Sibande, L., Bailey, A. &Davidova, S. (2017) *Food Policy*, 69, 190-206
https://doi.org/10.1016/j.foodpol.2017.04.001

The impact of farm input subsidies on maize marketing in Malawi

Lonester Sibande[†1]

[†1] *Corresponding author, School of Economics, Keynes College, University of Kent, Canterbury, CT2 7NP, United Kingdom, Tel:+44(0)1227823936, lonestersibande@gmail.com*

Alastair Bailey[1]

School of Economics, Keynes College, University of Kent, Canterbury, CT2 7NP, United Kingdom, Tel: +44(0)1227823277, A.Bailey@kent.ac.uk.

Sophia Davidova[1]

School of Economics, Keynes College, University of Kent, Canterbury, CT2 7NP, United Kingdom, Tel: +44 (0) 1227824764, S.M.Davidova@kent.ac.uk.

Abstract

This paper investigates the effects of subsidised fertilizer on marketing of maize in Malawi. It uses the nationally representative two-wave Integrated Household Panel Survey (IHPS) data of 2010 and 2013. The results suggest that subsidised fertilizer on average increases farmers' maize market participation as sellers, total quantity of maize sold, and maize commercialisation. In addition, participation in subsidised fertilizer programme is found to increase the probability of farmers to be net sellers and increases net quantity of maize sold. However, the study finds no evidence of effect on net quantity of maize bought and on household maize self-sufficiency. These results suggest that the farm input subsidy program has contributed toward an increased level of maize market supply engagement for small farmers and in this sense, the policy has the potential to provide the wider external benefits. Furthermore, the results have implication on the sustainability of the subsidy programme, policy formulation and design of programmes for the agricultural sector and small farmers in developing countries.

Keywords: Farm Input Subsidy; Maize Marketing; Malawi.

JEL Classification: Q1, Q13, Q18.

Acknowledgement:

We are greatly thankful to three anonymous reviewers for their constructive comments and suggestions on the earlier version of this article.

1 Introduction

It is widely accepted that small farmers' participation in markets is one of the most important factors necessary for economic growth and poverty reduction in developing countries (Heltberg and Tarp, 2002, Muriithi et al., 2015, Pingali, 2007, World Bank, 2007). Markets offer households opportunities to engage in productive activities through investments in diversified livelihood strategies and sell both labour and products (IFAD, 2003, Njuki et al., 2008, World Bank, 2000). Access to input and output markets is also important for farm households' adoption of modern technologies (e.g. fertilizers and hybrid seed varieties), which are crucial for increased productivity and income (Dorward and Kydd, 2005, Zeller et al., 1997). However, in developing countries poor access to, and low participation in markets are pervasive, especially as far as small farmers are concerned, which limit livelihoods opportunities and perpetuate their poverty (Barrett, 2008, Heltberg and Tarp, 2002, Jayne et al., 2010, Poulton et al., 2006). This is one of the major concerns for governments which depend on agriculture as a pro-poor growth strategy (de Janvry et al., 1991).

In the literature, small farmers' lack of access to, and low participation in, markets is mainly attributed to barriers to entry (Barrett, 2008, Jayne et al., 2010). These barriers include high inputs requirements in the form of land, chemicals, fertilizer and processing; high products' quality demand, and high transaction costs of marketing (Barrett, 2008, Heltberg and Tarp, 2002, Mather et al., 2013, Poulton et al., 2006). The global agricultural market conditions are rather instable due to multiple factors, including changes in farm policies in high-income countries and a significant decline in donor and state support to the agricultural sector (Jayne et al., 2010). Therefore, several factors, including the ones presented above, have led the majority of small farmers in developing countries to focus on production of food crops for subsistence.

To increase the use of both fertilizers and hybrid seeds by small farmers, and consequently, improve crop production and productivity, a range of farm input subsidy programmes have been used as policy tools by many developing countries prior to the implementation of structural adjustment and stabilisation programmes (IMF, 2008). Although most of these input subsidy programmes were phased out in the 1980s and early 1990s in most countries in sub-Saharan Africa (Husain, 1993, World Bank, 2007), several countries including Malawi have reintroduced them since 1998, (Dorward et al., 2008, IMF, 2008). Since the input subsidies target specific crops, coupons used to redeem subsidised inputs are crop-specific and this may affect farmers' decisions on cropping patterns and, therefore, may have direct effects on marketing of food crops. Such potential marketing effects have not been fully analysed in previous studies.

The main objective of this study is to investigate the effects of subsidised fertilizer on marketing of maize in Malawi. The specific objectives include the estimation of the impact of subsidised fertilizer on farmers' participation in maize market as sellers and the quantity sold; the net quantities sold and bought and the commercialisation of maize, (i.e. the ratio of maize quantity sold to total quantity of maize harvested. In simple terms a farmer is defined as a net maize seller if the total quantity of maize sold is higher than the quantity bought and the difference between the two quantities is the net quantity sold and vice versa for a farmer defined as a net maize buyer. The case if a farmer neither buys nor sells maize or the quantity sold is equal to the quantity bought is defined as maize autarky (self-sufficiency). Determining the extent of farmers' maize market participation as sellers, quantity sold, the degree of commercialisation or autarky, net quantity sold and bought is important to give insights into the potential increase or decrease in maize market supply and demand, respectively, as a result of the fertilizer subsidy programme. Such information is essential in understanding the effects on maize prices since the majority of small farmers are net maize buyers. It will also provide an indication of the ability of the programme beneficiaries to self-finance the purchase of fertilizer at commercial prices in the future with income derived from the sale of maize produced with subsidised inputs and hence the ability of the subsidy programme to lift households from autarky and subsidy dependence.

To our best knowledge, this is the first study to empirically quantify the effects of subsidised fertilizer on marketing of maize in Malawi, and specifically on farmers' supply and demand of maize. The only studies which are close to some of the aspects analysed in this paper are Ricker-Gilbert et al. (2013), who investigate the effects of fertilizer subsidy on maize prices in Malawi and Zambia, and Takeshima and Liverpool-Tasie (2015), who analyse the effects of fertilizer subsidies on grain prices in Nigeria. Both studies find insignificant effect of fertilizer subsidies. In contrast to previous studies which focused on marketing of food crops and which consider the general supply side of the market, this paper also includes an evaluation of factors influencing commercialisation of maize in order to identify key determinants necessary for the transition of farmers from subsistence to commercial maize farming.

This paper is structured as follows. The next section presents a review of farm input subsidies in developing countries and reforms in the implementation of the programme in Malawi. Section three discusses the performance of the agricultural sector and marketing in Malawi. Sections four and five present the conceptual framework and the empirical models, respectively. Data sources, descriptive statistics and endogeneity tests are discussed in section six. Results and discussions are presented in section seven, and section eight concludes and discusses policy implications.

2 Reintroduction of farm input subsidies in developing countries

Against the orthodox evidence that subsidies distort markets in the economy, a new wave of agricultural input subsidies is emerging in most developing countries, especially in sub-Saharan Africa (SSA) (DANIDA, 2011, Druilhe and Barreiro-Hurle, 2012, Ricker-Gilbert et al., 2013). Introduction of input subsidies is aimed at addressing challenges of low output and productivity of poor small farmers who are financially constrained to purchase improved inputs for production with the ultimate objective to move towards food self-sufficiency at household and national levels and ultimately to promote poverty alleviation.

There are several studies on the impact of the recently implemented farm input subsidy programmes in SSA. They have focused on both direct and partial equilibrium effects. The effect on crop output generated by farm input subsidies is one of the areas which has been extensively studied. Research by Chibwana, et al. (2010), Dorward et al. (2013), Holden and Lunduka (2010), Ricker-Gilbert and Jayne (2011) finds statistically significant and positive effects of farm input subsidies on maize production and productivity in Malawi. Ricker-Gilbert and Jayne (2011) find that an additional kilogram (kg) of subsidised fertilizer increases maize production by 1.82 kg in the current year and 3.16 kg in the third year of using subsidised fertilizer. These are strong effects because the 1.82 kg and 3.16 kg effects translate to an addition of about 200 kg and 300 kg of maize, respectively, if a household uses 100 kg of subsidised fertilizer. Analysing maize yield response to farm input subsidies, Chibwana, et al. (2010) estimate that using subsidised fertilizer only increases maize yield by 249 kg per hectare, while using both subsidised hybrid maize and fertilizer increases maize yield by 447 kg per hectare. Dorward et al. (2013) evaluate the 2012/2013 Farm Input Subsidy Programme (FISP) and they report that a full FISP package increases maize production by at least 500 kg, while only one 50 kg bag of subsidised fertilizer or with hybrid maize seed increases maize production by between 200 kg and 400 kg. Similar results are reported in a study by Mason et al. (2013) who analyse the effects of subsidised fertilizer on maize production in Zambia and find that an additional kilogram of subsidised fertilizer increases maize production by 1.88 kg. A study by Wiredu et al. (2015) who analyse the impact of fertilizer subsidy on land and labour productivity in Ghana finds that receipt of subsidised fertilizer increases rice production by 29 kg per hectare.

The effects of farm input subsidies on input market has also been analysed by several researchers. Ricker-Gilbert et al. (2011) and Mason and Ricker-Gilbert (2013) find that an additional kg of subsidised fertilizer and hybrid maize seed in Malawi crowd-out commercial purchases of fertilizer and hybrid maize seed by 0.22 kg and 0.58 kg, respectively. A similar effect of crowding-out is reported in a study by Chirwa et al. (2013), who find a decrease in purchase of commercial fertilizer of between 0.15 % and 0.21% for a 1 % increase in subsidised fertilizer. However, Xu et al. (2009) report both crowding-out and crowding-in effects on commercial fertilizer purchases in Zambia, and Liverpool-Tasie (2014) find that subsidised fertilizer increases both participation in the private fertilizer markets in Kano State, Nigeria and the quantities of commercial fertilizer bought in these markets.

Farm diversification effects of input subsidies have also been examined in the context of their impact on land allocation to various crops at household level. Chibwana, et al. (2012) and Holden and Lunduka (2010) are some of the recent studies for Malawi. However, these two studies find contradicting results, which is mainly attributed to differences in the methodologies employed (Lunduka et al., 2013). Chibwana et al. (2012) find increased land allocated to maize, while Holden and Lunduka (2010) find a decreased land area. Dorward et al. (2013) and NSO (2014b) support the decrease in land allocated to maize and report that an increasing proportion of farmers grow other crops, mainly legumes. A study by Yi et al. (2015) who analyse the effects of grain subsidies on area under grains in China find positive effects, but only on the liquidity-constrained households.

Several studies have also analysed the household welfare effects of farm input subsidies in Malawi. Chirwa et al. (2013), Dorward and Chirwa (2011), and Dorward et al. (2013) all find improvement in adequacy of food availability at household level. A study by Ricker-Gilbert and Jayne (2011) report that, on average, an additional kg of subsidised fertilizer increases farm net crop income by US$1.16, however, they find no evidence of effects on household asset values. Ricker-Gilbert and Jayne (2012) also analyse the effects of subsidised fertilizer on crop income and find increased crop income to richer households at the top percentiles and no statistically significant effect on poor households at the bottom percentiles. Chirwa, et al. (2013) analyse the effects of farm input subsidies on poverty, primary school enrolment and sickness of under-five year old children and they find an overall increase in primary school enrolment and reduced probability of having sick under-five year old children, but the study finds no statistically significant effects on subjective self-assessed poverty at household level. However, Dorward et al. (2013) find no significant differences on school attendance, sickness of a household member or of under-five year child in relation to the number of times of receipt of subsidies.

Studies at a more macro level have focused on food prices and macroeconomic indicators. Ricker-Gilbert et al. (2013) find small effects on maize prices in Malawi and Zambia. Similar results are found by Takeshima and Liverpool-Tasie (2015) who analyse the effects of fertilizer subsidies on grain prices in Nigeria. Chirwa et al. (2013) study the effect of farm input subsidies on GDP and agricultural sector growth, poverty and inflation trends in Malawi. They find that during the implementation period of the programme, Malawi experienced increased GDP and agricultural sector growth, and a decline in poverty and inflation, which are attributed to the FISP. However, that study does not analyse the causal relationship between the macroeconomic indicators under consideration and the farm input subsidy programme.

2.2 Malawi's Farm Input Subsidy Programme implementation reforms

The Malawi government reintroduced a large farm input subsidy programme in the 2005/2006 agricultural season and has been implementing it since in every agricultural season. The main objective of FISP is to facilitate access to improved farm inputs of resource poor small farmers, and consequently to achieve food self-sufficiency of programme beneficiary households and at national level, and improve farm incomes from crop sales (Dorward and Chirwa, 2013). The implementation in 2015/2016 marks 10 years of implementation of this large scale farm input subsidy programme.

