irrigation during dry season. In addition, we also examined whether a household practiced perennial crop farming or animal farming. We therefore defined an agricultural household as a household that fulfilled any one or more of these conditions. In the same manner, we investigated whether a household was a net food buyer or seller or autarkic by subtracting the value of food consumption from the value of food production. If the value of food production was greater than the value of food consumption, then the household was defined as a net seller of food. If the difference was negative, we define the household as a net buyer of food. If the difference was equal to zero, then household was defined as autarkic (Timmer et al., 1983).

Other variables that were obtained from the agricultural questionnaire relevant for food security were whether the household adopted improved technology and had access to inputs. We used adoption of improved seed as an indicator of technology adoption. Mutenje et al. (2016) found that adoption of improved technology is associated with increased food security. Secondly, we also create a dummy variable whether a household received subsidized farm inputs or not. The Government of Malawi introduced a farm input subsidy in 2005 to improve effective demand for agricultural inputs (Kankwamba et al., 2018).

Mendola (2007) used institutional factors as control variables in assessing average causal effects of technology adoption on welfare. In this study, we also use institutional and community variables as control variables. Our community and institutional control variables include whether a household has access to a savings and credit cooperation, distance to the main road. distance to the main auction market and distance to the main population center. In addition, we also control for year, and location dummies. Location is determined by district dummies.

Results

Descriptive statistics

Table 2 summarizes results of the descriptive statistics of the variables used in the study. Dependent variables used in the analysis are presented first. Across all three survey periods, entrepreneurs have significantly

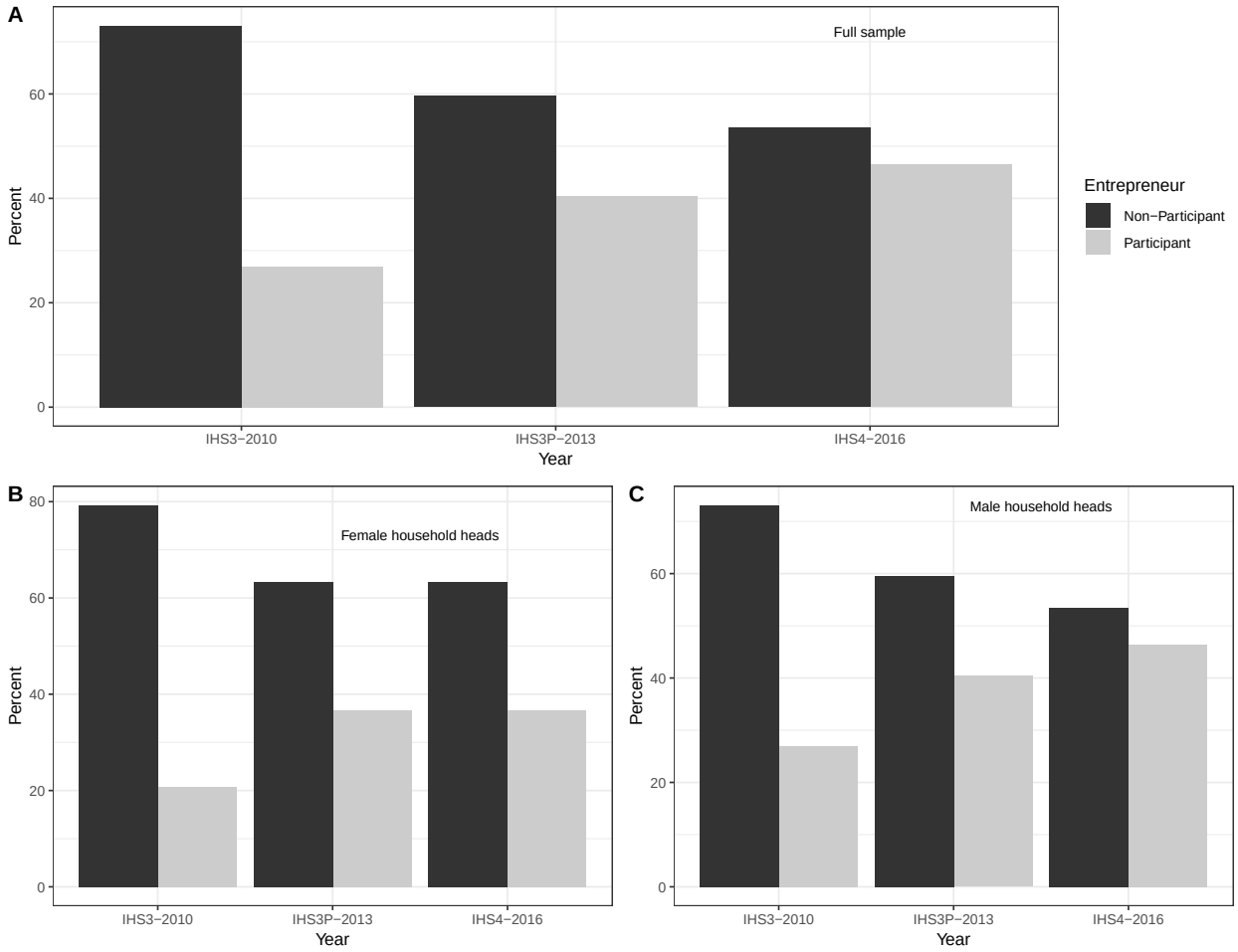

Figure 1: Distribution of households practising entrepreneurship disaggregated by gender

