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Agricultural Commercialization, Fertilizer Use and Non-Farm Employment: What Options for Smallholder Farmers in Nigeria?

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Abstract:

Abstract Agricultural commercialization is necessary for increased agricultural intensification and productivity in Nigeria. However, there is paucity of empirical information on the effects of agricultural commercialization on input use, labor demand and engagement in non-farm employment across the country. This study examined the effects of agricultural commercialization at the household level on fertilizer use, demand for hired labor and participation in non-farm employment in Northern Nigeria. Household Commercialization Index (HCI), Two-stage Least Squares (2SLS) and Instrumental Variable (IV) estimations were used to analyze the primary data collected from 270 maize farming households in Kaduna and Kano States. The study revealed that commercialization had the potentials for increasing the demand for fertilizer usage and hired labor among maize farming households. However, it reduced the tendency for households to participate in non-farm employment. Smallholder commercialization of maize should therefore be promoted through adoption of complementary technologies that free labor from on-farm activities. Keywords: agricultural commercialization, input market, staple, Instrumental variable, Nigeria JEL: C26, D13, Q12

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JEL Codes: D1, Q12

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1. Introduction

Africa has experienced a relatively strong economic growth in recent times. Specifically, between 2002 and 2014, the continent's economy grew at an average of 5.3 percent; far above the global average between 2001 and 2010, and even higher than that of developing East Asia and the Pacific estimated at 3.8 percent (AfDB, OECD and UNDP, 2014). This return to economic growth since the 2000s, along with burgeoning urbanization and buoyant global commodity markets, now provide unprecedented market opportunities for Africa to develop a competitive and dynamic agricultural sector.

The urban population of SSA is projected to double by 2030.With per capita income growing by 4% per year to meet the NEPAD targets, urban food markets are set to quadruple to US$ 400 billion by 2030 (World Bank, 2013). Rising food demand, both quantity and quality, will require not only rapid commercialization of African agriculture but major investments in processing, logistics, market infrastructure and retail networks (Byerlee & Haggblade, 2013).

The prospect of using agriculture to escape from poverty by smallholder farmers relies, to a large extent, on their ability to improve not only intensification but also their level of integration to the market. A pre-condition for successful participation in the market is the ability to meet market demand whose prerequisite is generation of marketable surplus (Rola-Rebzen and Hardaker, 2006). However, smallholder farmers' ability to meet market demand has been constrained by market failures including but not limited to high transaction costs that continue to serve as a barrier to smallholder market participation thereby making those participating to do so only at the margins (Jayne *et al.*, 2006; Barrett, 2007).

Increasingly, most households in rural areas are diversifying into the non-farm sector as about 70% are involved in non-farm activity. The most common non-farm activity is microenterprises/informal sector with 60% participation rate followed by non-farm wage employment with 22% participation rate (World Bank, 2014). This diversification has given the farming households opportunity for improved income and leverages in the event of failures.

Despite this optimistic outlook for the agriculture sector, some major challenges remain. Productivity is low in the agricultural sector. For example, yield per hectare in Nigeria is about 20 to 50% of what obtains in similar developing countries. This low yield is attributed to low use of productivity-enhancing inputs such as fertilizer and improved seed. This situation had made issue

of soil fertility a binding constraint to crop productivity (Mathenge *et al*., 2014; Adeyinka *et al*., 2013; Pretty *et al.,* 2011; IFAD, 2011).

Increased fertilizer use is necessary for accelerated agricultural productivity growth in Nigeria. At the same time, promoting commercialization of smallholder agriculture can foster increased use of fertilizer because farmers that are oriented to the market are likely to make extra cash income that can be invested in input purchase. However, the extent to which agricultural commercialization promotes input intensification in Nigeria is not clear. Furthermore, there is growing evidence of diversification among the farming households into non-farm activities at the national level but the implication of household diversification into non-farm activities on the need to commercialize agriculture in Nigeria is less studied. The wider implication of increased commercialization on non-farm employment or labour supply among smallholder farmers has also not been clearly understood.

To this end, this study intends to answer the following questions: How does the level of maize commercialization impact on fertilizer use? Is there a tradeoff in labour supply for maize farmers' commercialization and to non-farm employment? What is the transmission mechanism of commercialization to on-farm labour demand?

This work is justified based on the following. Commercialization and participation in non-farm employment provides sources of extra cash for households but the households are often faced with trade-offs when allocating labour resource between commercialization and non-farm employment. Understanding whether commercialization and non-farm employment complement household labour supply or compete for it is important for government to promote rural industrialization where labour scarcity is a binding constraint especially during the peak of farming season. Understanding how the effects of commercialization of staple on intensification, employment and labour demand would play out in a country like Nigeria with widespread unemployment and a rural-urban migration, is important. Understanding this effect is critical for policy on employment creation. In the same manner, disentangling the effect of commercialization on input use could provide insight as to whether intervention that addresses market access also triggers input intensification.

The rest of the paper is structured as follows: Section 2 focuses on the conceptual framework and empirical model, Section 3 describes the data, Section 4 presents the result of empirical analyses while Section 4 concludes the paper.