Although the main objective of the FISP focuses on addressing the problems of persistent food and income insecurity among the resource poor small farmers, achieving political objectives by the ruling party elites may have been an additional underlining influence in the implementation of the FISP (Poulton, 2012). If Poulton is correct, the implementation processes of this and other programmes may be prone to political influence which could act against the achievement of efficiency and effectiveness. It might also be the case that political considerations may compromise an effective exit strategy from the programme and result in the FISP continuing long after it has produced its 'market-start' purpose. Poulton (2012) explains in more detail the processes of developing agricultural policy design and implementation in the context of potential political and technical influence.

Since its inception in the 2005/2006, the FISP targeting and implementation processes have undergone several reforms. Dorward and Chirwa (2013) outline the changes in the targeting criteria of FISP in the period from the 2005/2006 to the 2009/2010 agricultural seasons concerning the area and beneficiary levels. Area targeting, which refers to districts or Extension Planning Area (EPAs), has been always done by the Ministry of Agriculture and Food Security (MoAFS) Headquarters. The process of targeting beneficiaries at the village level has been unclear in some seasons and has been done by different groups in different seasons. The district targeting and coupons allocation criteria have changed from focusing on tobacco and maize in the 2005/2006 and 2006/2007 agricultural seasons to a focus on the number of farm households in a district or EPA in later years (Dorward and Chirwa, 2013).

In terms of beneficiary targeting, the 2005/2006 FISP had no clear criteria, while in the later years although technical criteria have been well defined there have been variations in the actual implementation. The official targeting criteria have been changing over the years from: "fulltime smallholder farmers unable to afford the purchase of one or two unsubsidised fertilizer" in the 2006/2007 agricultural season to "resource poor local resident with land, guardians looking after physically challenged, and the vulnerable (the vulnerable include the elderly, child or female headed holdings or people living with HIV)" in the 2009/2010 agricultural season (Dorward and Chirwa, 2013).

The processes of allocating coupons to villages have also undergone several reforms. In the 2005/2006 FISP, village coupons allocations were done by traditional authorities (TAs); in the 2006/2007 and 2007/2008 by the District Development Committees (DDCs), Area Development Committees (ADCs) and TAs; while in the 2008/2009 and 2009/2010 by MoAFS staff, DDCs, ADCs and TAs (Dorward and Chirwa, 2013).

The use of farm household registers and open meetings was introduced in the 2008/2009 and was facilitated by MoAFS staff, while the use of voter registration numbers and personal identity cards (IDs) was introduced in the 2009/2010 agricultural season (Dorward and Chirwa, 2013). However, Dorward and Chirwa (2013) report that in spite of these changes reallocation and redistribution of coupons at village level has been common in all the years of FISP implementation, and thus, defeating the whole purpose of the reforms.

The types of farm inputs which were included in the FISP and the subsidy rates have also been changing over time. Lunduka et al. (2013) report that the subsidies in 2005/2006 were only for fertilizer for maize production and the subsidy rate per 50 kg bag of fertilizer was 64 per cent of the commercial price. In 2006/2007 subsidised inputs were fertilizer and maize seed for maize production; in 2007/2008 were fertilizer, maize and legumes seed for maize and legumes production; in 2008/2009 were fertilizer and maize seed for maize, tobacco and cotton production; while in 2009/2010 and 2010/2011 were fertilizer, maize and legumes seed for maize, legumes and cotton production. Storage pesticides were also included in the 2009/2010 agricultural season and the subsidy rate for a 50 kg bag of fertilizer was increased to about 95 per cent of the commercial price (Lunduka et al., 2013).

All of the above means that the standard programme 'full package' per targeted farm household under the FISP has also undergone several modifications. For the 2009/2010 and 2012/2013 agricultural seasons, the full standard programme package was designed to support the purchase of 100 kg of subsidised fertilizer (50 kg bag NPK and 50 kg bag Urea); one pack of improved maize seed (5 kg hybrid or 8 kg open pollinated variety (OPV)) required for a maize plot size of a quarter of a hectare; and one legume pack (Dorward, et al., 2013). However, earlier studies (Chibwana et al., 2010; Holden and Lunduka, 2010, Ricker-Gilbert and Jayne, 2011) have shown that FISP beneficiaries received heterogeneous coupon packages (such as coupons for only maize seed, for one 50 Kg bag of fertilizer or for three 50 Kg bags of fertilizer).

3 Agricultural sector performance and marketing in Malawi

In the post-structural adjustment reform period the performance of the agriculture sector in Malawi has been poor and this has been attributed to the low productivity and profitability of the sector, emanating from multiple risks associated with production and marketing processes (World Bank, 2004). Inadequate access to agricultural markets due to high transaction costs is a major challenge to most small farmers in Malawi. The World Bank (2010) reports that markets for agricultural products in Malawi are inefficient and the presence of traders' margins in excess of those realised by producers provides some support for this claim. The unfavourable developments of agricultural terms of trade have been another challenge facing the agriculture sector, which has contributed to low profitability. These adverse developments have been due to the high costs of transport of both imports and exports (World Bank, 2004), and the inefficiency of the marketing systems in rural areas (Dorward et al., 2004).

Low agricultural production and the presence of significant transaction costs faced by small farmers have resulted in only a small proportion of Malawian small farmers participating as sellers of cereals and legumes. Using the 1997/1998 data from the first integrated household survey (IHS1), Chirwa (2006) reports that while in general 39 per cent of households which produced crops participated in markets as sellers, only 9 per cent of households which produced maize sold that crop. Employing data from the second integrated household survey (IHS2), Chirwa (2009) finds some improvement reporting that in 2004/2005 this percentage increased to 15. Figure 1 presents trends in market participation of farmers as sellers of selected cereals, including maize, and legumes based on surveys conducted between 1997/1998 (IHS1) and 2013 integrated household panel survey (IHPS). Although over 90 per cent and less than 10 per cent of the farmers cultivated maize and rice respectively (Table A1 in the appendix), out of these farmers less than 20 per cent sold maize, while about 40 per cent sold rice (Figure 1). Survey data also indicates that the proportion of farmers who sold beans, groundnuts, and rice had significantly decreased in the first half of

2000s compared to the 1997/1998 levels. A comparison between the period before (statistics based on the 2004/2005 data) and after the implementation of FISP suggests there has been no significant increase in the proportion of farmers who sold maize or rice. However, data reveals an increase in the proportion of sellers of groundnuts, beans and pigeon peas. These facts lead us to question the impact of the FISP on its objective.

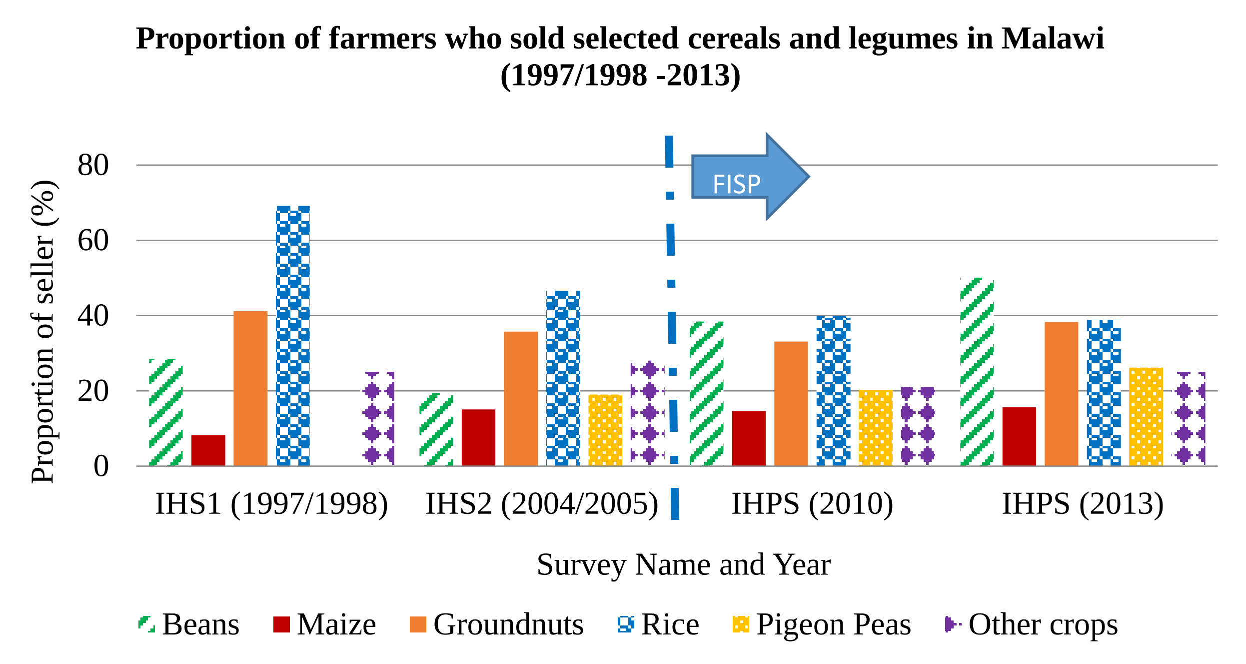

Figure 1: Proportion of farmers who sold selected cereals and legumes in Malawi (1997/1998 -2013)

Notes: IHS: Integrated Household Survey; IHPS: Integrated Household Panel Survey.
Source: Authors' calculation based on IHS1 (1997/1998), IHS2 (2004/2005), IHPS (2010 and 2013) data and NSO (2014b).

The low level of market participation by small farmers as sellers, the small quantities sold, coupled with the low rates of commercialisation of cereals are significant factors contributing towards the persistence of poverty among small farmers whose livelihoods are dependent on production of staple food crops. This raises doubts in the effectiveness of various agricultural policies aimed at facilitating commercialisation of major cereals and legumes in Malawi.

However, overall and at national level, the performance of the agricultural sector in Malawi has improved since the reintroduction of FISP. In terms of agricultural production at national level, total cereals (maize, rice, sorghum, finger millet, and pearl millet) production and productivity has improved (Figure 2).

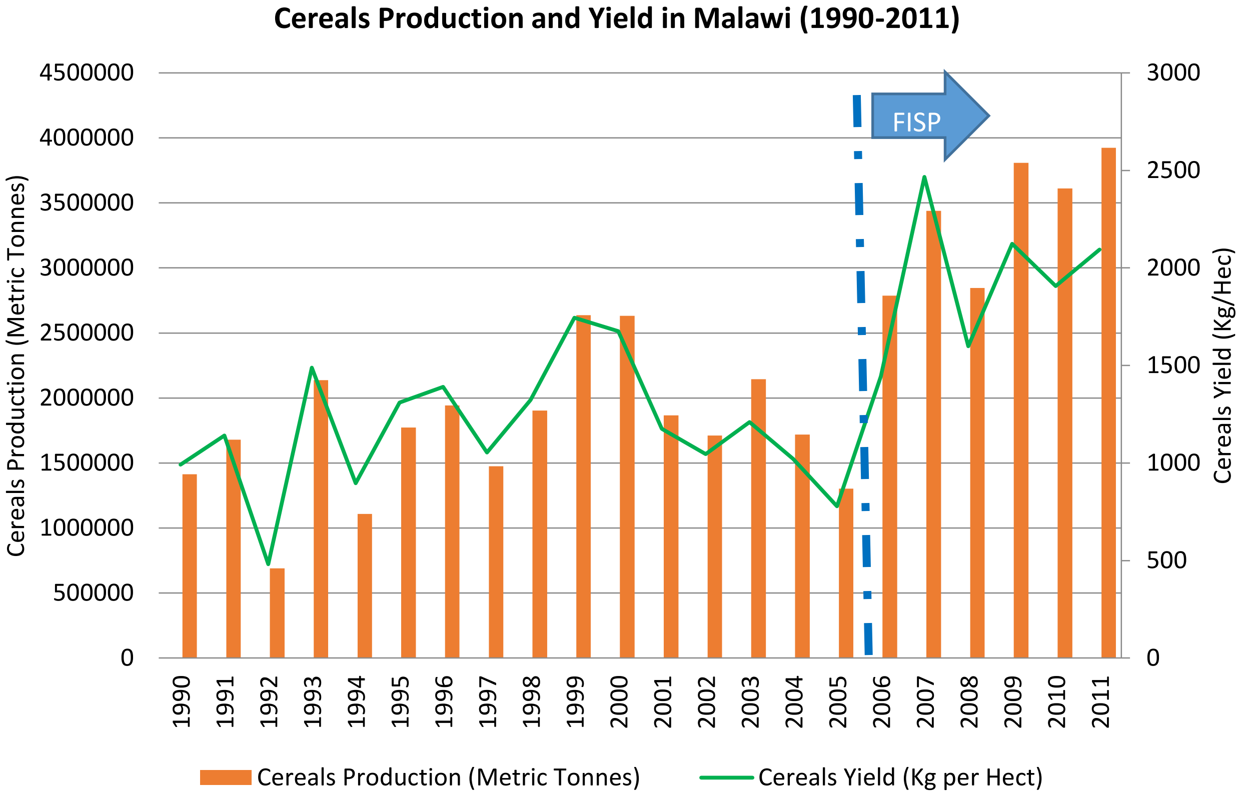

Figure 2: Cereals Production and Yield in Malawi (1990-2011)
Source: Authors' calculations based on FAOSTATS Data (2014).