higher values of food budgets than non-entrepreneurs. In addition, results show that entrepreneur households have significantly more calorie consumption per capita per day across in the 2013 and 2016 survey periods. The Berry and Entropy indices of dietary variety are higher among households that ventured into entrepreneurship. Further, results also show that household that entered into entrepreneurship reported less days of reduced food production. Similarly, households that entered into entrepreneurship experienced higher value of food production.

Figure 1, 2 and 3 summarize consumption changes as incomes rise in the 2010 survey period. In general, results show that consumption patterns between entrepreneurs and non-entrepreneurs are similar cereal and meat products but differ markedly for vegetables and legumes. For instance, the unconditional expenditure elasticity for cereals in 2010 was -0.16, which means that if incomes increased by 1% the share of the food budget allocated to cereals would decrease by 16%. In 2010, when incomes increased by 1% the share allocated to cereals decreased by 14% while in 2016 it decreased by 12%. In all three survey periods,

non-participants had higher shares than participants.

In all survey periods, results showed that as incomes increase shares allocated to meat products increase. For instance, as incomes increased by 1% shares allocated to food products increased by 14%, 15% and 15% in 2010,2013 and 2016 survey periods, respectively.

Results for vegetables and fruits indicate an inverse relationship between shares of expenditure and income increases but the results are not statistically significant in all survey periods. Of note, allocations to leguminous food commodities showed an inverse relationship across all survey periods such that a 1% increase in income resulted in 5%, 1% and 4% in 2010, 2013 and 2016, respectively. Non-entrepreneur households had significantly larger household sizes as compared to households that practice entrepreneurship. Across the survey periods, there was 1 male adult in the household. This statistic did not statistically differ between 2010 and 2013 but moved to 2 in 2016. On average, across all three surveys and between participants and non-participants, there were 2 male children per household. Between 2010 and 2013, and between participants and non-participants, there was one female adult in the household. However, in 2016, there were 2 female adults in the household. Further, the household had 2 female children, between participants and non-participants across all survey periods.

Most household heads participating in entrepreneurship were in a monogamous marital relationship with 75% in 2010, 83% in 2013 and 88%, respectively. About 7% of households were in a polygamous marital relationship. Results for polygamous marital status do not differ significantly between entrepreneur and non-entrepreneur households. About 6% of households were separated. However, the are not statistical differences between participants and non-participants. About 5% of households are divorced and do not differ significantly between the participants and non-participants across the 3 survey periods. About 13% of households are widowed and do not differ markedly across the survey periods and between participants and non-participants. The proportion of single and unmarried household heads was 3%. However, the number of participants significantly increased from 2% to 5% and 6% across the survey periods.

About 87% of household heads participating in entrepreneurship in 2010 had no formal schooling. Another 61% and 62% of household heads participating in entrepreneurship had no formal schooling in 2013 and 2016 survey periods, respectively. In 2010, 3% of household heads had attained primary school certificate and participated in entrepreneurship and 12% and 8% had attained primary school. In 2010, about 5% of households participating in entrepreneurship had attained junior secondary education, while in 2013, 16% had attained primary school. Less than 1% of households that participated in entrepreneurship across all surveys

Land holding sizes and adoption of modern farming technology did not vary substantively across participants and non-participants in all survey periods. Noteworthy, there are statistically significant differences