2. Conceptual framework and empirical model

2.1 Conceptual framework for smallholder commercialization

Majority of populations in Africa lives in rural areas and depends on small scale agriculture for food and income. Faced with limited prospects for rural industrialization, smallholder agriculture remains the major engine of rural growth and livelihood improvement for some time. Meeting the challenge of improving rural incomes in Africa will require some form of transformation out of the semi-subsistence, low-input, low-productivity farming systems that currently characterizes much of rural Africa (Govereh *et al*., 1999). Many national governments and international development bodies see intensification and commercialization of smallholder agriculture playing a central role in delivering broad-based growth in rural areas, where the majority of the poor still live. An alternative view, though, is that strategies to promote commercial agriculture will benefit primarily large-scale farms plus a minority of smallholder farmers– to the detriment of the majority of poor rural households (Leavy and Poulton, 2007; FAC, 2012).

Pingali and Rosegrant (1995) argued that the process of commercialization involves transition from traditional self-sufficiency goals towards income and profit-oriented decision making. As economies grow, farmers tend to be more responsive to market trends in their production decisions and procure more of their inputs from the markets. Accordingly, use of inputs such as family labour declines relative to production for the market and hired labour becomes predominant. The proportion of farm income in total household income declines, accompanied by significant reduction in the agriculture dependent population as family members find more lucrative non-agricultural employment opportunities (Leavy and Poulton, 2007). However, in the earliest stages of agricultural development, commercialization may well be associated with diversification, because market-oriented crop or livestock represent diversification away from production of basic food for home consumption and may be an important way to spread market-related risks (Chirwa and Matita, 2012).

Smallholder farmer commercialization is not necessarily about cash crop production. Although, Heltberg (2001), as cited by Chirwa *et al*., (2012), observes that farmers tend to add cash crops to existing food production activities in order to achieve food self-sufficiency in environments of large transaction costs and high risks found in many sub-Saharan African (SSA) countries, Govereh et al., (1999) noted that the issue of whether cash-cropping improves smallholder welfare in Sub-Saharan Africa (SSA) has been controversial and debated for decades. He further submitted that using analytical insights from the New Institutional Economics literature, Dorward *et al*. (1998) have shown that export-oriented cash crops may serve to stimulate smallholder crop

productivity and income growth, provided that ubiquitous credit market failures can be overcome through institutional innovations in farmer/marketing agent relationships.

From Figure 1, the extent to which smallholder farmers commercialize at household level depends on exogenous factors (A) which are identified in the literature to include agro-climatic conditions and risks; access to markets and infrastructure; community and household resource and asset endowments; input and factor markets; laws and institutions; cultural and social factors affecting consumption preferences, production and market opportunities and constraints (von Braun and Kennedy,1994; von Braun, 1995; Jaleta *et al*., 2009). The main exogenous forces that drive commercialization include population and demographic change, urbanization, availability of new technologies, infrastructure and market creation, macroeconomic and trade policies. These factors affect commercialization by altering the conditions of commodity supply and demand, output and input prices, transaction costs and risks that farmers, traders and others in the agricultural production and marketing system have to cope with (Pender and Alemu, 2007). For example, the potential benefits from commercialization such as higher product prices and lower input prices are not effectively transmitted to poor households when market access is poor (Chirwa *et al*., 2012). In addition to the exogenous factors, some household head, household characteristics, farm and productivity factors (Rios *et al*., 2008; Okoboi, 2011) are also found in the empirical literature to explain smallholder commercialization behaviour. The relationship between the exogenous (A), household level factors (B) and maize output commercialization (C) are shown in Figure 1.

The cause-effect relationship among maize output commercialization, fertilizer use and participation in non-farm employment are shown by the direction of arrows in Boxes C, D and E. For instance, Strasberg *et al*., (1999) found a significant and positive effect of household agricultural commercialization on food crop fertilizer use and productivity after controlling for endogeneity of household agricultural commercialization variable. In essence, increased production of maize occasioned by additional input (fertilizer) use provides opportunity for credit-constrained household to purchase additional inputs leading to more intensive input use and thus higher productivity. Similarly, increased sales can also provide additional income for purchase of fertilizer. As can be seen from Figure 1, a 2-way relationship is hypothesized on the direction of the arrow between maize output commercialization and fertilizer use. This bi-directional relationship suggests a potential reverse causality; an estimation issue that is addressed in econometrics through the use of Instrumental Variable (IV) or other quasi-experimental design approaches. A bi-directional relationship is also hypothesised for hired

labour demand through increased used of fertilizer and consequently, higher output. As for the effect of maize output commercialization on participation in non-farm employment, a one way relationship is hypothesized. Non-farm employment relaxes liquidity constraint through additional income which can be used to purchase input thereby increasing productivity first and then marketable surplus, which ultimately leads to higher level of commercialization. However, there is jointness between commercialization of output which is basically supply of labour on farm and sending same labour off farm. With this jointness hypothesis, there would be a negative relationship between commercialization and participation in non-farm employment because of competition for labour. Households that are commercially oriented supplies less labour for non-farm employment compared to households in autarky.

The productivity increases as a result of increased input use either through higher sales of output or income from non-farm employment can free labour for off farm employment. This causes a dual-employment effect: non-farm wage employment for the immediate household that is commercializing and agricultural wage employment for others that enjoy secondary benefit of commercialization. This study considers non-farm employment because as noted by Hernandez *et al*. (2010), rural non-farm employment is much more important than farm wage labour and often more important than cash cropping as a source of liquidity in most countries.