Similarly, Malawi's international cereal trade balance records significant improvement since the implementation of the FISP. The period from 2006 to 2011 shows a substantial increase of exports and decrease of import of cereals (Figure 3). Although the statistics in Figures 2 and 3 do not indicate causality relationship between FISP and cereals production, productivity, exports and imports, they suggest improvement in cereals' marketing at national level in Malawi since the implementation of the FISP.

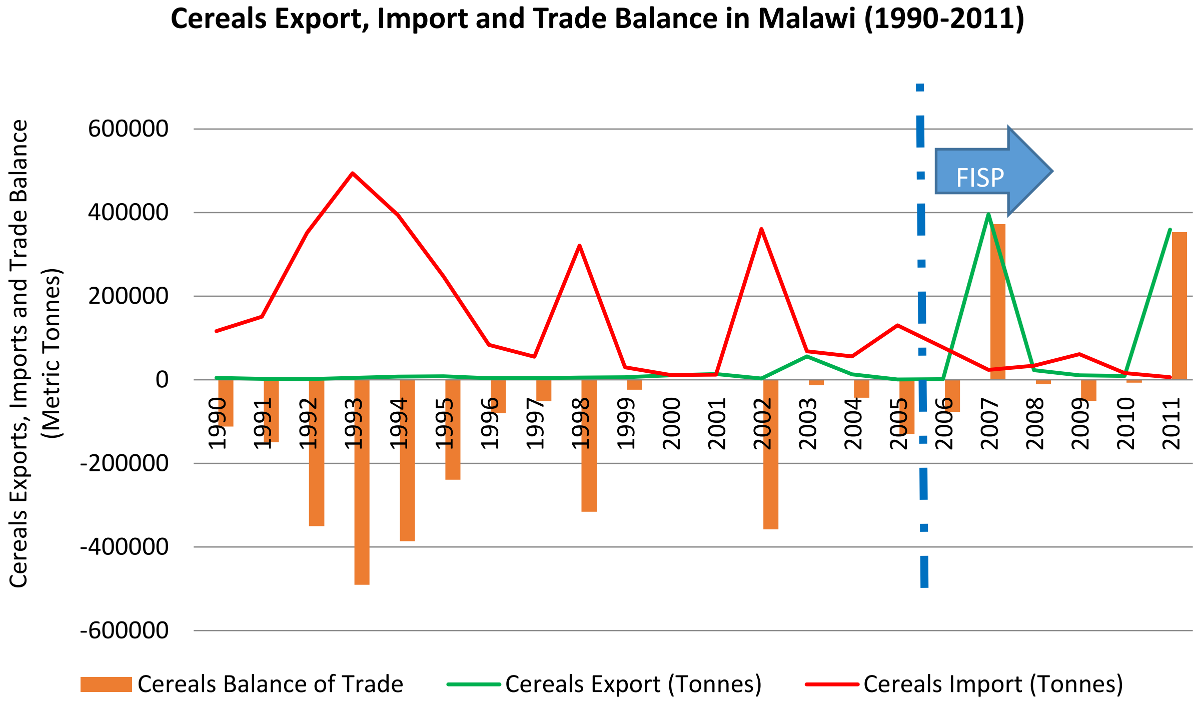

Figure 3: Cereals Export, Import and Trade Balance in Malawi (1990-2011)
Source: Authors' calculations based on FAOSTATS Data (2014).

4 Conceptual framework

Farm input subsidies are expected to improve the purchasing power of the beneficiaries, and thus make the subsidised inputs more affordable and the adoption of the improved technologies associated with the subsidised inputs more attractive. Access to coupons of the subsidised inputs is assumed to have effects on the rural livelihood strategies employed by households, especially on farming, rural wage labour and migration. These effects can occur through a direct benefit which may arise from either selling the received coupons or buying the inputs and using them in crop production (SOAS, 2008).

The use of improved inputs purchased with coupons is expected to lead to three positive effects in crops production: first, increased yields that could result in improved household food availability and hence better household food security; second, increased market participation and higher quantities sold by smallholder farmers, and therefore, increased farm income from crop sales; and third, reduced market participation as buyers of food crops, resulting in savings of household income (Chirwa and Dorward, 2013, SOAS, 2008). The income from crop sales and the savings from decreased purchases of food crops could be invested in farming or in non-agricultural enterprises, and/or used to increase the consumption of non-farm produced food and of non-food commodities and services. The savings which are invested in farming could lead to a further increase in the purchases of farm inputs in subsequent agricultural seasons and boost the future agricultural production and productivity. At the macroeconomic level, increased crop production and productivity is expected to result in reduced food crop prices due to the expected decrease in the demand for food commodities by the FISP beneficiaries, and consequently to improve food security of the urban population and rural net food buyers (Chirwa and Dorward, 2013, SOAS, 2008).

The purchase of durable assets and the consumption of food and non-food commodities could lead to an overall improvement in household welfare and to increased investment in human, social and physical capital - essential for future sustainable production and smooth phase-out of the subsidy programme itself. Furthermore, the improved food and income security, and the overall household welfare could reduce the reliance on rural wage labour and decrease the attraction of migration. This may lead to a lower rural wage labour supply and, hence, increased wages in the rural economy; and reduced rural to urban, rural to rural and seasonal migration of farm household members and thus, contributing to reduced urbanisation, urban food insecurity and poverty.

Analytically, this study follows the framework developed in Goetz (1992) for modelling the effects of subsidised fertilizer on farmers' participation in the maize market as sellers and on the quantities sold and bought. On the supply side, the use of subsidised fertilizer is expected to increase maize production and productivity, and therefore, it is presumed to increase maize market participation by farmers who benefit from the subsidy programme as sellers and vice versa as buyers. However, the farmer decides on the quantities devoted to household consumption not only based on the crop production levels, but also on output prices, consumption characteristics (e.g. the number of household members), exogenous income sources and farm profits and so any analysis of the FISP must take account of these factors.

Production of cereals by most farmers in Malawi is rain-fed and, consequently, has an annual production cycle. The farm input subsidies considered in this study are for the main rainy season only, and there is one rainy season in Malawi each year. A proportion of small farmers (8 per cent in 2010 and 13 per cent in 2013) employ irrigation or residual moisture maize farming, but they are not able to access FISP subsidies for their inputs (NSO, 2014a). Due to poor storage facilities, and resulting post-harvest losses of cereals and legumes in Malawi and for simplification in this study it is assumed that there are no inter-temporal decisions on consumption at household level.

Based on the expected increase in maize production and productivity as a result of the use of subsidised fertilizer (Chibwana, et al., 2010, Dorward et al., 2013, Holden and Lunduka, 2010, Ricker-Gilbert and Jayne, 2011), four hypotheses are formulated in relation to farm households' participation in maize market: (1) There is a positive relationship between the use of subsidised fertilizer and the decision to sell maize; (2) There is a positive relationship between the use of subsidised fertilizer and quantities of maize the farm household sell; (3) There is a positive relationship between the use of subsidised fertilizer and maize commercialisation (i.e. ratio of quantity sold to quantity harvested); (4) There is a negative relationship between the use of subsidised fertilizer and the quantity of maize the household buys for consumption.

The random utility theory proposed by Greene (2003) is employed in this study in order to model the choice of the marketing decision. Assuming that the i^{th} farmer is faced with two marketing decisions, indexed *m*, the farmer maximises utility by choosing marketing decision *m*, which can be presented as:

$$MaxU_{im} = X_{im}^{'}\beta + \varepsilon_{im} \quad (1)$$

where U_{im} is the utility derived from choosing marketing decision *m* and *m*=1 if the farmer participates in the market, otherwise *m*=0; $X_{im}^{'}$ is a vector of attributes of farmer's characteristics; β is a vector of parameter coefficients; and ε_{im} is an idiosyncratic error term.

Suppose the farmer's utility of two choices is represented by U_m and U_c, where U_m is utility of market participation as a seller or buyer and U_c is utility of consumption (i.e. no market participation as a seller or buyer). If the farmer chooses one of the two decisions, this implies that the observed decision provides greater utility compared with the unobserved utilities. Therefore, the observed chosen marketing decision equals 1 if $U_m > U_c$, and 0 if $U_m < U_c$.

5 Empirical models

In this study, the key covariate of interest is the subsidised fertilizer and, therefore, the estimation of its average partial effect (APE), is the focus of this study. The use of panel data allows us to control for the unobserved time-invariant household heterogeneity. In case of continuous dependent variables and without sample selection bias consideration, the most common estimation strategy would be to use the fixed effects (FE) estimator. However, when estimations involve binary dependent variables, discrete dependent variables, and fractional dependent variables, this makes the use of FE estimators inconsistent and unable to control for the time-invariant factors (Wooldridge, 2010, 2013). Furthermore, we suspect the covariate 'subsidised fertilizer' to be endogenous in all the equations and this requires estimation with IV method using the control function approach. For the estimators in this study to be consistent and the APEs to be identified, we apply the correlated random effects (CRE) approach (Wooldridge, 2010) following Mundlak (1978) and Chamberlain (1984).

Six empirical models are employed with regard to: (i) farmers' participation in maize market as sellers; (ii) quantities of maize sold; (iii) commercialisation index (i.e. ratio of total quantity sold to total quantity harvested); (iv) net quantities of maize sold; (v) net quantities of maize bought; and (vi) autarky (self-sufficiency).

Since only a small proportion of farmers sell maize in Malawi the data contain only a small number are net sellers, the data on quantity sold contain a large number of zero observations. A relatively high proportion of zeros are also observed concerning the quantities bought as a result of a high proportion of maize autarky households. The production of maize mainly for subsistence by most farmers provides economic justification for the decision not to sell or buy maize and this decision is strategic to the farmers' livelihoods. Therefore, this study does not consider non-participation of famers in maize marketing as a pure selectivity issue, as is the case with missing data sample selection models, but rather as a corner solution. The quantity sold or bought of maize has the characteristics of truncated data, with large number of zero data units. For such dependent variables, the adequate models to be employed in estimations are the Tobit model for corner solution and the Double Hurdle model. In the case of incidental truncation of the data (missing data for non-participants), which causes the problem of sample selection bias, most empirical studies using cross-section data employ the Heckman model (Heckman, 1979) or the two stage sample selection model. The sample selection model is based on the assumption that the unobserved quantities sold or bought by non-participants in the market as sellers or buyers are attributed to barriers to entry due to constraints conditional on household characteristics, such as assets endowments and transaction costs.

As mentioned previously, the farm input subsidy programme in Malawi provides coupons which entitle the recipient to purchase specified quantities of subsidised fertilizer and other selected inputs at subsidised prices. The allocation of these coupons is based on a set of targeting criteria set out by the government of Malawi. Since the coupons are not randomly distributed, the observed and unobserved household heterogeneity factors influencing the receipt of coupons may also influence the maize market participation and the quantity sold or bought, consequently making subsidised fertilizer endogenous.

Therefore, our empirical strategy must address the potential endogeneity of subsidised fertilizer (hereafter, subsidised fertilizer refers to fertilizer purchased with coupons). In this study the dependent variables are non-linear. For market participation as sellers, net sellers, net buyers and autarky the dependent variable is binary; the commercialisation index variable is proportional bounded between zero and one; and for quantity sold and bought of maize it is discrete and includes zero quantity for non-maize sellers and buyers. The quantity of subsidised fertilizer redeemed by the beneficiaries is also discrete and includes zero quantity for non-beneficiaries. We therefore, estimate market participation, autarky, quantity of maize sold, net quantity of maize sold, net quantity of maize bought, and commercialisation index using correlated random effects (CRE) models following Papke and Wooldridge (2008) and Wooldridge (2010, 2013).