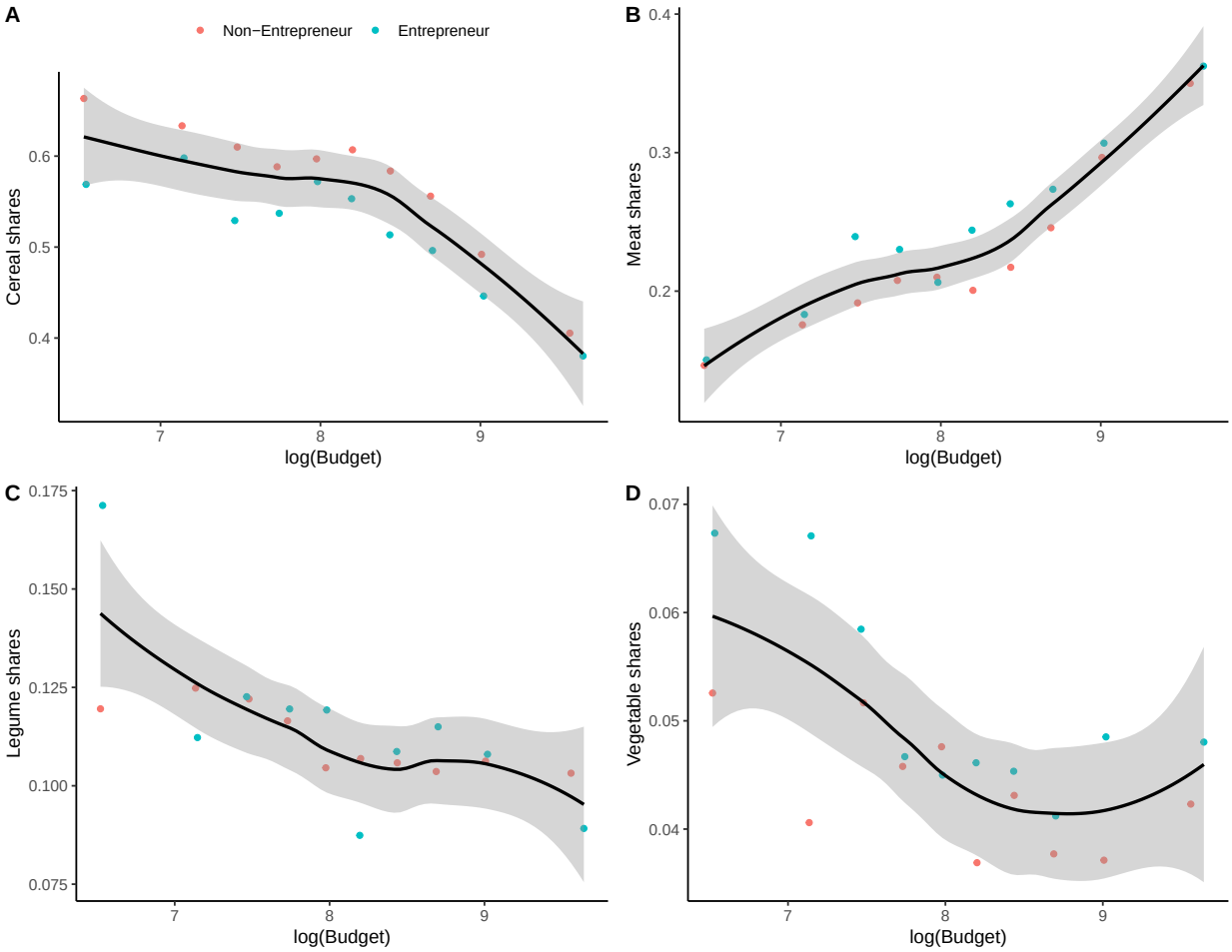

Figure 2: Non-parametric Engel curves for food items by entrepreneurship status in 2016