2.2 **Empirical model**

The relationship between commercialization, fertilizer use and non-farm employment was assessed using different methodologies. Ordinary Least Square (OLS) and Two-Stage Least Square (2SLS) methods were adopted in evaluating linear effects of household commercialization on fertilizer use while IVQR was utilized for assessing the non-linear relationship; probit model was used to investigate the relationship between commercialization and non-farm employment, the dependent variable being the decision to participate; while the effect of commercialization on demand for hired labour was examined with an OLS model.

In modelling the econometric relationship between fertilizer use and household commercialization, some degree of reverse causality is expected. This necessitated the use of instrumental variables in order to identify an exogenous source of variation in the observed regressors. It is also possible that there is potential simultaneity of household level of commercialization to fertilizer use due to unobserved heterogeneity and measurement error. For example, fertilizer use could depend on earnings from commercialization of maize output. In

addition, commercialization could compete for labour with non-farm activities especially where input markets are missing; a situation which is pervasive in Nigeria.

Instrumental Variables (IV) are variables which (i) are correlated with the endogenous variable (household commercialization level) and (ii) are correlated with the error term in the outcome equation (Kumar *et al.*, 2014). It is only when these two conditions are satisfied that one can identify a consistent estimate of causal effect of household level of commercialization on the fertilizer use. The instrument for household commercialization in this study is household sales location which could either be farm gate or other distance market. Sales location is a plausible instrumental variable whose validity depends on the degree to which it is correlated with a household's fertilizer use only through commercialization and not through any direct link to fertilizer use.

Following Rios *et al., (*2008) and Babatunde (2012), the IV model is specified as follows:

$$\text{Fert_maizehh}_i = \beta_{oo} + \beta_1 Hhage + \beta_2 Hhage^2 + \beta_3 xAdultfemale_i + \beta_4 adultmale + \beta_5 Hhedu + \beta_6 totalfarmsize + \beta_7 Fre_contact + \beta_8 creditmarket + \beta 2' \, Hhcom\acute{e}rcu_x\imath + \varepsilon_{1,i} \quad \ldots (1)$$

$$Hhcomercii_x_i = \gamma_{oo} + \gamma_1 Hhage + \gamma_2 Hhage^2 + \gamma_3 xAdultfemale_i + \gamma_4 adultmale + \gamma_5 Hhedu + \gamma_6 totalfarmsize + \gamma_7 Fre_contact + \gamma_8 creditmarket + \gamma_2' X_{2i}' + \mathcal{V}_{1,i} \quad \ldots (2)$$

where

Fert_maizehh_i = dependent variable (amount of fertilizer used by household *i* in kg).

$\beta_{oo}, \gamma_{oo}, \beta_{is}', \gamma_{is}'$ = unknown parameters of interest,

β_{1-9}' *and* γ_{1-9}' = vector of common exogenous variables hypothesized to be correlated with both household fertilizer use variable and commercialization.

$Hhcom\acute{e}rcu_x\imath$^ = predicted value of household commercialization, $\varepsilon_{1,i}$ = error term,

X_{2i}' = vector of instrument for household commercialization (sales location, which is captured as farm gate or distance market),

$\mathcal{V}_{1,i}$ = error term, $E(\varepsilon_{1,i}) = 0$ and $cov((\varepsilon_{1,i}, \mathcal{V}_{1,i}) = 0$.

The 2SLS was used because of computational ease and continuous nature of the dependent variable. Since the IV model has one endogenous variable (household commercialization index)

and one instrument (sales location), the model is exactly identified. Therefore, there is no need for an over-identification test (Angrist & Krueger, 2001 as cited in Kumar, 2014). The instrument was tested for endogeneity and weakness using the *endog* option of *ivreg2* in Stata.

Some of the covariates used in the models are as follows: age and age squared of household head (years), number of adult male and female in the household, education level of the head (years), land area cultivated (hectares), frequency of extension contact and amount of credit obtained (Naira).

Household Commercialization Index (HCI)

Household commercialization is defined here in terms of sales as a proportion of total output, going by the proposal of Govereh and Jayne (1999); Govereh *et al*. (1999) and Strasberg *et al*., (1999). The approach is to consider the percentage of crop production marketed by a farm or household.

$$\text{HCI} = \frac{\text{Gross value of all maize grain sales}}{\text{Gross value of all maize production}} * \ 100 \qquad \ldots (3)$$

A value of zero for the HCI signifies total subsistence, while a HCI value approaching 100 indicates higher degrees of commercialization.The measure is intended to measure commercialization in a scale-neutral manner, independently of the household's wealth (Rios *et al*., 2008).

3. Data and Descriptive Statistics

3.1 Sources and types of data

Primary data were used for this study and was collected through the use of a structured interview schedule that was pre-tested for appropriateness. Information collected include maize producing household socioeconomic characteristics, farm level data on inputs use and prices, expenditure on maize as well as sales, household assets, transaction cost, social network, labour, migration and access to credit and subsidy. Data collection was carried out between October, 2012 and November, 2013.

3.2 Sampling procedure

Two-stage sampling procedure was employed to select the respondents from Lere and Rano zones in Kaduna and Kano States respectively. Kaduna and Kano are the two largest producers of maize in Nigeria. In 2013, Kano had the largest area on which maize was planted, and highest

output in Nigeria (569,976 ha and 866,364 MT) followed by Kaduna with a total of 411,455 hectares and 616,359MT (Agricultural Production Survey, 2013). Similarly, Lere and Rano Agricultural Development Programme (ADP) zone in Kaduna and Kano States, are ADP zones where maize production is most predominant (Bamire *et. al.*, 2010; Ibrahim, 2012).

