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Agricultural free input support schemes, input usage, food insecurity and poverty in rural Zimbabwe

Advanced policy-focused poverty analysis in Zimbabwe

Carren Pindiriri
Grown Chirongwe
Fortune Mazvita Nyajena
Grace Nicholas Nkomo

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ABSTRACT

High poverty remains a major concern in the rural areas of Zimbabwe despite continued provision of free input support for the vulnerable communities by the government. In this regard, this paper evaluated the association between free seed support and poverty and food security outcomes among smallholder farmers using the Zimbabwe National Statistics Agency (ZIMSTAT) Poverty, Income, Consumption and Expenditure Survey (PICES) and Agriculture Productivity Module (APM) survey of 2017. Firstly, the paper assessed the spatial distribution and targeting of free input support schemes. Secondly, the regional differential impact of the free seed on poverty and food insecurity was estimated using a Heckman probit model. Thirdly, the association between free seed and poverty and food insecurity outcomes was estimated using treatment effects based on propensity score matching. The findings show that free input support schemes target the poor. However, the current design of free input programmes falls short of spatial equality, regional and gender sensitiveness. The major policy implication from the study findings is that although free input support schemes for the vulnerable farmers are rightly targeted, their design is not sufficient to move vulnerable farmers out of poverty and food insecurity. Hence, they need to be redesigned in order to achieve the objectives of reducing poverty and improving food security in the country. The design of the free input support schemes needs to consider the minimum input quantity required to move a 5-member household out of poverty. In addition, it must consider gender, regional distribution, regional ecological and soil characteristics and other supporting services.

Key words: Free seed, spatial distribution, dependency, poverty impact, food security

1. Introduction

Low input usage and food production gap continue to persist in many African countries such as Zimbabwe, Zambia, Malawi, Kenya, Ghana and Tanzania among others, despite the continued application of agricultural input subsidies (Dorward 2009). Since independence, agricultural input subsidies have been applied as a tool to increase input usage, enhance agricultural productivity and reduce poverty among rural households in Zimbabwe. Even the new Government dispensation of 2017, with strong liberal policies, has continued to pursue agricultural input subsidies. Budget allocation to agricultural input subsidies has been significant and extreme in some cases, contributing over US$900 million (over 50 percent) of Zimbabwe's domestic debt in 2018. For instance, in the 2016/17 agricultural season, the country spent an average of over US$554 million on agricultural crop input support (Ministry of Finance and Economic Development 2018). Furthermore, in the 2018/19 season, a total of US$130 million was allocated for agricultural input support programmes targeting over one million vulnerable households (Ministry of Finance and Economic Development 2018) but the country still experienced a food production gap of over 50 percent of the required national consumption (Ministry of Finance and Economic Development 2019). Input subsidy schemes are centered on the assumption that by reducing the costs of agricultural inputs, their usage will go up and thereby increasing production and food security (Druilhe & Barreiro-Hurle 2012).

On one hand, Governments face a dilemma or a trade-off on whether to increase expenditure on subsidising vulnerable households or manage budget deficit through cutting down subsidies. On the other hand, cutting down subsidies for vulnerable households may have future budgetary implications as the demand for food aid may rise in the future. Thus, governments may be tempted to subsidize these vulnerable households in order to avoid unforeseen outrageous expenditures. The other reason for subsidising vulnerable households is to improve food security for this group of households thereby reducing food poverty. In line with this, the Government of Zimbabwe devised three input support schemes namely: the Command agriculture input scheme which is aimed at mobilizing sustainable and affordable funding for farmers with large farms in order to boost agricultural productivity in staple crops and livestock to ensure food security; Presidential input support and the input support for vulnerable groups which supports agricultural recovery of vulnerable small scale and subsistence farmers to ensure food self-sufficiency and food security. Command agriculture's impact on input usage and yield in Zimbabwe has previously been examined (see Gwatidzo and Muyengwa 2020). However, when looking at food security and poverty, it is important to study the distribution and impact of all these schemes. This study therefore focuses specifically on the impact of other Government input support schemes outside the command agriculture Programme, namely the Presidential input support and input support for the vulnerable managed by social welfare department. In addition, free input support from non-state actors is also considered since it equally acts as a form of subsidy or grant.

Studying the impact of the command scheme only without the other schemes can have serious problems regarding the sample of participating households. The first problem is that of self-selection, that is, households participating in the command agriculture have generally larger farms, have banking knowledge and some are socially connected. The second problem is that of a very small response rate relative to the population of households since only few households participate in the program. For instance, only about 4% of the respondents in the Agricultural productivity Module (APM) of the PICES 2017 participated in command agriculture. The third is the composition of households participating in command agriculture. Participants in the command agriculture are not mainly resource-constrained. They have larger farms and better farm equipment such as tractors. Food insecurity and poverty in Zimbabwe are mostly concentrated in the communal areas where an insignificant number of households participate in command agriculture. These areas are, however, covered by the Presidential and vulnerable households input schemes. Hence, these two schemes are more important for poverty alleviation and food security policy interventions.