Table 2: Descriptive Statistics of variables used

Variable	2010		2013		2016	
	Non-Entre	Entre	Non-Entre	Entre	Non-Entre	Entre
	(1)	(2)	(3)	(4)	(5)	(6)
	A: DEPENDENT VARIABLES					
Value of food consumed	7.614	9.119	8.434	10.192	9.775	11.177
		(-7.493***)		(-9.610***)		(-10.623***)
Energy	7.246	7.252	7.283	7.433	7.209	7.338
		(-.162)		(-4.059***)		(-4.210***)
Berry Index	.165	.217	.526	.575	.810	.994
		(-3.985***)		(-1.579*)		(-5.044***)
Entropy Index	.245	.329	.076	.139	.231	.590
		(-4.420***)		(-4.841***)		(-11.626***)
Days without food	.379	.312	.588	.596	1.234	1.217
		(1.399)		(.179)		(.241)
Food Production value	8.323		8.475	9.987	12.510	13.490
		(-0.532)		(.754)		(-1.857*)
	B: DEMOGRAPHIC VARIABLES					
No. Male Adults	1.354	1.440	1.416	1.353	1.730	1.913
		(-1.831*)		(1.553*)		(-3.441***)
No. Male Children	1.692	1.791	1.624	1.441	1.859	1.730
		(-1.445)		(3.722**)		(2.333***)
No. Female Adults	1.339	1.374	1.417	1.324	1.707	1.957
		(-.869)		(2.427***)		(-4.954***)
No. Female Children	1.715	1.699	1.662	1.466	1.848	1.829
		(.243)		(3.631***)		(.331)
Household size	4.635	5.649	6.255	7.656	7.274	10.987
		(-2.778***)		(-4.123***)		(-13.2679***)
Marital status						
Married Monogamous	.697	.749	.744	.830	.755	.880
		(-1.895*)		(-4.023***)		(-6.244***)
Married Polygamous	.066	.075	.054	.080	.086	.075
		(-.616)		(-2.048***)		(.764)
Separated	.051	.027	.059	.057	.081	.092
		(1.943**)		(.175)		(-.804)
Divorced	.050	.019	.051	.060	.065	.066
		(2.597***)		(-.814)		(-0.052)
Widowed/ Widower	.096	.099	.155	.113	.176	.161
		(-.163)		(-2.343**)		(.749)
Never Married	.028	.024	.021	.047	.027	.063
		(.375)		(-2.897***)		(-3.419***)
Adult Equivalence Scale	57.216	49.736	68.808	56.676	11.934	11.932
		(2.277***)		(3.607***)		(.003)
Education status						
No schooling	78.45	86.49	63.50	61.29	77.86	62.89
Primary School (PSLC)	9.44	2.70	9.50	11.83	7.05	7.86
Junior Secondary (JCE)	4.01	5.41	11.14	16.13	4.31	8.49
Senior Secondary (MSCE)	5.77	5.41	10.39	7.53	7.71	14.15
Tertiary (Diploma)	.99	.00	3.21	3.23	1.82	3.77
Tertiary (Degree)	1.06	.00	1.64	.00	1.16	2.52
Tertiary (Graduate level)	.28	.00	.62	.00	.08	.31
		(3.102)		(5.259)		(36.289***)
	C: AGRICULTURAL AND OTHER VARIABLES					
Total cultivated land	4.116	1.202	.360	.233	.392	.372
		(.680)		(3.197***)		(.709)
Adoption of modern technology	.563	.489	.617	.542	.597	.607
		(2.479***)		(2.904***)		(-.382)
Ease of doing business (Rank/190)		141		171		133
Extent of corruption (Rank/190)		85		91		120
Consumer price index (base = 2014)		320		500		80
Food inflation		9.6		38		28

NOTE: t-statistics and χ^2 values in parentheses,for continuous and categorical variables, respectively.
*Significantly different from zero at 90 percent confidence
**Significantly different from zero at 95 percent confidence
***Significantly different from zero at 99 percent confidence

across the covariates which means that in absence of modeling the selection process explicitly, our results would be biased. Thus, based on this assessment, we proceed to model the selection process.

Mechanism of selection into entrepreneurship

Table 3 presents results of a probit model that explicitly models the selection process into entrepreneurship. Results comprise household demographics and socioeconomic factors. The probit model first with a Wald chi-square statistic equal to 563.47 with 54 degrees of freedom on 4537 observations. In general, results indicate that the overall probability of venturing into entrepreneurship is 36%. Results indicate that household characteristics significantly affect the entrepreneurship decision. For instance, an additional male adult in the household increases the probability of venturing into entrepreneurship by 2% ($p < .05$). Similarly, an additional female adult in the household increases the probability of venturing into entrepreneurship by 1%. An additional male and female child increase the probability of venturing into entrepreneurship by 1%, respectively.

Of note, if a household head is in a monogamous marriage in comparison to a single non-married head, the probability of venturing into entrepreneurship increases by 16% ($p < .01$) higher while for polygamous households it increases by 15% ($p < .01$). For separated and separated households, it stands at 7% ($p < .05$) and 6% ($p < .10$) respectively. The probability of participating into entrepreneurship increases by 9% ($p < .01$) among widowed households as compared with single non-married households.

Compared to household heads that had never attended formal schooling, primary school attendance is associated with 9% increase in the probability of venturing into entrepreneurship. Household heads that attended junior and secondary school education had 8% higher probabilities of venturing into entrepreneurship. Only at diploma level of tertiary education do we find statistically significant evidence that attainment would increase the probability of venturing into entrepreneurship by 1%.

We find that agricultural households are 5% likely to venture into entrepreneurship than non-agricultural households if all things are controlled for. We do not find sufficient evidence that access to socioeconomic amenities affects the decision to venture into entrepreneurship. We assume that these are affected by location fixed effects.