In the first stage, 25% of villages were randomly selected from the two zones using village listing. This amounted to 30 villages in Lere, Kaduna and 25 villages in Rano, Kano. In all, 55 villages were selected from the two zones. Approximately 5 households were selected per village. The second stage involved random selection of 300 maize farming households from the list of all households (sampling frame) within the selected ADP zones, proportionate to the distribution of farm families in the two zones. The proportionate factor used is expressed in equation 4**.**

$$H_i = \frac{h_i}{TH} \times S \qquad \ldots (4)$$

Where $\frac{h_i}{TH}$ = the proportion of household heads in $zone_i$ out of the total in the two zones

H_i = the no of households selected from $zone_i$(i= 1 to 2)

h_i = the no of households in $zone_i$ (385 076 for Zone 1 in Kano zone and 98 640 for Lere zone in Kaduna)

TH = Total no of households in the two zones

S = number of households selected from the two zones

In all, a total of 239 and 61 households were selected from Kano and Kaduna States respectively. Of this, 263 households that reported maize as their primary crops were used for the analysis, others were dropped.

Table 1 describes the socioeconomic and demographic characteristics of the respondents while Figure 2 shows their level of commercialization. From Table 1, the average household size for the whole sample is nine members, and the age of the household head was similar, whether they commercialize or not. A typical household head is 49-year-old and has about 6 years of formal education. Non-commercializing households have a higher number of years of schooling compared to commercializing households and the difference is significant at 5%. This finding might reflect the effect of education in household decision to commercialize or not among the sampled maize farming households. The average number of adult male and female in the households which is a proxy for household labour supply is 3, regardless of whether households

commercialize or not. This is found to be significantly different in the two categories of households.

On average, about 33% of households in the sample participated in a non-farm activity but non-farm employment participation rate was significantly higher for households that do not commercialize. This finding may well reflect the jointness between farm and non-farm activities which can be explained not only by technical interdependencies but also by the presence of fixed input and market imperfections (Havlik *et al*., 2005). The concept of jointness used in this study follows that of OECD (2001) and allows two activities to be represented by a joint production where an increase or decrease in the supply of one output affects the supply of the other. Meanwhile, about 82% of the sampled households sold part of their harvest to some form of market. This shows the high rate of participation in the output market. Figure 2 shows that many of the households fall at the lower (left) end of the distribution indicating small level of household commercialization,overall.

4. Results

4.1 Effect of household commercialization on fertilizer use

Tables 2, 3 and 4 present the results of linear analyses of the effect of commercialization on fertilizer use. Most of the results in Table 2 were in line with expectation and the model fits the data going by the significance of the F-statistic (F-value=8.13; Prob>F=0.000). The pooled data were also evaluated for structural stability using Chow test. The diagnostic result (chi^2=25; Prob>chi^2=0.945) of non-significance suggests that coefficients of the models are the same in the two agro-ecologies and it is therefore efficient to pool the data.

From the results in Table 2, HCI (p>0.05) and number of adult male (p>0.10) were positively related to fertilizer use, whereas education level of household head (p>0.05), farm size (p>0.05), amount of credit received (p>0.05) and frequency of extension contact (p>0.05) had negative relationship with fertilizer use. One percentage (1%) increase in the commercialization index will improve the likelihood of fertilizer use by about 6 kilograms. This result shows that household level of commercialization is important to decision on fertilizer use among the sampled maize farmers in the study area. This finding is consistent with empirical findings in Strasberg *et al., (*1999); and Rios *et al., (*2009) where household commercialization had a significant and positive effect on food crop fertilizer use and productivity. The result of the adult male variable shows that households' labour supply is critical for fertilizer use which is labour intensive. This is consistent with findings of Mathenge *et. al.,* 2013).

From the results, for every additional year of schooling, fertilizer use will decrease by about 26kg as against the expectation that higher level of education will allow farm households to switch between labour-using to capital saving technologies. This situation is perhaps because the degree of schooling is low among sampled respondents with the highest number of education corresponding to primary education. Similarly, a unit increase in the size of the land cultivated will reduce fertilizer use by about 5kg. Finding may be an indication of households using a mix of inorganic and organic fertilizers. It may also mean that farmlands are fertile requiring less amount of fertilizer or land intensification is practised in the study area. Use of input could also be affected by economies of scale: as land increases, the use of variable input can be more efficient (Hernandez *et al*., 2010). This finding reinforces earlier findings by Rios *et al*., (2009) and Sheahan and Barret (2014).

The amount of credit received by the household has a marginal effect on fertilizer use and the direction of the effect is negative. Contrary to expectation, for every additional Naira received as credit fertilizer use will decrease by 0.1 kg. The negative influence of contact with extension agent on fertilizer use may suggest that there is limited knowledge transfer to farmers on fertilizer technology. This finding supports the empirical evidence from Banful *et al*. (2010) that fertilizer technology is often not transmitted to farmers and that are gaps in the extension agent's knowledge of fertilizer technology.