5.1 Model of farmers' participation in maize market as sellers, net sellers, net buyers and autarky (self-sufficiency).

Farmers' maize market participation decision as sellers, net sellers, net buyers and autarky is modelled using the pooled Correlated Random Effects (CRE) Probit model, taking into account the potential endogeneity of subsidised fertilizer by using the Control Function (CF) approach as an instrumental variable (IV) method (Papke and Wooldridge, 2008, Wooldridge, 2010, 2013). The maize market participation equation to be estimated can be written as follows:

$$y_{it1} = hhc_{it1}\beta_1 + r_{it1}\beta_2 + mkt_{it1}\beta_3 + subfert_{it1}\beta_4 + v_{it2}\beta_5 + \overline{Z}_i\beta_6 + c_i\beta_7 + \mu_{it1} \quad (2)$$

where y_{it1} is the binary dependent variable and equals one if the farmer participated in the market as a seller, net seller, net buyer or is in autarky concerning maize, otherwise equals zero; hhc_{it1} is a vector of household characteristics and includes gender, age and education of household head, total land, rural location, real value of durable assets, household size and crop diversification; r_{it1} is a vector of regional dummies representing household location in north, south or central region; mkt_{it1} is a vector of marketing factors and includes ICT information on maize marketing and distance to daily market; $subfert_{it1}$ is a vector of subsidised fertilizer; v_{it2} is a vector of the generalised residuals from the reduced form pooled CRE Tobit model of quantity of subsidised fertilizer $subfert$; c_i is the time-invariant unobserved heterogeneity of the household; $\overline{Z}_i$ are the time averages of the time-variant explanatory variables; μ_{it} is an idiosyncratic error term; $\beta_1......\beta_n$ are the parameters to be estimated; sub-index *i* is the individual household and *i*=1,2,3….*n*; *t* is time period of the study and *t*=1 and 2; 1 represents the outcome model while 2 represents the reduced form model.

5.2 Model of total quantity of maize sold, net quantity sold and net quantity bought.

The total quantity of maize sold, net quantity sold and net quantity bought by farmers are estimated using the pooled Double Hurdle CRE Model. We take into account the potential endogeneity of subsidised fertilizer by applying the Control Function (CF) approach of instrumental variables (IV) methods. The pooled Double Hurdle CRE Model has been applied recently by Mather et al. (2013) in estimating maize marketing by smallholder farmers in southern and eastern Africa.

We also estimate two other competing models to check the robustness of the empirical estimates - the pooled CRE Tobit Model for corner solution and the pooled CRE OLS Model, which takes into account both sample selection bias and the potential endogeneity of subsidised fertilizer. The control function approach is used as an IV method to address the potential endogeneity of subsidised fertilizer (Semykina and Wooldridge, 2010, Wooldridge, 2013). All other explanatory variables for the quantity equation are the same as in Eq. (2) with the exception of the ICT and crop diversification covariates, which are not included and are used as exclusions for selectivity into market participation in the pooled Double Hurdle CRE Model and pooled CRE OLS Model. In addition, the quantity equation in the pooled CRE OLS Model includes the inverse Mills ratio as an additional covariate (Heckman, 1979). The quantity equation for estimation of the pooled Double Hurdle CRE Model is as follows:

$$\varphi_{it1} = hhc_{it1}\beta_1 + r_{it1}\beta_2 + dis_{it1}\beta_3 + subfert_{it1}\beta_4 + v_{it2}\beta_5 + \overline{Z}_i\beta_6 + c_i\beta_7 + \mu_{it1} \quad (3)$$

where φ_{it1} is the discrete dependent variable representing the total quantity of maize sold, net quantity sold and net quantity bought by farmer i in natural logarithm; dis_{it1} is a vector of distance to daily market, v_{it2} is a vector of the generalised residuals from the reduced form subsidised fertilizer $subfert$ equation.

The selection of this model against the pooled CRE Tobit Model for corner solutions and the pooled CRE OLS model is based on the test for selection of non-nested models (Vuong, 1989). The Vuong test results have shown that the pooled Double Hurdle CRE Model fits better the data we use here with p-value of 0.000 on the Likelihood Ratio statistic and so this model forms the basis of the analysis to follow.

5.3 Model of maize commercialisation

Estimation of the commercialisation index uses the pooled CRE Fractional Probit Model and estimators are obtained by employing the generalised linear model (GLM) approach, taking into account the potential endogeneity of subsidised fertilizer by using the Control Function (CF) approach as an instrumental variable (IV) method (Papke and Wooldridge, 2008; Wooldridge, 2010, 2013). The estimation equation is as follows:

$$\zeta_{it1} = hhc_{it1}\beta_1 + r_{it1}\beta_2 + dis_{it1}\beta_3 + subfert_{it1}\beta_4 + v_{it2}\beta_5 + \overline{Z}_i\beta_6 + c_i\beta_7 + \mu_{it1} \quad (4)$$

where ζ_{it1} is the fractional dependent variable and is a ratio of total quantity sold to total quantity harvested - a continuous variable bounded between zero and one; all other explanatory variables are the same as in Equations (2) and (3) with the exception of the ICT and crop diversification covariates; v_{it2} is a vector of the generalised residuals from the reduced form subsidised fertilizer $subfert$ equation.

5.4 Estimation approach

We control for the correlation between the time-invariant unobserved household heterogeneity c_i and all the explanatory variables, represented by X_{it} in all the three equations (Eq. 2-4). Estimation assumes strict exogeneity of X_{it}. However, we test for endogeneity of X_{it}, and an IV method is applied. The estimation of the CRE estimators allows the correlation between the time-invariant unobserved household heterogeneity c_i and the explanatory variables, X_{it}. In addition to the assumption of strict exogeneity, the application of the CRE estimator method also assumes that the correlation between c_i and

x_{it} is of the form: $c_i = \psi + \overline{X}_i\gamma + a_i$ and $c_i|X_i \sim$ Normal $(\psi + \overline{X}_i\gamma, \sigma_a^2)$, where ψ is the constant, $\overline{X}_i$ are the time averages of the time-variant explanatory variables, and a_i is the error term (Wooldridge, 2010). Therefore, estimation of the CRE estimators requires the inclusion of $\overline{X}_i$ as an additional set of independent variables in order to control for the time-invariant unobserved household heterogeneity c_i .

Since not all households in the sample received coupons for subsidised fertilizer, the covariate quantity of subsidised fertilizer has a corner solution characteristic with zero data units for non-beneficiaries. Given that the subsidised fertilizer is recorded as a discrete variable, when using the quantities of subsidised fertilizer, we test and if necessary, address its endogeneity by using the control function approach (CF) of the IV methods (Wooldridge, 2010).

Application of the CF approach follows a two-step procedure. In the first step, a reduced form pooled CRE Tobit model of corner solution of the quantity of subsidised fertilizer is estimated and the generalised residuals, v_{it} is generated. We use as an IV a variable indicating whether a Member of Parliament (MP) is a resident in or visited the particular community in the past three months. The economic intuition of using this IV is that subsidy programmes are prone to be used by MPs to gain political support, and therefore communities which have resident MPs or their MPs frequently visit them have a greater likelihood to receive more coupons than their counterparts (Mason and Ricker-Gilbert, 2013, Ricker-Gilbert and Jayne, 2011).

Although allocation of subsidy coupons to districts is done at national level by the MoAFS Headquarters, mainly based on the number of farm households among other criteria, allocations to villages is done at the district level and this is where MPs can influence the process. Since MPs which reside in or frequently visit their communities are likely to attend more district level meetings, they may influence to allocate more subsidy coupons to their constituencies than their counterparts. However, there is no reason to believe that the presence or frequent visit of an MP may affect farmer's decision on maize marketing. Empirical results presented in Table A.2 in Appendix show that the variable MP residence or visit in the community is not statistically significant in all the three equations (2-4) concerning farmer's maize market participation.

Since the instrument used is at a higher, community level, we assume it is exogenous to the individual households[1]. Furthermore, t-test results of the weighted mean differences in characteristics between communities with and without MPs resident or visit in the past three months preceding the surveys show that the differences are statistically insignificant. This suggests that there are no systematic differences between these two communities and the

[1]Mason and Ricker-Gilbert (2013) use ruling party victory of household's district presidential election results of 2004 in Malawi and ruling party victory of the household's constituency for last presidential election in Zambia as instruments. Ricker-Gilbert and Jayne (2011) use Member of Parliament resident in the community in Malawi. Both studies show that subsides are politicized in Malawi and Zambia.

variable MP resident or visit to the community is exogenous. However, the chosen instrument might be weak and, consequently, distorting the models' estimation results. But to the best knowledge of the authors, there is no method of testing weak instrumental variables under the CF approach.

The second step is the estimation of the structural equations (2-4) and includes the generated generalised residuals, v_{it}, as an additional covariate. The statistical significance of the generalised residuals, v_{it} (i.e. β_5) in the equations indicates that the subsidised fertilizer is not exogenous and therefore, requires to address the endogeneity.

The use of the pooled Double Hurdle CRE Model in estimation of Eq. (3) allows us to use different covariates for the selection and quantity equations. This is important because the same covariates can be used in estimating the competing pooled OLS CRE model to check the robustness of the estimates[2]. The market participation decision in equation (2) is estimated by pooled CRE Probit model, using the receipt of maize marketing information through ICTs and crop diversification as exclusion variables.

The choice of these two exclusion covariates is based on the economic intuition that the acquisition of means to analyse marketing information presents a fixed transaction cost to farmers, which only affects market participation decision and not the quantity sold or bought (Key et al., 2000). This is because once farmers get marketing information such as location of buyers, sellers or prices, they can decide the quantity to sell or buy without incurring further costs for acquiring the same information. The crop diversification (i.e. the number of crops grown) is also expected to only affect the market participation decision because the decision to produce crops for the market or only for consumption is made prior to production. Normally, when the production is for self-consumption different types of crops are grown in order to satisfy the diversified nutritional needs of the household. The farmer decides on the quantities to sell or buy after the harvest. To test the validity of the chosen variables as good exclusions in our estimations, we test their statistical significance in both market participation decisions and quantity equations. Empirical results show that they have statistically insignificant effect on maize quantity sold, net quantity sold and net quantity bought.

6 Data source and descriptive statistics

This study uses the nationally representative two-wave Integrated Household Panel Survey (IHPS) data for Malawi from the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) Project. The first wave of the data was collected between March and November 2010; and the second wave between April and December 2013 by the National Statistics Office of Malawi. The IHPS data is a balanced panel sample of 4000 households with an overall low attrition rate at household level of 3.78 per cent. However, this study uses a balanced panel sample of 3086 households after

[2] For details on the procedures of estimating a sample selection linear panel data model see Semykina and Wooldridge (2010).

excluding non-agricultural and households with incomplete information for main variables used in the empirical analyses.

Table 1 presents descriptive statistics of variables used in the empirical analyses and a comparison between fertilizer subsidy beneficiaries and non-beneficiaries. The data presented here are the household's averages for each variable calculated across the two-time periods included in the survey. We focus our discussion in this section on the descriptive statistics for fertilizer subsidies and maize marketing variables.

Table 1 about here

The IHPS collected detailed information on FISP covering the 2009/2010 and 2012/2013 agricultural seasons. Furthermore, the survey collected household historical information on maize seed and fertilizer coupon benefits from 2008/2009 to 2012/2013 agricultural seasons. Overall, 53 per cent of farmers nationwide were targeted with coupons to purchase subsidised fertilizer. On the average, when accounting for all survey respondents, subsidised fertilizer redeemed was 38 Kg, while the average redeemed by beneficiaries only was 80 Kg. This suggests that the government met the objective to reach at least 50 per cent of farmers. Data also show that FISP beneficiaries received different coupon packages. These statistics are consistent with earlier studies (Chibwana et al., 2010; Holden and Lunduka, 2010; Ricker-Gilbert and Jayne, 2011).