Balancing tests for participants and non-participants

In order to control for selection bias, we used propensity score analysis. Table 4 summarizes results of balancing t-tests after propensity score analysis. Given that none of the control variables are statistically different between participants and non-participants, we can assume that the covariates have been well balanced to

Table 3: Probit model results of the selection mechanism into entrepreneurship

VARIABLES	Entrepreneurship	Marginal Effects
	(1)	(2)
No. Male adults	.048**	.016**
	(.024)	(.008)
No. Female Adults	.042*	.014*
	(.025)	(.008)
No. Male Children	.032*	.011*
	(.019)	(.006)
No. Female Children	.038**	.013**
	(.019)	(.006)
Married – Monogamous	.472***	.157***
	(.076)	(0.025)
Married – Polygamous	.456***	.152***
	(.097)	(.032)
Separated	.219**	.073**
	(.093)	(.031)
Divorced	.169*	.056*
	(.101)	(.034)
Widowed/Widower	.268***	.089***
	(.080)	(.027)
Primary school	.246***	.085***
	(.070)	(.025)
Junior secondary school	.223***	.076***
	(.081)	(.028)
Senior Secondary School	.019	.006
	(.076)	(.025)
Tertiary (Diploma)	.281**	.097**
	(.135)	(.048)
Tertiary (Degree)	.132	.045
	(.174)	(.060)
Tertiary (Post-Graduate)	-.160	-0.052
	(.319)	(.099)
Distance to main road	-.002	-.001
	(.004)	(.001)
Distance to nearest population center	-.002	-.001
	(.002)	(.001)
Distance to the nearest auction floors	-.001	-.000
	(.001)	(.000)
Distance to the border post	.002	.001
	(.001)	(.000)
Member of microfinance org.	.001	.000
	(.000)	(.000)
Distance to nearest bank	.000	.000
	(.000)	(.000)
Agricultural Household	.137***	.046***
	(.047)	(.016)
Constant	-.918***	
	(.124)	
Observations	4,537	4,537
District FE	YES	YES
Year FE	YES	YES

NOTE: Robust standard errors in parentheses
*Significantly different from zero at 90 percent confidence
**Significantly different from zero at 95 percent confidence
***Significantly different from zero at 99 percent confidence

mimic a randomized control trial. Figure 3 summarizes households on support and those not after propensity score matching. Hence, assuming that we have controlled for a sufficient number of covariates, we can now use conventional fixed effects regression analysis to assess effects of entrepreneurship of welfare variables.

Table 4: Balancing tests for participants and non-participants

VARIABLE	Treated (1)	Control (2)	%bias (3)	t (4)	p>t (5)
No. male adult	1.524	1.529	-.600	-.160	.873
No. female adult	1.562	1.527	4.000	1.110	.268
No. male child	1.248	1.215	3.100	.900	.370
No. female child	1.301	1.298	.300	.090	.925
Married – Monogamous	.832	.830	.500	.150	.882
Married – polygamous	.076	.076	.300	.080	.937
Separated	.064	.067	-1.000	-.280	.779
Divorced	.053	.060	-3.400	-.940	.345
Widowed/Widower	.127	.130	-.700	-.200	.844
Primary school	.109	.106	1.000	.260	.797
Junior secondary	.097	.099	-1.000	-.240	.807
Senior secondary	.109	.118	-2.800	-.730	.464
Tertiary (Diploma)	.035	.032	1.900	.460	.643
Tertiary (Degree)	.019	.024	-3.600	-.860	.389
Tertiary (Post-Graduate)	.004	.003	1.900	.560	.573
Distance to the main road	6.526	6.711	-2.000	-.640	.525
Distance to the next population center	25.531	25.795	-1.300	-.380	.706
Distance to the auction	51.856	52.669	-1.600	-.490	.621
Distance to the border post	52.200	52.415	-.700	-.190	.846
Member of microfinance org.	38.882	39.146	-.500	-.140	.892
Distance to the nearest bank	45.337	54.297	-5.500	-1.120	.265
Agricultural household	.453	.460	-1.300	-.370	.712

NOTE: Robust standard errors in parentheses
*Significantly different from zero at 90 percent confidence
**Significantly different from zero at 95 percent confidence
***Significantly different from zero at 99 percent confidence

Impact of entrepreneurship on food security

Average treatment effects on the treated

After adjusting our sample for selection bias, we estimate the impact of participating in entrepreneurship on food security using inverse-probability-weighted regression adjustment (IPWRA) and nearest neighbour propensity score matching (PSM-NNM) at household level. In all models, demographic characteristics of households, district fixed effects and stratum fixed effects i.e. rural, urban, northern, central and southern region interacted dummies were used. Results generally indicate that entry into entrepreneurship increases the value of food consumed by 70% using the IPWRA doubly robust technique. Using PSM-NNM, the impact of entrepreneurship on the value of the food budget was 88%. Further, the IPWRA results indicate