Tables 3 and 4 respectively show the first and second stage results of the 2SLS IV regression for the fertilizer use model. The instrument used (sales location variable: market) was positive and significantly affects household commercialization at 5%, satisfying the relevant condition of usage. This also means that as the households shift from selling at the farm gate to a distant market, fertilizer use will increase by about 3 kg. Column 2 of Table 4 shows the result from the second stage IV estimation for the fertilizer use model in comparison with earlier OLS result which is contained in Column 1. This second stage result is robust to both arbitrary heteroskedasticity and arbitrary intra-group correlation. The result is also robust to LGA fixed effect.

Based on the results from OLS and the IV estimations, the impact of household commercialization on fertilizer use has been confirmed. However, the OLS has underestimated the effect with the IV estimate about 8 times larger than the OLS estimate. While in the OLS, an additional increase in the proportion of output sold will lead to an increase in fertilizer use by

about 6kg, in the IV estimate, the increase in fertilizer use will be about 49kg. This result reinforces the evidence of the impact of household commercialization on food crop fertilizer use (Govereh *et. al.,* 1999). On household labour stock proxy by the number of adult male and female in the households, a stronger effect was noticed for households in the IV. The coefficient of the number of adult male shows that for every additional male adult in households, fertilizer use will increase by approximately about 145kg (~3bags). Similar to the OLS, the coefficient of the farm size variable showed a significant but negative effect on fertilizer use.

The non-linear effect of fertilizer use on household commercialization examined with IVQR is presented in Table 5 (Column 1 represents the earlier 2SLS result for comparison). Understanding this non-linear effect is important for answering the question of how the level of commercialization varies with different levels of fertilizer use. Wald test was used to evaluate the equality of coefficient across the quantiles for the IVQR model. Its significance points to the fact that the coefficient vectors are not the same for the different quantiles equation. The results show that the causal effect of household commercialization is heterogeneous ranging from 30kg at the 10th percentile to 937kg at 90th percentiles. The IVQR estimate for the effect of household commercialization is consistently positive across all the quantile but becomes significant from the 25th conditional quantile of fertilizer use upwards thereby confirming the result of the 2SLS. Notably, the point estimate and intercept at the 50th percentile are larger than the estimate from the OLS and 2SLS, indicating that the distribution of fertilizer use outcome is significantly left skewed. This suggests that average effect masks the heterogeneity in the effect of household commercialization on fertilizer use. Fertilizer use is affected positively by the household level of commercialization for all the percentiles except for households in the lowest 10th percentile and the effect increases with the quantile. Unlike in the 2SLS model, the effect of age is significant in the IVQR. Similar to the 2SLS estimate, the number of the adult male in the household is positive but significant only at the 90th quantile.

With respect to the effect of farm size on fertilizer use, the sign of the coefficient across all the quantiles was the same, but the effect is only significant at the 25, 50 and 75 percentiles of fertilizer use respectively. Household access to credit is only significant at the q25 and q50 of fertilizer use. This finding also shows that fertilizer use is heterogeneous to the amount of credit obtained by the households. Overall, household commercialization, the number of the adult males and farm size are the predictors of fertilizer use among the sampled households.

4.2 Effect household commercialization on non-farm employment

Table 6 shows the result of the effect of household commercialization on participation in non-farm employment. The result from a linear probability model (LPM) was also reported in the table as a robustness check in addition to the probit result. The results show significantly negative effect of the household commercialization index variable presenting evidence of competition between the use of household labour for on-farm and non-farm activities which may reflect binding constraint on labour. For every 1% change in the household commercialization index, the probability of household freeing labour to participate in non-farm employment is reduced by 1.4%. This result is persistent regardless of the estimation method used. This suggests that for households that are commercialized, the opportunity cost of sending labour for non-farm activities is high. This result contradicts findings from earlier studies (Oseni and Winters 2009; Babatunde, 2012; Mathenge *et al.*, 2013) where off-farm and on-farm activities were found to be complements. Although, the marginal effects are small in magnitude indicating that there are other more limiting constraints to household participation in non-farm employment, consistent statistical significance suggests that commercialization of maize is important in the decision to participate in non-farm employment and could not be ignored.

4.3 Effect of household commercialization on demand for hired labour

Table 7 presents the effect of household commercialization on demand for hired labour. The result is robust to outlier and heteroskedasticity. The F-statistics (4.05) is significant at 1%. The model was also evaluated for multicollinearity and the mean value VIF value of 1.46 eliminated the fear of multicollinearity. The household commercialization index showed positive and significant effect on demand for hired labour. One percentage (1%) change in the household commercialization index would increase the demand for hired labour by 34 man-days ($p<0.05$). It means that as household commercialization rate increases, the demand for hired labour increases. Similarly, most of the control variables that were significant behaved as expected with the exception of the number of adult female in the household which shows positive effect on demand for hired labour. For every additional adult female labour, the demand for hired labour will increase by about 2 man-days meaning that households with more female adult labour would demand more hired labour. This finding is plausible in that female labour is predominant in the downstream sector and is therefore seldom used for farm operations. It may also mean that female labour is a binding constraint for on-farm activities and may be connected to the opportunity cost of using female labour on-farm compared to non-farm activities. It means that controlling for household female labour supply is important in the hiring of labour.