In terms of maize marketing, the statistics are for one season i.e. 12 months (from the start of one harvesting period to the next). For Malawi, the period of maize harvesting mainly starts from April. For the 2009/2010 and 2012/2013 agricultural seasons, overall, 13 per cent of the farmers sold maize. Furthermore, 17 per cent of fertilizer subsidy beneficiaries sold maize compared to 9 per cent of non-beneficiaries and the difference is statistically significant at 1 % significance level. On quantity sold and for the whole sample, on average only 28 kg of maize is sold and fertilizer subsidy beneficiaries sell 19 kg more compared to non-beneficiaries and the difference is statistically significant. However, in terms of the average ratio of total output sold to total output produced (commercialisation index- CI), only three per cent of the maize produced is sold. The annual per capita maize consumption in Malawi is 133 kg and is considered as one of the highest in the eastern and southern Africa (Minot, 2010). Such high dependence on maize consumption could be the possible explanation for the small quantities of maize sold and the small proportion of farmers participating in the maize market as sellers in Malawi.

Considering only maize sellers, the average quantity of maize sold is 214 Kg and there is a slight difference between beneficiaries and non-beneficiaries, 217 Kg and 210 Kg, respectively. The average CI for maize sellers only is 23 per cent and the two groups of beneficiaries and non-beneficiaries have similar CI - 23 and 24 per cent respectively.

In the data used in this study there is no information on quantities of maize bought during the 2009/2010 and 2012/2013 agricultural seasons. The available information on both quantities sold and bought of maize is for the 2008/2009 and 2011/2012 agricultural seasons and therefore, for this period we use the subsidised fertilizer programme participation, i.e.

receipt of coupons in modelling net quantity sold, net quantity bought and autarky of maize. Summary statistics presented in Table A.3 in the Appendix show that while for this period 15 per cent of the farmers sold maize, 11 per cent were net sellers, 50 per cent were net buyers and 39 per cent were self-sufficient. On the supply side, more beneficiaries of FISP were sellers of maize and sold larger quantities compared to non-beneficiaries. While on the demand side, there are no statistically significant differences in the total and net quantities bought between the two groups of farmers. Concerning self-sufficiency, a lower proportion of beneficiaries are self-sufficient.

7 Empirical results and discussion

The most important empirical results concern the subsidised fertilizer covariate, which is of central interest to this study. The discussion is divided into six sub-sections. Depending on the different aspects analysed, the results include the factors determining receipt of coupons and the quantity of subsidised fertilizer redeemed; market participation of farmers as sellers and the quantity of maize sold; the commercialisation index; the factors determining farmers' maize market participation as net sellers, net buyers and autarky; and lastly the factors influencing maize net quantities sold and bought.

7.1 Determinants of receipt of coupons and quantity redeemed of subsidised fertilizer

The results regarding factors that determine the receipt of coupons to purchase subsidised fertilizer of the pooled CRE Probit model (model I) and the quantity of subsidised fertilizer redeemed of the pooled CRE Tobit model (model II) are presented in Table 2.

Table 2 about here

The results show that having a resident Member of Parliament (MP) or having an MP who visited the community in the past three months preceding the survey increases the probability of receiving coupons for subsidised fertilizer and increases the quantities of subsidised fertilizer redeemed. These results do appear to confirm that the subsidy programme in Malawi may be subject to a degree of politicisation even though there are clear guidelines for coupons distribution. Mason and Ricker-Gilbert (2013) also find that households in districts where the ruling party won the 2004 presidential election redeemed more subsidised maize seed and fertilizer.

Female headed households do not benefit more from the subsidy programme compared to male headed households. This is in contradiction to the design of the programme which targets more female headed households because they are considered to be the most financially constrained to purchase fertilizer at commercial prices. This finding is consistent with previous studies (Chibwana et al., 2010, Chirwa et al., 2013, Dorward and Chirwa, 2011, Fisher and Kandiwa, 2014, Holden and Lunduka, 2010, Ricker-Gilbert et al., 2013).

Those households headed by older farmers have increased probability of being targeted for the subsidy programme and redeem more quantity of subsidised fertilizer. This result supports one aspect of the FISP design, i.e. to target elderly headed households. The education level of the household head is found to have no statistically significant effect on access to coupons for subsidised fertilizer. Results on regional location of households show that households located in the central region have lower probability of being targeted for the programme and redeem less quantities of subsidised fertilizer compared to households located in the southern region. However, there are regional differences in climatic conditions, which affect maize production. The northern and central regions are considered more important maize producing regions compared to the southern region.

On the other hand, households with more land and higher value of the real durable assets have an increased probability of being targeted for the programme and redeem greater quantities of subsidised fertilizer. This suggests that richer households are benefiting more than poor households, contrary to the programme design.

7.2. Impact of subsidised fertilizer on farmers' participation in maize market as sellers

Table 3 presents four regression results on the determinants of farmers' participation in maize market as sellers. Models (I), (II) and (III) are presented to check the robustness of the estimates by applying different estimators. Since the results in model (IV) show that the generalised residuals are statistically significant, thus indicating and addressing the endogeneity of subsidised fertilizer, our discussion in this section will be based on this model's results. In subsequent sections the discussion will focus only on our preferred specifications.

Table 3 about here

The results show that subsidised fertilizer is associated with an increased probability of selling maize. An additional kilogram (kg) of subsidised fertilizer increases the probability of selling maize by 0.05 percentage point. In other words, the standard package of 100 kg of subsidised fertilizer increases the probability of farmers to participate in maize market as sellers by five percentage points. These results support the assertion that improving small farmers' access to modern farm inputs could lead to increased productivity (Chibwana, et al., 2010, Dorward et al., 2013, Holden and Lunduka 2010, Ricker-Gilbert and Jayne, 2011), and hence improve their market participation as sellers of agricultural produce. This is an important conclusion since farmers who have limited sources of income through their engagement in marketing of maize could become incentivised to specialise in farming and add a commercial component to their subsistence agriculture. Income from maize sales could also help farmers to self-purchase improved farm inputs at commercial prices, which is vital for the sustainability of the subsidy programme.

Availability of market information through electronic media increases the probability of farmers' participation in the market as sellers by four percentage points. This suggests the importance of information and communication technologies (ICTs) in reducing fixed transaction costs, such as searching costs. Growing different types of crops as indicated by the crop diversification covariate also increases the likelihood of selling maize. This may be due to availability of food from other food crops and, therefore, enabling households to sell part of their maize produce.

Households with more land and high value of real durable assets have higher probabilities of selling maize, and the results show that an additional hectare of land increases the probability of maize market participation by five percentage points. These results support the notion that household productive resource endowments are a prerequisite for market participation.

7.3. Impact of subsidised fertilizer on total quantity sold of maize

Regression results on factors influencing the quantity of maize sold by farmers are presented in Table 4. Results of model (IV) show that the generalised residuals are statistically significant and this indicates that subsidised fertilizer is endogenous. The following discussion focuses on the results of this model.

Table 4 about here

There is a positive effect of subsidised fertilizer on the total quantity of maize sold. Results for model (IV) suggest that on average, an additional kilogram of subsidised fertilizer increases quantity of maize sold by 0.15 per cent. Considering the standard FISP fertilizer package of 100 kg, this means that on average an additional 100 kg of subsidised fertilizer increases quantity sold by 15 per cent. These results point out towards the possibility to significantly increase the maize market supply. However, the magnitude of this effect might not be adequate to have an impact on the national maize market demand and this could be the explanation of the minimal effect it has had on retail maize prices in Malawi and Zambia (Ricker-Gilbert et al., 2013) and on grain prices in Nigeria (Takeshima and Liverpool-Tasie, 2015). Furthermore, the income generated from such a small quantity of maize sold seems unlikely to enable the beneficiary households to self-finance future purchases of fertilizer and improved seeds at commercial prices and, consequently, cast doubt on the sustainability of the programme in the absence of other sources of households' income.

The results suggest that the larger the size of the household the smaller is the quantity of maize sold. This is expected because households with more household members do retain a greater quantity of maize for self-consumption. Regional covariates have the expected effect. Households located in the northern and central region sell larger quantities of maize than those located in the southern region, which is not a major maize producer.

Household resource endowment is estimated to play a significant role in maize market supply. This is especially so for landholding size where an additional hectare of land increases the quantity of maize sold by 24 per cent. Households with more durable assets also sell larger quantities of maize, which suggest the effect on production levels. Rural location of households is associated with more quantity of maize sold. This is expected since most rural households have limited non-farm sources of income and, therefore, their household's income depends more on crops sales compared with those in urban areas.

However, we find no evidence of effect of the level of education, gender of the household head and distance to daily market on quantities of maize sold. This may suggest that the maize market is already well integrated, such that access to information on marketing is not dependent on education level of the household head and maize market is accessible to both male and female headed households. This may be due to the presence of small private traders in maize markets, who buy maize directly from small farmers and thus reduce transportation costs incurred by farmers when selling at central markets.

7.4. Impact of subsidised fertilizer on commercialisation of maize

We present regression results on factors determining commercialisation of maize in Table 5. This section's discussion focuses on the results of model (IV).

Subsidised fertilizer is found to have a positive effect on the commercialisation of maize and an additional kilogram of subsidised fertilizer increases the commercialisation index of maize by 0.01 per cent. The results in Table 5 reveal that subsidised fertilizer has a very marginal effect on maize commercialisation and that maize remains a crop which is produced mainly for subsistence at household level even when farmers purchase subsidised production inputs. Considering the programme standard package, an additional 100 Kg of subsidised fertilizer increases the commercialisation index of maize by only one per cent.

Table 5 about here

The small magnitude of effect suggests that in many cases the level of maize production at household level is likely to be lower than the quantity required to meet household food demand and does not allow the generation of a marketable surplus. Since FISP is targeting small farmers, the question is whether this is an appropriate strategic target group if the objective is to increase maize market supply and, consequently, reduce maize prices to the benefit of maize net buyers and non-farmers.

Age of the household head and household size covariates have negative effects on maize commercialisation, although the magnitudes of the effects are also very small. Landholding size has the expected positive effect where an additional hectare of land is estimated to increase the maize commercialisation index by one percent. Such a small magnitude of effect also corroborates the earlier conjecture that, in Malawi, maize is mainly produced by farm households for consumption.

7.5 Impact of participation in subsidised fertilizer programme on farmers' maize market participation as net sellers, net buyers and autarky (self-sufficiency)

Table 6 presents regression results of models (I), (II), (III) on factors determining farm households' participation in maize market as net sellers, net buyers and autarky, respectively.

For these three models, we did not find clear evidence of endogeneity of participation in the subsidised fertilizer programme and, as a result, the generalised residuals from the reduced form pooled CRE Probit model are not included in the estimations.

Table 6 about here

The participation in the subsidised fertilizer programme has a positive effect only on farm households' maize market participation as net sellers as it increases the probability of being a net seller by four percentage points. These results raise doubt on the effectiveness of the programme. FISP in Malawi has had marginal effect on the market supply of maize and has had no significant effect on improving household maize self-sufficiency and reducing rural farmers' dependency on the market to supplement their annual household maize requirements.

7.6 Impact of participation in subsidised fertilizer programme on the net quantities sold and bought of maize by farmers.

Regression results on factors influencing net quantities sold and bought of maize by farm households are presented in Table 7.

Table 7 about here

The discussion in this section focuses on results of models (II) and (IV), which are the pooled CRE Double Hurdle models for net quantities sold and bought of maize, respectively. Model (II) addresses endogeneity of participation in subsidised fertilizer programme, while we did not find clear evidence of endogeneity in model (IV). The results show that participation in subsidised fertilizer programme has positive effect only on the net quantity of maize sold and is found to increase the net quantity of maize sold by 22 per cent. Similar to the results in Table 6 on the effect on the probability of a household being a net maize buyer, this study finds no effect on the net quantity of maize bought.

The positive effect of participation in fertilizer subsidy programme on maize market supply is expected and this result is corroborated by several studies which have shown statistically significant effect on maize output. However, the insignificant effect on the quantity of maize purchased is puzzling. The possible explanation for this finding is that while the increment in the maize output due to FISP is expected to reduce the quantity of maize the farm households buy from the market; the initial effect may be a change in consumption patterns. This may include increasing the quantities consumed and, as a result, the households may run out of food from own production and rely on buying in the market for the rest of the period until the next harvest. Furthermore, there might be substitution and income effects at play which affect the consumption of maize and other food items.

On the other hand, the lack of statistical significance of participation in subsidised fertilizer programme on net quantity of maize bought and the moderate magnitude of the positive effect on net quantity of maize sold found here could be an important possible explanation of the insignificant effect on maize prices in Malawi and Zambia (Ricker-Gilbert et al., 2013), and grain prices in Nigeria (Takeshima and Liverpool-Tasie, 2015).