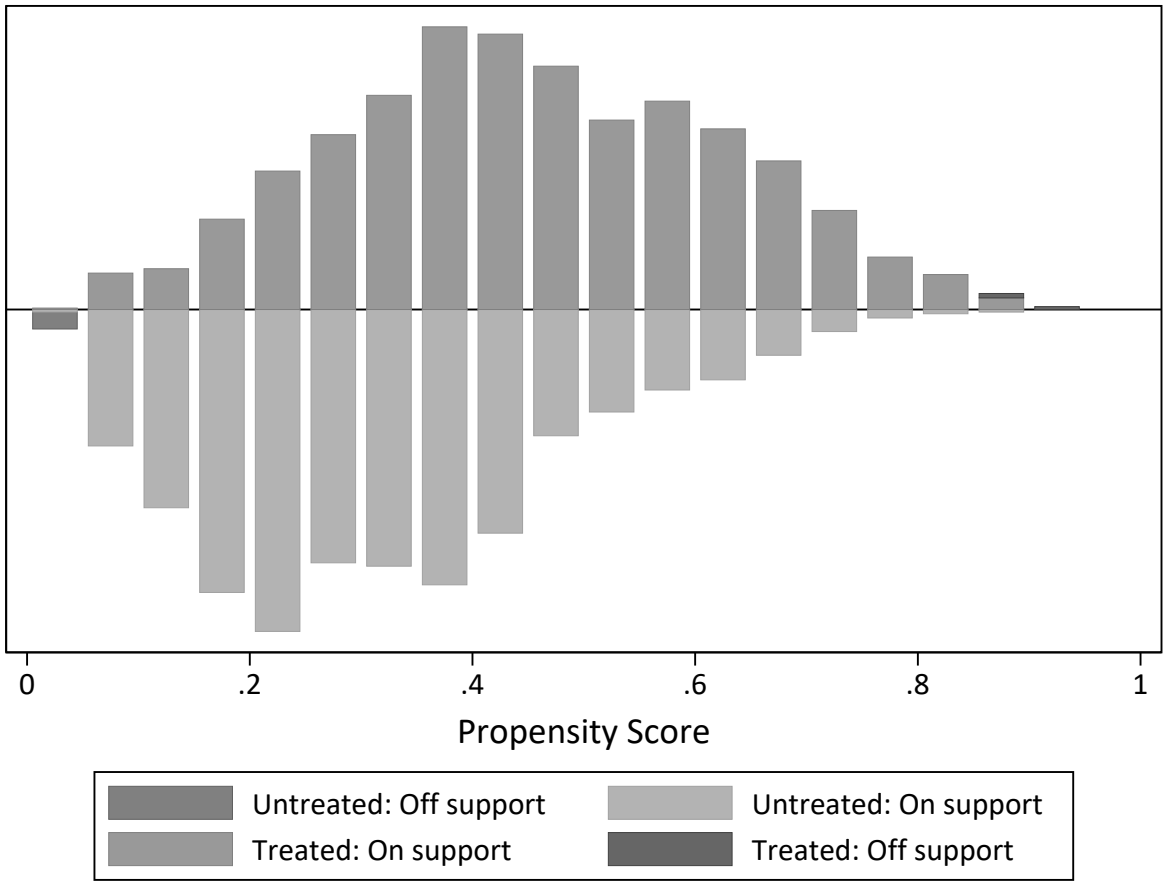

Figure 3: Participant and non-participant households after propensity score matching

that entrepreneurship has 5% impact on dietary variety while PSM-NNM found 6% impact. For the calories indicator, IPWRA shows that venturing into entrepreneurship increases calorific intake per capita per day by 8% while PSM-NNM also indicates 8%. In all results, we find that IPWRA is the most conservative while the PSM-NNM overestimates the results. However, all results fall within the same 95% confidence interval which implies that results from the two models consistently point towards positive impacts of entrepreneurship on food security.

Table 5: Impact of entrepreneurship on food security

	ln(Value of food)		Berry Index		Calories per capita	
	IPWRA	PSM-NNM	IPWRA	PSM-NNM	IPWRA	PSM-NNM
VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)
Entrepreneurship	.699***	.883***	.047 **	.064**	.078***	.076***
	(.084)	(.120)	(.021)	(.027)	(.021)	(.029)
Demographics	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

NOTE: Average Treatment Effects on the Treated reported.
Outcome model controls presented in the appendix.
Robust standard errors in parentheses
*Significantly different from zero at 90 percent confidence
**Significantly different from zero at 95 percent confidence
***Significantly different from zero at 99 percent confidence

Quantile treatment effects

Apart from assessing average treatment effects, it is important to examine the distribution of the impacts. Examining the distribution effects would help identify whether a policy strategy to encourage entrepreneurship helps poor households' incomes to rise faster than the richest. Table 6 presents results of the quantile treatment effects regression of the effects of entrepreneurship on food security. We present results for the 20^{th}, 40^{th}, 50^{th}, 60^{th}, 80^{th} and 95^{th} quantiles. The hypothesis of equality of parameters across the quantiles was resoundingly rejected at level ($p = .01$). Under the assumption that the individual remains in the same quantile of the distribution after the change, results indicate a general positive effect of entrepreneurship on the value of food consumption. The conditional quantile treatment effects are highest – 87% – in the 20^{th} quantile and 79% for the 95^{th} quantile but are between 49% and 67% between the 40^{th}, 50^{th}, $60^{th}$and 80^{th} quantiles.Noteworthy, our bootstrapped standard errors are smallest in the middle quantiles indicating higher precision as compared to the upper and lower parts of the distribution.