On farm size variable, there is positive and significant effect of farm size on demand for labour in line with expectation. Presumably, the more the land to be cultivated, the more the labour required beyond the family labour. An additional increase in the unit of land cultivated will increase the demand for hired labour by 43.9%. Among the influencing factors of demand for hired labour, farm size had the highest magnitude of coefficient. The result of the OLS estimation with interaction effect showed that household commercialization index had positive influence on demand for hired labour, as presented in Table 7. On the interpretation of the interaction terms, the larger the farm size, the greater the effect of contact with an extension agent, leading to greater influence of farm size on the demand for hired labour. In essence, there is a combined effect of the size of the farmland with extension contact on demand for hired labour. Perhaps, households with larger farm sizes and more frequent contact with extension are more likely to adopt technologies that will increase the demand for hired labour.

5. Conclusion

The average level of commercialization is low thereby suggesting scope for improvement. Promoting agricultural commercialization can be a pathway to improving fertilizer use but programs aimed at promoting the use of fertilizer must take the heterogeneous effect of commercialization into cognizance and should pay attention to farmers in the bottom of the pyramid. The negative association between household commercialization and non-farm employment indicates that government should promote farm and non-farm employment opportunities along with technologies that free labour from on-farm employment such as mechanization of farm operations.

Given the role of commercialization in increasing fertilizer usage, efforts should be made to provide necessary market infrastructure since market access is a necessary precondition for agricultural commercialization. Maize farmers should also be better oriented on the appropriate use of herbicide to reduce the intensity of manual labour use for production. The positive relationship between commercialization and hired labour is particularly more interesting for policy makers given the low level of commercialization in the country. Promoting agricultural commercialization can serve as an opportunity to improve the level of mechanization of farm activities, especially because of labour supply shortages during the peak of production.

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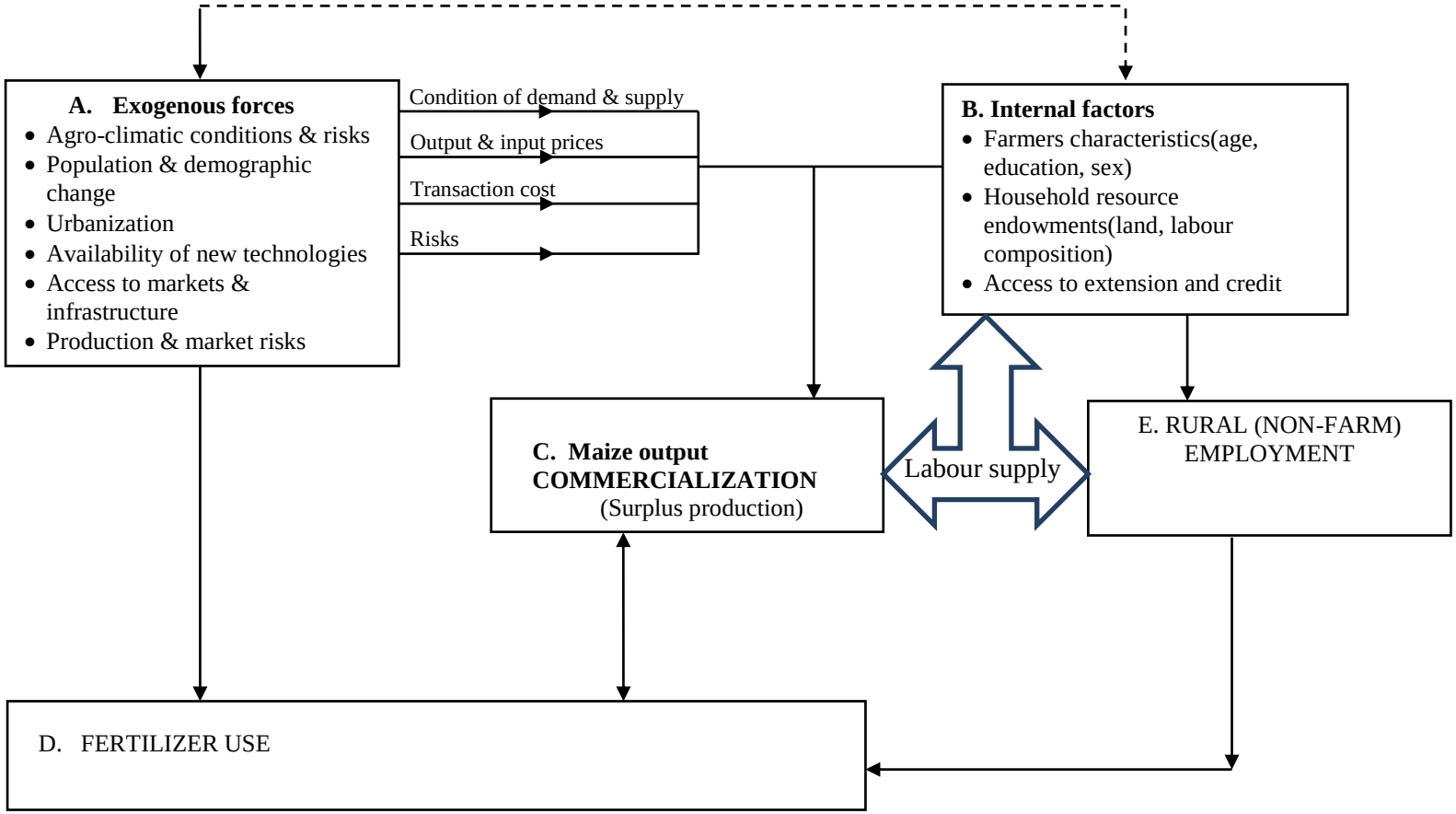