8 Conclusion and policy implications

This study has estimated the effects of farm input subsidies on the marketing of maize in Malawi using the nationally representative two-wave Integrated Household Panel Survey (IHPS) data of 2010 and 2013. Specifically, this study has estimated the impact of subsidised fertilizer on farmers' (i) participation in maize market as sellers; (ii) quantity of maize sold; (iii) commercialisation of maize, (i.e. the ratio of maize quantity sold to total quantity of maize harvested); (iv) net quantity of maize sold; (v) net quantity of maize bought; and (vi) maize autarky (self-sufficiency). Due to small number of households in the panel sample who grew and sold other cereal and legume crops, this study has been unable to analyse the effects of the subsidised fertilizer programme on the overall household food crops marketing. However, since maize is the main target crop in the FISP and staple food in Malawi, the empirical analyses on the effects on maize marketing are more important in understanding the direct policy implications on small farmers' market supply and demand.

The empirical results do suggest that subsidised fertilizer increases the farmers' probability of selling maize and being net sellers; the total and quantity sold; and the commercialisation of maize. However, the study also generates a number of other empirical results which suggest that the FISP has a number of shortcomings, and generates a number of unintended consequences, for which reform may be needed.

First, the study highlights the challenge faced by farming households in decision making to sell staple food crops when the households' priority for producing such crops is subsistence. The main possible reason for the low maize commercialisation despite the implementation of the FISP is that without the subsidies most farmers would have achieved very low yields and would stay below their households' food requirements. Despite the increased productivity and production of maize due to the use of subsidised inputs, the increment may not be large enough to meet household food requirement for most households, taking into account the average household size in Malawi. Consequently, most of the produced maize may still be reserved for household consumption rather than for the market.

Second, designing programmes to suit climatic conditions of specific regions may be more beneficial than a standard programme for all regions. Despite maize being the staple food for the majority of the population, some districts are not suitable for its production, such as Lower Shire Valley and the mountainous districts in the southern region. Therefore, programmes focusing on other interventions and types of crops might generate more positive effects on households' income.

Third, the magnitude of effect of landholding size on the commercialisation of maize is small and implies that maize is not considered a viable commercial crop by farm households. The government intervention in the marketing of maize in Malawi, in the guise of export controls on maize during acute food shortage months, or when estimates show national food deficit, might have contributed to the commercial un viability of maize.

Overall, the results in this study suggest that the input subsidy programme, as implemented in Malawi, has contributed toward an increased level of maize market supply engagement for some farm households within the sample. In this sense, the policy has the potential to provide the wider external benefits espoused by the proponents of 'market smart' policies. It remains to be seen whether this policy can deliver reduced transactions costs and risks, and allow the private sector to take over the delivery of inputs at a price small farmers can benefit from in the future.

Table 1: Descriptive Statistics (Average of two-time periods – 2010/2011 and 2013)

Variable	All (Full Sample) (I)		Beneficiaries Only (II)		Non-Beneficiaries Only (III)		Mean Difference (II-III) (IV)
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean
Household head (female)	0.23	0.42	0.25	0.43	0.20	0.4	0.05***
Household head age (years)	43.56	16.05	46.09	16.3	40.74	15.28	5.35***
Head no formal education	0.19	0.39	0.21	0.41	0.16	0.37	0.05***
Head primary education	0.56	0.50	0.61	0.49	0.50	0.50	0.12***
Head second. education	0.21	0.41	0.17	0.37	0.26	0.44	-0.1***
Head tertiary education	0.04	0.20	0.01	0.10	0.08	0.26	-0.07***
Household size	5.02	2.33	5.34	2.3	4.66	2.31	0.69***
Rural location	0.83	0.38	0.92	0.27	0.72	0.45	0.2***
Northern region	0.20	0.40	0.20	0.42	0.17	0.38	0.05***
Central region	0.39	0.49	0.36	0.48	0.43	0.5	-0.07***
Southern region	0.40	0.49	0.42	0.49	0.4	0.49	0.02
Total land (hectares)	0.70	0.68	0.82	0.70	0.57	0.65	0.25***
Real durable asset ‘K1000’	427	24391	33.27	191.2	865.4	35458	-832.13
Distance to daily mkt‘Km’	8.14	17.82	10.71	22.05	5.27	10.68	5.44***
MP resident or visit	0.27	0.44	0.30	0.46	0.23	0.42	0.07***
Maize sold (kg)	27.94	148.5	36.92	172.7	17.93	114.9	18.99***
Sold maize dummy	0.13	0.34	0.17	0.38	0.09	0.28	0.08***
Commercialisation Index	0.03	0.11	0.04	0.12	0.02	0.10	0.01***
Subsidised fertilizer (Kg)	37.98	44.38	79.92	28.14	-	-	-
Number of obs.	6172		3252		2920		

Note: *** represents statistically significant at 1 % level; K=Malawi Kwacha; Km=Kilometres; MP=Member of Parliament; Mkt=Market

Table 2: Factors determining receipt and quantity redeemed of coupons to purchase subsidised fertilizer.

Explanatory Variables	Dependent Variable: Received subsidised fertilizer coupon=1		Dependent Variable: Quantity of subsidised fertilizer (Kg)	
	Pooled CRE Probit Model (I)		Pooled CRE Tobit Model (II)	
	APE	**P-Value**	**APE**	**P-Value**
MP resident or visit	0.03**	0.017	2.21**	0.020
Household head (Female)	-0.02	0.590	-1.79	0.408
Household head age (years)	0.01***	0.000	0.38***	0.000
Household size	-0.002	0.440	0.04	0.829
Rural location	0.31***	0.000	21.7***	0.000
Household head primary education	-0.004	0.892	-0.64	0.749
Household head secondary education	-0.07	0.125	-5.51*	0.067
Household head tertiary education	-0.07	0.343	-6.33	0.310
Northern	-0.03*	0.067	-0.19	0.890
Central	-0.09***	0.000	-9.09***	0.000
Total land (hectares)	0.07***	0.000	5.64***	0.000
Log real durable asset value (MK)	0.01***	0.005	0.77***	0.000
Log distance to daily market (Km)	-0.001	0.903	0.23	0.677
Year 2013	-0.16***	0.000	-10.3***	0.000
No. of Observations	6172		6172	
F-Statistic/Wald χ^2: Joint sig. of all explanatory variables	702.74***	0.0000	46.81***	0.000
F-Statistic/ χ^2: Joint significance of time averages explanatory variables	83.74***	0.0000	4.28***	0.000
Sigma			74.60	
Log pseudo likelihood	-3841.823		-18961.794	
Correctly classified	66.82 %			

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE represents Correlated Random Effects; Estimations include time averages of time-varying explanatory variables; APE represents average partial effect.

Table 3: Regression results of factors determining farmers' maize market participation as sellers (Dependent variable: Binary-Sold Maize)

Explanatory Variables	Pooled Probit Model (I)	Probit RE Model (II)	Pooled CRE Probit (III)	Pooled CRE Probit & CF Residuals(IV)
	APE/SE	APE/SE	APE/SE	APE/SE
Generalised residuals				0.07*** (0.01)
Subsidised fertilizer (Kg)	0.0007*** (0.0001)	0.0006*** (0.0001)	0.0003*** (0.0001)	0.0005*** (0.0001)
Electronic media market information	0.02 (0.02)	0.02* (0.01)	0.04** (0.01)	0.04** (0.01)
Crop diversification	0.02*** (0.01)	0.02*** (0.004)	0.01*** (0.004)	0.01*** (0.004)
Household head (Female)	0.004 (0.01)	0.004 (0.01)	0.02 (0.02)	0.02 (0.02)
Household head age (years)	-0.001*** (0.0003)	-0.001*** (0.0002)	-0.002** (0.001)	-0.002** (0.001)
Household size	-0.01*** (0.002)	-0.01*** (0.002)	-0.02*** (0.002)	-0.02*** (0.002)
Rural location	0.09*** (0.02)	0.08*** (0.02)	0.06* (0.03)	0.05* (0.03)
Household head primary education	0.03* (0.02)	0.03** (0.01)	0.01 (0.02)	0.01 (0.02)
Household head secondary education	0.05** (0.02)	0.04*** (0.02)	-0.02 (0.02)	-0.01 (0.03)
Household head tertiary education	-0.02 (0.03)	-0.01 (0.03)	0.03 (0.06)	0.04 (0.06)
Northern	0.05** (0.02)	0.05*** (0.01)	0.05*** (0.01)	0.06*** (0.01)
Central	0.08*** (0.02)	0.07*** (0.01)	0.06*** (0.01)	0.05*** (0.01)
Total land (hectares)	0.03*** (0.01)	0.03*** (0.01)	0.05 *** (0.01)	0.05*** (0.01)
Log real durable asset value (MK)	0.004*** (0.002)	0.004*** (0.001)	0.004** (0.002)	0.004** (0.002)
Log distance to daily market (Km)	0.01** (0.01)	0.01*** (0.003)	0.01 (0.01)	0.01 (0.01)
Constant	0.13*** (0.01)	0.09*** (0.01)		
Number of observations	6172	6172	6172	6172
Correctly classified	86.86%		86.78%	86.78%
Wald χ^2 Joint sig. all variables	227.19***	262.99***	2380.71***	2369.06***
χ^2 Joint sig. time averages variables			67.62***	57.13***

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE (Correlated Random Effects) estimations of models (III) and (IV) include time averages of time-varying explanatory variables; APE=average partial effect; SE=standard errors; MK=Malawi Kwacha; Km=Kilometres; CF=Control Function; Controls include Year 2013 dummy.

Table 4: Regression results of factors determining farmers' maize quantity sold (Dependent variable: Quantity of Maize sold in Log Kg)

Explanatory Variables	Pooled Tobit CRE Model With CF Residuals (I)	Pooled OLS CRE Model With IMR and CF Residuals (II)	Pooled Double Hurdle CRE Model (III)	Pooled Double Hurdle CRE with CF Residuals (IV)
	APE/SE	APE/SE	APE/SE	APE/SE
Generalised residuals	0.17***	0.22***		0.13***
	(0.06)	(0.08)		(0.04)
Inverse Mills Ratio (IMR)		1.68***		
		(0.12)		
Subsidised fertilizer (Kg)	0.0029***	0.0023**	0.0017**	0.0015**
	(0.0008)	(0.0011)	(0.0007)	(0.0007)
Household head (female)	0.15	0.41**	0.15	0.15
	(0.12)	(0.19)	(0.12)	(0.12)
Household head age (years)	-0.01**	-0.01	-0.01*	-0.01*
	(0.004)	(0.01)	(0.004)	(0.004)
Household size	-0.10***	-0.05**	-0.04***	-0.04***
	(0.01)	(0.02)	(0.01)	(0.01)
Rural location	0.35*	0.05	0.23	0.23*
	(0.18)	(0.28)	(0.15)	(0.14)
Household head primary educ.	0.06	0.02	0.03	0.03
	(0.11)	(0.2)	(0.11)	(0.11)
Household head secondary ed.	-0.09	0.03	-0.08	-0.08
	(0.17)	(0.27)	(0.14)	(0.15)
Household head tertiary educ.	0.21	0.31	0.14	0.14
	(0.36)	(0.56)	(0.33)	(0.34)
Northern	0.31***	0.49***	0.28***	0.28***
	(0.08)	(0.09)	(0.07)	(0.07)
Central	0.35***	0.82***	0.45***	0.42***
	(0.07)	(0.09)	(0.05)	(0.05)
Total land (hectares)	0.32***	0.50***	0.24***	0.24***
	(0.07)	(0.11)	(0.05)	(0.06)
Log real durable asset MK	0.03**	0.04*	0.02*	0.02*
	(0.01)	(0.02)	(0.01)	(0.01)
Log distance to daily Km	0.03	0.12***	0.002	0.002
	(0.03)	(0.04)	(0.002)	(0.002)
Number of observations	6172	804	6172	6,172
Log pseudo likelihood	-4132.75	-3361.58	-3232.84	-3231.37
Wald χ^2/F-Stat.: Joint sig. (all)	44.25***	870.13***	193.13***	210.90***
Sigma	6.41		0.90	0.90
F-Stat: Joint sig. time averages	6.14***		46.73***	46.10***
Pseudo R-square /R-square		0.96	0.09	0.09

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE (Correlated Random Effects) estimations include time averages of time-varying explanatory variables; APE=average partial effect; SE= standard errors; MK=Malawi Kwacha; Km=Kilometres; CF=Control Function; Controls include Year2013 dummy.