Table 6: Quantile regression model results showing distributional impacts of entrepreneurship on food security

VARIABLES	q20	q40	q50	q60	q80	q95
	(1)	(2)	(3)	(4)	(5)	(6)
Entrepreneurship	.870***	.567***	.556***	.490***	.566***	.798***
	(.142)	(.081)	(.071)	(.063)	(.083)	(.103)
Constant	-4.869	3.135*	4.671***	6.705***	6.343***	8.188***
	(3.330)	(1.687)	(1.658)	(1.779)	(2.299)	(2.613)
Observations	4,537	4,537	4,537	4,537	4,537	4,537
R-Squared	.21	.21	.21	.22	.26	.30
Demographics	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES
District FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

NOTE: Robust standard errors in parentheses
Logarithm of the value of food consumed is the dependent variable.
*Significantly different from zero at 90 percent confidence.
**Significantly different from zero at 95 percent confidence.
***Significantly different from zero at 99 percent confidence.

Discussion

In this study we evaluated the impact of entrepreneurship on household food security in Malawi using two distinct methods namely inverse probability weighting regression analysis and propensity score matching using nearest neighbour matching techniques. Second, we assessed distributional impacts of entrepreneurship on food security using quantile regression techniques. In the first technique we used propensity score adjusted quantile regression while in the second method we used a novel quantile regression model that adjusts for selection bias. A combination of techniques ensures that our results are robust to measurement and specification errors.

Patterns and drivers of entry into entrepreurship

Using a series of indicators of food security such as the value of the food budget, Berry index of dietary variety and calories consumed per day per capita, we find four key results. First, entrepreneurship is low despite government efforts and investments. Second, various factors, chief among which are education, access to credit and household composition, affect entry into entrepreneurship. Third, entrepreneurship significantly increases the value of food consumed, variety and calories consumed at household level. Fourth, we find positive distributional impacts of entrepreneurship on food security.

We discuss the first finding, that entrepreneurship is low but steadily increasing, using a number of

reasons. The lower levels of entrepreneurship are a direct result of worsening indicators of doing business, corruption and living standards. Although there are efforts to increase entrepreneurship, we also find that they are thwarted by worsening governance indicators. As (Sriram and Mersha, 2010) observed, an enabling environment plays a larger role in stimulating entry into entrepreneurship.

Nevertheless, the steady increase in the number of households getting into entrepreneurship after 2011 is a direct results of the government's shift in its trade facilitating strategy by investing into entrepreneurship. The MGDS II specifically outlined some strategies, such as youth and women empowerment and school curriculum changes, to encourage entrepreneurship. Of note, in support of the country's development strategy, other institutions also embarked on the campaign to encourage entrepreneurship endeavours among the youth. For instance, the United States of America's Embassy, through its Young African Leaders' Initiative (YALI), has been training the youth in entrepreneurial skill development. Most YALI members have been deployed to further the campaign across the country (US Department of State, 2019). Our results are consistent with Mwatsika (2015) who found that Malawians have positive attitudes towards entrepreneurship but lack of supportive environments impede development. Therefore, any effort to nudge individuals to venture into entrepreneurship would yield significant positive outcomes.

Entrepreneurship is affected by demographic and institutional factors. Consistent with Nagler and Naudé (2017), we found that household composition positively affected entry into entrepreneurship. Larger household sizes were invariably associated with entrepreneurship activities. Further, household heads that were more educated were associated with entry into entrepreneurship. This finding corroborates De Gobbi (2014) who also found that highly educated, youthful individuals with access to credit are more likely to venture into entrepreneurship. The effect of education on welfare through entrepreneurship can be easily traced through Mincer and Polachek (1974)'s finding, that education of a head and other family members – a spouse in particular – affects earnings, by raising a household's human capital. Since One of the explanations of the low entrepreneurship levels can also be traced to low education levels of household heads.