Figure 1: Conceptual framework of smallholder commercialization, fertilizer use and non-farm employment

Table 1: Characteristics of maize farming households

	Commercialized	Non-commercialized	Pooled	T-test
Household size	8.91	9.02	8.93	0.14
	(4.19)	(4.76)	(4.65)	
Age of household	48.69	47.71	48.51	-0.47
	(12.55)	(14.13)	(12.82)	
Education of household Head	5.74	6.85	5.93	1.69**
	(0.26)	(0.15)	(0.25)	
No. of adult males in the household	2.62	2.64	2.62	0.06
	(1.96)	(1.57)	(1.89)	
No. of adult females in the household	2.47	2.68	2.51	0.81
	(1.65)	(1.49)	(2.51)	
Distance to town	7.36	10.37	9.83	-2.38
	(8.41)	(7.74)	(7.93)	
Distance to market	9.70	10.39	10.27	-0.56
	(7.95)	(7.48)	(7.56)	
Distance to road	7.32	9.65	9.23	-1.74
	(8.89)	(8.15)	(8.32)	
Contact with extension agent	21.37	28.26	22.33	1.79**
	(21.12)	(19.07)	(20.94)	
Participate in nonfarm activity	33%	49%	36%	2.03**
Sold part of harvest	82%	0%	82%	-

Note: Figures in parentheses are standard deviation

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

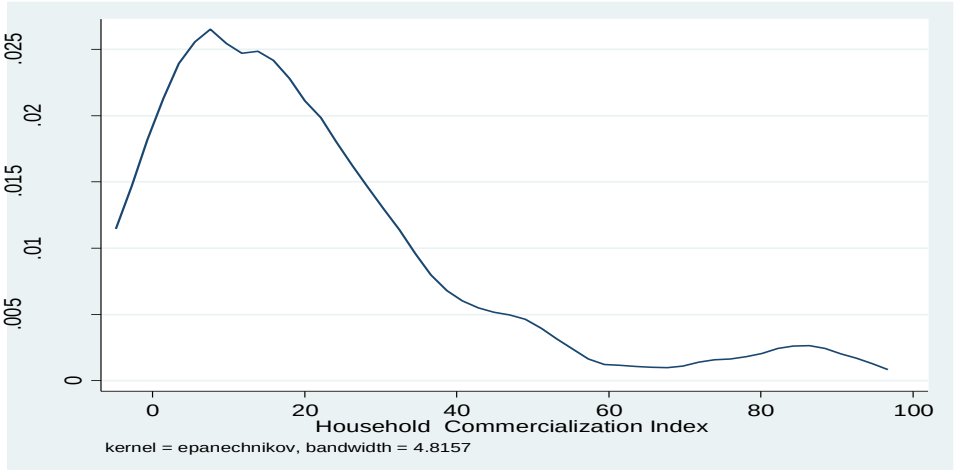


Figure 2: Kernel density estimate for Household Commercialization Index

Table 2: Linear effect of household commercialization on fertilizer use

Dependent variable: Fertilizer use			
Variables	Coefficient	t	P>|t|
Household Commercialization Index	5.516**	2.840	0.006
Age of household head	0.057	0.040	0.706
Age-squared of household head	-9.702	-1.410	0.166
Number of adult male in the household	59.172*	1.790	0.078
Number of adult female in the household	55.748	1.110	0.276
Educational level of household head	-26.364**	-2.170	0.027
Farm size	-5.630**	-2.390	0.016
Amount of credit received	-0.001**	-2.530	0.015
Frequency of contact with extension agent	-5.595**	-2.450	0.013
Constant	837.103**	3.310	0.000
Number of observation	263.000		
R-squared	0.095		
Goodness of fit of model Prob > F	0.0000		

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

Table 3: First stage 2SLS IV results of the linear effect of household commercialization on fertilizer use

	Dependent variable: fertilizer use		
Variables	Coefficient	t	P >t
Age of household head	0.029	-0.89	0.377
Age-squared	-0.003	0.23	0.815
Number of adult male in the household	-1.367	-2.13	0.034
Number of adult female in the household	-0.484	-0.62	0.535
Educational level of household head	-0.370	-1.16	0.249
Farm size	0.080	1.19	0.235
Amount of credit received	0.000	-2.57	0.011
Frequency of contact with extension agent	-0.118	-1.88	0.061
Market	3.959	2.5	0.013
Constant	21.796	2.67	0.008
Centered R-squared	0.144		
Uncentered R-squared	0.600		
Number of observations	225		

Prob > F 0.0000

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

Table 4: Second stage results of the linear effect of household commercialization on fertilizer use

	Dependent variable: Fertilizer use	
	(OLS)	(2SLS)
Variables	Coefficient	Coefficient
Household Commercialization Index	5.516**	49.469**
	(1.990)	(21.021)
Age of household head	0.057	0.152
	(0.152)	(0.220)
Age-squared	-9.702	-14.180*
	(7.011)	(7.898)
Number of adult male in the household	59.172*	145.340**
	(33.611)	(57.891)
Number of adult female in the household	55.748	113.471*
	(51.149)	(62.297)
Educational level of household head	-26.364**	-14.363
	(11.910)	(20.750)
Farm size	-5.630**	-10.629**
	(2.340)	(3.523)
Amount of credit received	-0.001**	0.001
	(0.000)	(0.004)
Frequency of contact with extension agent	-5.595**	0.654
	(2.251)	(4.650)
Constant	837.103***	-365.667
	(249.494)	(807.393)
Number of observation	263.000	225.000
LGA Fixed effect	No	Yes
Instrumented/endogenous variable	Household commercialization variable	
Instrument used	Sales location	

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.
Standard error in parenthesis.