Table 5: Regression results of factors determining farmers' maize commercialisation (Dependent variable: Commercialisation Index of Maize)

Explanatory Variables	Pooled OLS Model (I)	Linear RE Model (II)	Pooled CRE Fractional Probit Model (III)	Pooled CRE Fractional Probit Model with CF (IV)
	APE/SE	APE/SE	APE/SE	APE/SE
Generalised residuals				0.01*
				(0.003)
Subsidised fertilizer Kg	0.0001***	0.0001***	0.00004	0.0001**
	(0.00003)	(0.00003)	(0.0001)	(0.00004)
Household head (Female)	-0.001	-0.0003	0.004	0.004
	(0.003)	(0.003)	(0.01)	(0.01)
Household head age (years)	-0.0004***	-0.0004***	-0.001**	-0.001**
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Household size	-0.002***	-0.002***	-0.01***	-0.01***
	(0.001)	(0.001)	(0.001)	(0.001)
Rural location	0.02***	0.02***	0.001	-0.0002
	(0.004)	(0.004)	(0.01)	(0.01)
Household head primary educ.	0.002	0.002	0.004	0.004
	(0.004)	(0.004)	(0.01)	(0.01)
Household head secondary ed.	0.02***	0.014**	0.002	0.003
	(0.01)	(0.01)	(0.01)	(0.01)
Household head tertiary educ.	0.0002	0.0000	0.002	0.003
	(0.01)	(0.01)	(0.02)	(0.02)
Northern region	0.01***	0.013***	0.02**	0.02**
	(0.004)	(0.004)	(0.01)	(0.01)
Central region	0.02***	0.02***	0.01*	0.01
	(0.003)	(0.003)	(0.01)	(0.01)
Total land (hectares)	0.02***	0.02***	0.02***	0.01***
	(0.004)	(0.004)	(0.01)	(0.01)
Log real durable assets value	0.001***	0.001***	0.001	0.001
	(0.0004)	(0.0004)	(0.001)	(0.001)
Log distance to daily market	0.003**	0.003***	-0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.002)
Year 2013 dummy	-0.01***	-0.01***	-0.02***	-0.02***
	(0.003)	(0.003)	(0.003)	(0.003)
cons	0.004	0.01		
	(0.01)	(0.01)		
Number of observations	6172	6172	6172	6172
F-Stat./Wald χ^2 : Joint sig.	9.58***	131.62***	3610.27***	3610.32***
χ^2: Joint sig. time averages			104.00***	92.12***
Log pseudo likelihood			-744.49	-741.75
R-square	0.04			

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE (Correlated Random Effects) estimations include time averages of time-varying explanatory variables; APE=average partial effect; SE= standard errors; MK=Malawi Kwacha; Km=Kilometres; CF=Control Function; Controls include Year2013 dummy.

Table 6: Regression results of factors determining farmers' maize market participation as Net sellers; Net Buyers and Autarky (Dependent variable: Binary)

Explanatory Variables	Maize Net Seller	Maize Net Buyer	Maize Autarky (Self-Sufficiency)
	Probit CRE Model(I)	Pooled CRE Probit (II)	Pooled CRE Probit (III)
	APE/SE	APE/SE	APE/SE
Subsidised fertilizer Programme	0.04**	0.002	-0.04
	(0.02)	(0.03)	(0.03)
Electronic media market information	0.03*	-0.01	-0.02
	(0.02)	(0.03)	(0.03)
Crop diversification	0.02***	0.03***	-0.05***
	(0.01)	(0.01)	(0.01)
Household head (Female)	0.05**	0.03	-0.07**
	(0.02)	(0.03)	(0.03)
Household head age (years)	-0.001	0.004***	-0.003***
	(0.0001)	(0.001)	(0.001)
Household size	-0.001	0.02***	-0.02***
	(0.003)	(0.004)	(0.004)
Rural location	0.01	0.06	-0.06
	(0.03)	(0.04)	(0.04)
Household head primary education	-0.03	0.0003	0.02
	(0.02)	(0.03)	(0.03)
Household head secondary education	0.01	-0.01	0.01
	(0.03)	(0.04)	(0.04)
Household head tertiary education	-0.01	0.01	-0.003
	(0.04)	(0.07)	(0.07)
Northern	-0.10**	-0.07	0.17**
	(0.05)	(0.08)	(0.09)
Central	0.06	-0.10*	0.03
	(0.04)	(0.06)	(0.06)
Total land (hectares)	0.04***	-0.07 ***	-0.01
	(0.01)	(0.02)	(0.02)
Log real durable asset value (MK)	0.01***	-0.01***	0.005
	(0.002)	(0.003)	(0.003)
Log distance to daily market (Km)	-0.004	-0.01	0.02*
	(0.01)	(0.01)	(0.01)
Number of observations	6172	6172	6172
Correctly classified	88.89%	63.09%	65.94%
Wald χ^2 Joint sig. all variables	2711.34***	571.83***	657.94***
Log pseudo likelihood	-1861.59	-3926.06	-3890.24
χ^2 Joint sig. time averages variables	61.93***	75.47***	66.21***

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE (Correlated Random Effects) estimations include time averages of time-varying explanatory variables; APE=average partial effect; SE= standard errors; MK=Malawi Kwacha; Km=Kilometres; CF=Control Function; Controls include Year2013 dummy.

Table 7: Regression results of factors determining farmers' maize Net quantity sold and Net Quantity Bought (Dependent variable: Net Quantity of Maize sold/bought in Log Kg)

Explanatory Variables	Maize Net Quantity Sold		Maize Net Quantity Bought	
	Pooled Tobit CRE Model With CF Residuals (I)	Pooled Double Hurdle CRE with CF Residuals (II)	Pooled Tobit CRE Model With CF Residuals (III)	Pooled Double Hurdle CRE with CF Residuals (IV)
	APE/SE	APE/SE	APE/SE	APE/SE
Generalised residuals	-0.20*	-0.18**	-0.30*	
	(0.11)	(0.08)	(0.17)	
Subsidised fertilizer Program	0.34**	0.22**	0.04	0.06
	(0.14)	(0.10)	(0.12)	(0.16)
Household head (female)	0.38**	0.24*	0.13	0.17
	(0.17)	(0.14)	(0.12)	(0.18)
Household head age (years)	-0.003	-0.002	0.02***	0.02***
	(0.01)	(0.004)	(0.004)	(0.01)
Household size	0.002	-0.001	0.11***	0.14***
	(0.03)	(0.02)	(0.02)	(0.03)
Rural location	0.30	0.13	0.33**	0.20
	(0.23)	(0.14)	(0.16)	(0.26)
Household head primary educ.	-0.22	-0.15	0.05	0.05
	(0.18)	(0.13)	(0.13)	(0.17)
Household head secondary ed.	-0.07	-0.03	0.04	0.16
	(0.24)	(0.16)	(0.18)	(0.25)
Household head tertiary educ.	-0.10	-0.04	0.15	0.39
	(0.37)	(0.25)	(0.34)	(0.46)
Northern	-1.03**	-0.47**	-0.44	-0.48
	(0.41)	(0.20)	(0.41)	(0.53)
Central	0.47	0.48*	-0.55**	-0.58
	(0.35)	(0.28)	(0.26)	(0.40)
Total land (hectares)	0.40***	0.23***	-0.24***	-0.37***
	(0.07)	(0.05)	(0.08)	(0.11)
Log real durable asset MK	0.07***	0.05***	-0.04***	-0.05**
	(0.02)	(0.01)	(0.01)	(0.02)
Log distance to daily Km	-0.04	0.0002	-0.05	-0.004
	(0.04)	(0.002)	(0.04)	(0.003)
Number of observations	6172	6172	6172	6,172
Log pseudo likelihood	-3659.1	-2855.72	-11243.4	-8303.44
F-Stat/Wald χ^2.: Joint sig. (all)	25.39***	519.14***	23.47***	162.30***
Sigma	8.33	1.03	4.65	1.01
Pseudo R-square	0.08	0.14	0.03	0.05

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE (Correlated Random Effects) estimations include time averages of time-varying explanatory variables; APE=average partial effect; SE= standard errors; MK=Malawi Kwacha; Km=Kilometres; CF=Control Function; Controls include Year2013 dummy.

Appendix

Table A1: Proportion (%) of farmers who cultivated selected cereals and legumes in Malawi (1997/1998 – 2013)

Crop Type	**Year and Name of the Survey**			
	IHS1 (1997/1998)	**IHS2 (2004/2005)**	**IHPS (2010)**	**IHPS (2013)**
Maize	98.11	97.07	97.03	94.62
Beans	10.69	20.3	14.09	22.23
Groundnuts	32.03	37.3	32.53	37.01
Rice	7.26	7.8	4.66	4.25
Pigeon Peas	-	25.31	21.26	28.58

Notes: IHS: Integrated Household Survey; IHPS: Integrated Household Panel Survey.
Source: Authors based on IHS1 (1997/1998), IHS2 (2004/2005), IHPS (2010 and 2013) data and NSO (2014b).

Table A.2: Regression results of factors determining farmers' maize market participation as sellers, quantity sold and commercialisation of maize

Explanatory Variables	Sold Maize	Quantity Sold (Log-Kilogram)	Commercialisation Index
	Pooled CRE Probit Model (I)	**Pooled CRE Double Hurdle Model (II)**	**Pooled CRE Fractional Probit Model (III)**
	APE/SE	**APE/SE**	**APE/SE**
MP residence or visit in the community	0.01	0.04	0.01
	(0.01)	(0.08)	(0.01)
Household head (Female)	0.02	0.12	0.004
	(0.02)	(0.11)	(0.01)
Household head age (years)	-0.001**	-0.01*	-0.001**
	(0.001)	(0.003)	(0.0002)
Household size	-0.01***	-0.04***	-0.01***
	(0.002)	(0.001)	(0.001)
Rural location	0.07*	0.24*	0.001
	(0.03)	(0.14)	(0.01)
Household head primary education	0.01	0.02	0.004
	(0.02)	(0.11)	(0.01)
Household head secondary education	-0.02	-0.09	0.002
	(0.03)	(0.14)	(0.01)
Household head tertiary education	0.03	0.14	0.003
	(0.06)	(0.32)	(0.02)
Northern	0.05***	0.29***	0.02**
	(0.01)	(0.07)	(0.01)
Central	0.08***	0.41***	0.01
	(0.01)	(0.05)	(0.01)
Total land (hectares)	0.05***	0.23***	0.01***
	(0.01)	(0.05)	(0.01)
Log real durable asset value (MK)	0.004**	0.02**	0.001*
	(0.002)	(0.01)	(0.001)
Log distance to daily market (Km)	0.01	0.002	-0.001
	(0.01)	(0.002)	(0.002)
Electronic media market information	0.03*		
	(0.01)		
Crop diversification	0.02***		
	(0.004)		
Number of observations	6172	6172	6172
Correctly classified	86.89%		
Wald χ^2 Joint sig. all variables	2687.12***	195.46***	2369.06***
χ^2 Joint sig. time averages variables	19.83**	42.56***	94.52***
Log pseudolikelihood/Log likelihood	-2200.62	-3271.88	-750.69

Note: ***, **, * represents statistically significant at 1 %, 5 % and 10 % levels, respectively; CRE(Correlated Random Effects) estimations of all models include time averages of time-varying explanatory variables; APE=average partial effect; SE=bootstrap standard errors (500 replications); MK=Malawi Kwacha; Km=Kilometres; ; Controls include Year 2013 dummy

Table A.3: Maize marketing summary statistics (average of two-time periods – 20008/2009 and 2011/2012 agricultural seasons).

Variable	All (Full Sample) (I)		Beneficiaries Only (II)		Non-Beneficiaries Only (III)		Mean Difference (II-III) (IV)
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**
Maize total quantity sold (kg)	68.85	363.01	89.47	418.34	57.18	327.05	32.29*** (9.61)
Maize total sold dummy	0.15	0.36	20.00	40.00	0.13	0.34	0.07*** (0.01)
Maize net quantity sold (kg)	60.27	348.69	78.95	405.40	49.69	311.61	29.26*** (9.23)
Maize net seller dummy	0.11	0.32	0.15	0.36	0.09	0.29	0.06*** (0.01)
Maize total quantity bought (kg)	166.79	403.52	174.27	406.17	162.55	402.01	11.72 (10.69)
Maize total bought dummy	0.53	0.50	0.58	0.49	0.50	0.50	0.08*** (0.01)
Maize net quantity bought (kg)	158.21	394.06	163.75	384.92	155.06	399.16	8.70 (10.44)
Maize net buyer dummy	0.50	0.50	0.54	0.50	0.47	0.50	0.07*** (0.01)
Maize autarky	0.39	0.49	0.31	0.46	0.44	0.50	-0.13*** (0.01)
Number of obs.	6172		2231		3941		

Note: *** represents statistically significant at 1 %; standard errors are in parentheses.