Chowdhury et al. (2016); Becker (1974) and Wong (1986) proved that, within the household, specialization and cooperation in marriage could lead to better welfare outcomes through increased marginal value productivity of labour. As our results show, in both monogamous and polygamous marriages, there are higher probabilities –15%– of venturing into entrepreneurship compared to single unmarried household heads. In line with Wong (1986), we argue that members benefit from a set of skills distributed across the household such that others could specialize in skills that are honed particularly for entrepreneurship while others may specialize in subsistence oriented activities. The net cross-productivity gains from different human capital endowments of individuals within the household are benignly shared aggregated for overall welfare gain. This theory further explains the results that consistently show that additional members of the household have a

significant positive change in the probability of venturing into entrepreneurship. Additional members of the household also mean increase in the supply of labour. Given aforementioned factors could raise marginal value productivity of the household labour. These results are also consistent with Doss (2013).

Given the cross-productivity gains in human capital, it can be inferred that any valuable skills gained by household members from, say, training in form of schooling or apprenticeship that the MGDS II advocated (Government of Malawi, 2011) can be shared effortlessly across the household. Thus, it cannot be far fetched to reason that entrepreneurship skills taught in schools, incubation centers, and technical and vocational centers can easily spillover within the household and could lead to a surge in entrepreneurship.

The study findings are consistent with (Sriram and Mersha, 2010) who found that most African entrepreneurs are not only influenced by socioeconomic factors such as family structure and education but also external market structure and the business environment regulated by government. Our finding about doing business in Malawi is consistent with the authors that when complex procedures of doing business are not well streamlined, entrepreneurship levels would be low.

Impact of entrepreneurship on food security

Our second finding, that participating in entrepreneurship improves the value, variety and amount of calories and micro-nutrients consumed per capita per day, is not only consistent with what economic theory predicts but also has pro-poor implications. After correcting for selection bias, a disruption into the household budget caused by entrepreneurship would shift the budget set upwards. A higher budget set implies that the household would have access to varied quantities of high value foods – in income effect from entrepreneurship. A change in preferences, moving from a lower indifference curve to a higher affordable one, implies that the household can substitute lower value, less desirable commodities such as starchy foods to more lucrative high value foods such as mean products. Results from the Working-Leser variety of Engel curves affirm the theory and support the finding that households in lower quantiles are very sensitive to changes in the budget line. We find corroborating evidence from Bonney et al. (2013) who – in a general qualitative study on trends in entrepreneurship in Africa recommended that, as an alternate logic to solving food security problems, governments should encourage entrepreneurship. The study reported that an increase in collective entrepreneurship among farm households would increase food security by strengthening food value chains since it would leverage the farm households to have a larger say in their businesses, thereby, reconceptualizing distribution of resources by reducing market chains through removal of unwanted actors such as middlemen. Efficient, farm household driven entrepreneurship would lead to efficient market outcomes and welfare (Bonney et al., 2013). We also argue, though, that the largest benefits would result from direct marginal changes

in household incomes from entrepreneurial activities regardless of their position in the value chain. Our results also corroborate Otoo et al. (2011), who – in West African countries of Ghana and Sierra Leone – found that entrepreneurship contributes to food security and overall welfare by a magnitude of over 16%.

While the positive impact derives directly from economic theory, not all entrepreneurs benefit equally. All things being equal, results from quantile regression indicate that venturing into entrepreneurship benefits the poorest more than any other group of households. We notice a greater than 30 percentage point difference in average effects of entrepreneurship from the poorest to the median impact. Despite making the richest group of households richer, impacts on the losers – those on which entrepreneurship had the least impact – are still above 50%. To all intents and purposes, entrepreneurship is welfare improving. Thus, any policy geared towards increasing the level of entrepreneurship will be Pareto optimal. This finding is consistent with pro-poor growth literature which suggests that incomes of the poor have to grow faster than the richer households (Kakwani et al., 2000; Rogerson, 2018; Asongu, 2016; Dorward et al., 2004)

Conclusion

The study econometrically assessed patterns and causal effects of entrepreneurship on food security using representative panel data from Malawi. The study also assessed implications of changing incomes from entrepreneurship on the quantity, variety and value of food consumed per capita per day.

Results generally indicate that entrepreneurship is lower but has been steadily increasing over the survey periods. The mechanisms driving entry into entrepreneurship were demographic factors such as education, marital status and household size.

The study found that entrepreneurship has a positive effect on the value, variety and quantity of food consumed per capita per day at household level. The study also found that the poorest households benefitted the greatest from venturing into entrepreneurship. The household specific and heterogeneous impacts imply that investing in entrepreneurship is not only a good strategy for economic development but is also a pro-poor policy strategy.

Since government assignment of treatment was non-ignorable, the study recommends that delivery of investments to increase entrepreneurship levels should be designed in such a way that attribution can be easily identified. While randomization might be unethical, sequential delivery of investments across districts or regions can ensure cleaner difference-in-difference assessment of impacts.

The finding that entrepreneurship levels are still low calls for focused and increased efforts to encourage entrepreneurship through streamlining and reducing costs associated with doing business in the country and improving governance efforts such as fighting corruption.

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