Table 5: Non-linear effect of household commercialization on fertilizer use

	Dependent variable: Fertilizer use					
	2SLS	q10	q25	q50	q75	q90
Variables	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Household Commercialization Index	49.469**	30.096	281.288**	373.276**	502.931**	937.304**
	(21.021)	(45.621)	(34.169)	(34.000)	(118.512)	(244.033)
Age of household head	-14.180*	0.023	0.017	-0.085	-6.223	-27.289
	(7.898)	(0.667)	(0.446)	(0.252)	(8.147)	(19.994)
Age of household head Squared	0.152	-0.000	-0.001	-0.001	-0.028	0.082
	(0.220)	(0.026)	(0.017)	(0.007)	(0.185)	(0.516)
Number of adult male in the household	145.340**	0.122	0.929	1.068	12.748	179.039*
	(57.891)	(2.884)	(3.217)	(1.351)	(31.001)	(96.950)
Number of adult female in the household	113.471*	-0.361	-0.209	0.154	-4.054	108.684
	(62.297)	(7.756)	(1.616)	(1.097)	(51.849)	(96.894)
Educational level of household head	-14.363	-0.373	-0.036	0.017	-24.905*	-45.983
	(20.750)	(1.809)	(1.289)	(0.611)	(14.382)	(31.420)
Farm size	-10.629***	-1.106	-6.825**	-8.486**	-7.967**	-6.442
	(3.523)	(1.166)	(0.704)	(0.416)	(2.496)	(5.036)
Amount of credit received	0.001	-1.226	-5.349***	-4.450*	1.048	14.935
	(0.004)	(1.513)	(2.002)	(2.679)	(8.746)	(21.620)
Frequency of contact with extension agent	0.654	0.000	-0.000	-0.000	-0.000	-0.001
	(4.650)	(0.000)	(0.001)	(0.001)	(0.002)	(0.005)
Constant	-365.667	74.985***	100.908***	135.584***	692.647**	1,309.135*
	(807.393)	(22.875)	(19.204)	(35.907)	(274.576)	(670.169)
Number of observations	225		263			
Pseudo R-squared		0.005	0.107	0.182	0.063	0.114

Note: 20+ replications were run

Wald test for equality of coefficient across quantiles [q10=q25=q50=q75=q90]

F(19, 252) = 122.97; Prob > F = 0.0000

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

Table 6: Effect of household commercialization on nonfarm employment

Dependent variable: Participation in non-farm employment		
	Probit	LPM
Variables	Coefficient	Coefficient
Household Commercialization Index	-0.013**	-0.004***
	(0.006)	(0.001)
Age of household head	0.016*	0.005
	(0.009)	(0.003)
Age-squared	-0.000	-0.000
	(0.000)	(0.000)
Number of adult male in the household	-0.043	-0.015
	(0.055)	(0.019)
Number of adult female in the household	0.030	0.010
	(0.064)	(0.023)
Educational level of household head	-0.020	-0.007
	(0.029)	(0.010)
Years of education of adult in the households	0.040	0.012
	(0.045)	(0.015)
Farm size	-0.016*	-0.004**
	(0.009)	(0.002)
Household access to credit	-0.643*	-0.245**
	(0.333)	(0.123)
Frequency of contact with extension agent	0.004	0.002
	(0.005)	(0.002)
Constant	0.319	0.658**
	(0.758)	(0.273)
Number of observation	245.000	245.000
Pseudo-R squared	0.008	-
R-squared	-	0.097
Log pseudo-likelihood	-139.92483	

Note: Columns (1) and (2) are marginal effects of probit estimate and LPM
*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

Table 7: Effect of household commercialization on demand for hired labour with and without interaction effects

Dependent variable: Amount of hired labour				
	Without interaction effect		With Interaction effect	
	Coefficient	p-value	Coefficient	p-value
Household Commercialization Index	0.343**	0.000	0.305**	0.000
Age of household head	-0.104	0.471	-0.140	0.327
Age of household head squared	0.000	0.998	0.001	0.859
Number of adult male in the household	1.623	0.101	1.562*	0.098
Number of adult female in the household	1.921*	0.076	1.409	0.124
Educational level of household head	0.321	0.378	0.284	0.391
Farm size	0.439**	0.037	0.088	0.634
Amount of credit received	-0.000	0.113	0.000**	0.015
Frequency of contact with extension agent	0.117*	0.084	-0.036	0.585
Farm size* contact extension			0.055**	0.044
Credit*years of education			-0.000***	0.010
Constant	3.370	0.619	8.943	0.139
Number of Observations	263		263	
R-square	0.167		19.045	

*, **, and *** indicate p-values significant at 10%, 5%, and 1%, respectively.

Prob > F = 0.0001