9 References

Barrett, C.B., 2008. Smallholder market participation: Concepts and evidence from Eastern and Southern Africa. *Food Policy*. 34, 299-317.

Chamberlain, G., 1984. Panel data. In: Griliches, Z., Intriligator, M.D., (Eds.). *Handbook of econometrics*, 2, 1247-1318. Amsterdam: North-Holland.

Chibwana, C., Fisher, M., Jumbe, C., Masters, W., Shively, G., 2010. Measuring the impacts of Malawi's farm Input Subsidy Programme. http://ssrn.com/abstract=1860867 (accessed on 25th January, 2014).

Chibwana, C., Fisher, M., Shively, G., 2012. Cropland Allocation Effects of Agricultural Input Subsidies in Malawi. *World Development*. 40,124-133.

Chirwa, E.W., 2006. Commercialisation of Food Crops in Rural Malawi: Insights from the Household Survey. Department of Economics, Chancellor College, University of Malawi, Working Paper No.2006/04.

Chirwa, E.W., 2009. Determinants of Marketing Channels among smallholder Maize Farmers in Malawi. Department of Economics, Chancellor College, University of Malawi, Working Paper No.2009/03.

Chirwa, E.W., Matita, M.M., Mvula, P.M., Dorward, A., 2013. Repeated Access and Impacts of the Farm Input Subsidy programme in Malawi. Any Prospects of Graduation? Future Agricultures, Working Paper 065.

Danish International Development Agency (DANIDA), 2011. Agricultural input subsidies in sub-Saharan Africa, International Development Cooperation, Ministry of Foreign Affairs of Denmark, Evaluation Study 2011/2.

De Janvry, A., Fafchamps, M., Sadoulet, E., 1991. Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained. *Economic Journal, Royal Economic Society*, 101(409), 1400-417.

Dorward, A. and Chirwa, E., 2013. *Targeting in the Farm Input Subsidy Programme in Malawi: Issues and Options*. Working Paper 66. Future Agricultures.

Dorward, A., and Kydd, J., 2005. *Making Agricultural Market Systems Work for the Poor: Promoting Effective, Efficient and Accessible Coordination Exchange*. Imperial College, London, No. 1.

Dorward, A., Chirwa, E., 2011. The Malawi Agricultural Input Subsidy Programme, 2005-6 to 2008-9. *International Journal of Agricultural Sustainability*. 9, 232-247.

Dorward, A., Chirwa, E., Boughton, D., Crawford, E., Jayne, T., Slater, R., Kelly, V., Tsoka, M., 2008. Towards Smart Subsidies in agriculture? Lessons from recent experience in Malawi. Overseas Development Institute, Natural Resource Perspective, No.116.

Dorward, A., Chirwa, E., Matita, M., Mhango, W., Mvula, P., Taylor, E., and Thorne, K., 2013. *Evaluation of the 2012/2013 Farm Input Subsidy Programme, Malawi, Final Report*, Ministry of Agriculture and Food Security, Malawi.

Dorward, A.R., Kydd, J.G., Morrison, J.A., Urey, I., 2004. A policy agenda for pro-poor agricultural growth. *World Development*, 32(1), 73 – 89.

Druilhe, Z., Barreiro-Hurle, J., 2012. Fertilizer subsidies in sub-Saharan Africa. ESA Working Paper No. 12-04, Rome, FAO.

Ecker, O., and Qaim, M., 2011. Analyzing nutritional impacts of policies: An empirical study for Malawi. *World Development*, 39 (3), 412-428.

Fisher, M., Kandiwa, V., 2014. Can agricultural input subsidies reduce the gender gap in modern maize adoption? Evidence from Malawi, *Food Policy*, 45, 101-111.

Goetz, S.J., 1992. A selectivity Model of Household Food Marketing behaviour in Sub-Saharan Africa. *American Journal of Agricultural Economics.* 74, 444-452.

Greene, W.H., 2003. *Econometric Analysis.* Fifth Edition, New York University, Pearson Education International, USA.

Heckman, J.J., 1979. Sample Selection Bias as a Specification Error. *Econometrica*.7, 153-161.

Heltberg, R. and Tarp, F., 2002. Agricultural supply response and poverty in Mozambique, *Food Policy, Elsevier*, 27, pp. 103-124.

Holden, S., Lunduka, R., 2010. Too poor to be efficient? Impacts of targeted fertilizer subsidy programme in Malawi on farm plot level input use, crop choice and land productivity. Department of Economics and Resource Management, Norwegian University of Life Sciences.

Husain, I., 1993. Poverty and structural adjustment: the African case. Human resources development and operations policy working papers; No. HRO9. Washington, DC: World Bank.

International Fund for Agricultural Development (IFAD), 2003. Promoting Market Access for the Rural Poor in Order to Achieve the Millennium Development Goals. Roundtable Discussion Paper for the Twenty-Fifth Anniversary Session of IFAD's Governing Council.

International Monetary Fund (IMF), 2008. Fuel and Food Price Subsidies: Issues and Reform options. IMF, Washington DC.

Jayne, T.S., Mather, D., Mghenyi, E., 2010. Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa. *World Development*. 38(10), 1384-1398.

Key N., Sadoulet, E., De Janvry, A., 2000. 'Transactions Costs and Agricultural Household Supply Response', *American Journal of Agricultural Economics*, Agricultural and Applied Economics Association, 82, 245-259.

Liverpool-Tasie, L.S.O., 2014. Fertilizer subsidies and private market participation: the case of Kano State, Nigeria, *Agricultural Economics*, 45, pp.663-678.

Lunduka, R., Ricker-Gilbert, J., Fisher, M., 2013. What are the farm level impact of Malawi's farm input subsidy programme? A critical Review. *Agricultural Economics*, (Accepted for Publication).

Mason, N.M., Jayne, T.S., and Mofya-Mukuba, R., 2013. Zambia's input subsidy programs. *Agricultural Economics*, 44, 613-628.

Mason, N.M., Richer-Gilbert, J., 2013. Disrupting Demand for Commercial Seed: Input subsidies in Malawi and Zambia. *World Development*, 45, 75-91.

Mather, D., Boughton, D., Jayne, T.S., 2013. Explaining smallholder maize marketing in southern and eastern Africa: The roles of market access, technology and household resource endowment. *Food Policy*. 43, 248-266.

Minot, N., 2010. Staple food prices in Malawi, Prepared for the COMESA policy seminar on "Variation in staple food prices: Causes, consequence, and policy options", Maputo, Mozambique, 25-26 January 2010, under the African Agricultural Marketing Project (AAMP)

http://fsg.afre.msu.edu/aamp/seminar_3/AAMP_Maputo_22_Malawi_ppr.pdf (accessed on 10th December 2016).

Mundlak, Y., 1978. On the pooling of time series and cross section data, *Econometrica*, 46, 69-85.

Muriithi, B.W., Matz, J.A., 2015. Welfare effects of vegetable commercialisation: Evidence from smallholder producers in Kenya. *Food Policy*. 50, 80-91.

National Statistics Office, 2014a. *Integrated Household Panel Survey 2010-2013: Basic Information Document*, Zomba, Malawi. National Statistics Office.

http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1233781970982/5800988-1271185595871/6964312-1404828635943/IHPS_BID_FINAL.pdf (accessed on 17th March 2015).

National Statistics Office, 2014b. *Integrated Household Panel Survey 2010-2013: Household Socio-Economic Characteristics Report,* Zomba, Malawi. National Statistics Office.

http://www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHPS%202013/IHPS%20Report.pdf (accessed on 17th March 2015).

Njuki, J., Karia, P., Sanginga P., Kaganzi, E., Magombo, T. 2007. *Empowering communities through market led development. Community agro-enterprise experiences from Uganda and Malawi*. Paper presented at Farmer First Revisited Conference, 2007, Sussex, by Future Agricultural Consortium, Institute of Development Studies (IDS) Sussex, UK, p. 13.

http://www.future-agricultures.org/farmerfirst/files/T1b_Njuki.pdf (accessed on 11th November 2011).

Papke, L.E., Wooldridge, J.M., 2008. Panel data methods for fractional response variables with an application to test pass rates, *Journal of Econometrics*, 145, 121-133.

Pingali, P., 2007. Agricultural growth and economic development: a view through the globalization lens. *Journal of Agricultural Economics.* 37, 1-12.

Poulton, C., 2012. *Democratisation and the political economy of agricultural policy in Africa.* Working Paper 43. Future Agricultures. http://www.future-agricultures.org/publications/research-and-analysis/1579-democratisation-and-the-political-economy-of-agricultural-policy-in-africa/file (accessed on 30th March 2015).

Poulton, C., Kydd, J., Doward, A., 2006. Overcoming Market Constraints on Pro-Poor Agricultural Growth in Sub-Saharan Africa. *Development Policy Review*, 24 (3) 243-277.

Ricker- Gilbert, J., Mason, N., Jayne, T., Darko, F., Tembo, S., 2013. What are the effects of input subsidy programmes on equilibrium maize prices? Evidence from Malawi and Zambia. Selected Paper prepared for presentation at the Agriculture and Applied Economics Association 2013 AAEC & CAE's Joint Annual Meeting, Washington DC.

Ricker-Gilbert, J., Jayne, T.S., Chirwa, E., 2011. Subsidies and Crowding out: A double hurdle Model of fertilizer demand in Malawi. *American Journal of Agricultural Economics*. 93, 26-42.

Ricker-Gilbert. J., Jayne, T.S., 2011. What are the enduring effects of fertilizer subsidies on recipient households? Staff Paper 2011-09. Department of Agricultural Food and Resource Economics, Michigan State University. East Lausing, MI. USA.

Semykina, A., Wooldridge, J.M., 2010. Estimating panel data models in the presence of endogeneity and selection. *Journal of Econometrics*, 157, 375-380.

Takeshima, H., and Liverpool-Tasie, L.S.O., 2015. Fertilizer subsidies, political influence and local food prices in sub-Saharan Africa: Evidence from Nigeria, *Food Policy*, 54, pp.11-24.

Vuong, Q.H., 1989. Likelihood Ratio Tests for Model Selection and Non-Nested Hypotheses. *Econometrica*, 57, 307-333.

Wiredu, A.N., Zeller, M., and Diagne, A., 2015. *Impact of fertilizer subsidy on land and labour productivity of rice producing households in North Ghana*. Centre for the Study of African Economies (CSAE) Conference Contributed Paper, 22nd -24th March, 2015, St. Catherine's College, Oxford.

Wooldridge, J.M., 2010. *Econometric analysis of cross section and panel data* (2nd ed.). Cambridge, MA: MIT Press.

Wooldridge, J.M., 2013. Non-Linear Models: Correlated Random Effects Panel Data Models, IZA Summer School in Labour Economics, Michigan State University.

World Bank, 2004. *Malawi Country Economic Memorandum: Policies for Accelerating Growth*, Poverty Reduction and Economic Management 1, Africa Region, World Bank, Report No. 25293-MAI.

World Bank, 2000. Attacking Poverty: Making Markets Work Better for Poor People. The World Bank, Washington DC, USA.

World Bank, 2004. Malawi Country Economic Memorandum: Policies for Accelerating Growth. Poverty Reduction and Economic Management 1, Africa Region, Report No. 25293-MAI.

World Bank, 2007. Agriculture for Development. World Development Report 2008, World Bank, Washington DC, USA.

World Bank, 2010. Malawi Country Economic Memorandum: Seizing Opportunities for Growth Through Regional Integration and Trade, Summary of main Findings and Recommendations. Poverty Reduction and Economic Management 1, Africa Region, vol. I, Report No. 47969-MW.

Xu, Z., Burke, W.F., Jayne, T.S., Govereh, J., 2009. Do input subsidy programmes 'crowd in' or 'crowd out' commercial market development? Modelling fertilizer demand in a two-channel marketing system. *Agricultural Economics.* 40, 79-94.

Yi, F., Sun, D., and Zhou, Y., 2015. Grain subsidies, liquidity constraints and food security-Impact of the grain subsidy programme on the grain-sown areas in China, *Food Policy*, 50, 114-124.

Zeller, M., Diagne, A., Mataya, C., 1997. Market access by Smallholder farmers in Malawi: Implications for Technological Adoption, Agricultural Productivity and Crop Income. Food Consumption and Nutrition Division, International Food Policy Research Institute (IFPRI), Washington DC, USA, FCND Discussion Paper No.5.