There are two major issues that arise from free input support schemes once implemented. The first concern is on the distribution and targeting of input support resources, that is, is there distributional equity of the input support resources across regions and across gender and are the resources properly targeted? Economic fairness requires the Government to equitably distribute resources generated from tax payers' money while effectiveness requires proper targeting. A detailed assessment of spatial distribution of input support schemes is therefore critical. This information is crucial for policy makers in Zimbabwe and even more important for guiding resource distribution during the implementation of devolution in the country. The global 2030 Agenda for Sustainable Development recognises inclusive growth (Sustainable Development Goal 8) as central to the improvement of the well-being of societies (Rosche 2016 and Razavi 2016). Reducing inequalities in both the economic and social spheres is an obligation for the 2030 Agenda. Hence, the government plays a central role in redistributing resources to achieve equity and to leave no one behind in the process of development. Leaving no one behind entails a balanced resource distribution across regions and across gender. The second concern regards whether these input support schemes achieve their intended objectives or targets. The government's two free input support schemes considered in this study have the sole objective of improving food security and reduce poverty amongst vulnerable households through enhancing agricultural productivity. Therefore, the question is whether these input support schemes (Presidential and input support for the vulnerable) achieve their stated objectives of enhancing productivity, improving food security and hence reducing poverty amongst the target populations. Generally, the policy concern is to understand whether the continuation of these subsidies is beneficial to communities, and if so, how can a more equitable regional distribution of subsidies' resources be achieved under devolution.

The effectiveness of agricultural input subsidies has remained a major area of contention, despite the policy belief that these subsidies are an important way of improving agricultural productivity in developing countries (Walls et al. 2018). On one hand, there is evidence that agricultural input support schemes raise farmers' productivity substantially and can sustain intensive agriculture in the long term (Hemming et al. 2018; Kanter et al. 2015; Jayne & Rashid 2013; Holden & Lunduka 2013; Baltzer & Hansen 2011 and Crawford et al. 2006). On the other hand, there also exists strong evidence that agricultural input subsidies may lead to inefficiencies, agricultural markets distortions and policy distortions which may drain the government's budget (Baltzer & Hansen 2011; Banful 2010 and Morris et al. 2007). Banful (2010) argues that the fertilizer subsidy programmes applied in many developing countries are prone to inefficiencies emanating from political manipulation and high administrative costs. Political manipulation and corruption are some of the issues which have been associated with Zimbabwe's command agriculture, implemented in the 2016/17 agricultural season, where farmers were supported with fuel, seed, and chemical & fertilizer inputs by the government (see Chisango and Tichakunda 2018). The Presidential input scheme in Zimbabwe has remained the most popular free input support scheme but has also been reportedly associated with political manipulation. Although the government of Zimbabwe recognized the negative impact of the command scheme on national budget in the 2019 budget statement, input support schemes were continued but targeting vulnerable households (Ministry of Finance and Economic Development 2018). The debate on the continued application of input subsidy and its design has therefore continued to occupy policy discussion space in Zimbabwe and other African countries.

Despite the significant share of input subsidies in the national budgets and widespread use of the practice, little emphasis has been placed on the evaluation of the impact of agricultural input subsidies on productivity, incomes and food security in Zimbabwe and other developing countries (see Lopez et al. 2017). Recently, Gwatidzo and Muyengwa (2020) evaluated the impact of command agriculture on maize yield in Zimbabwe and established that the Programme did not stimulate maize yield per hectare. It is, however, important to extend these findings in evaluating the poverty and food security impact of the alternative programmes targeting the vulnerable communities. It is crucial for policy makers to understand the change in wellbeing that can be directly attributable to the input support schemes. Impact evaluations are an important tool for analyzing policy interventions.

1.1 Objectives

A proper design of input support distribution is important in the implementation of devolution and attainment of regional food security. Hence spatial analysis of input support schemes is vital for policy makers. In addition, information on the implications of the possible removal of existing input subsidies is useful for planning and restructuring of some subsidy schemes, where the Government is contemplating to liberalize the economy. However, impact evaluations in agriculture are limited in Zimbabwe and other developing countries (see Lopez et al. 2017; Chirwa & Dorward 2013 and Jayne & Rashid 2013). The main goal of this study is, therefore, to cover this gap by providing a rigorous impact evaluation of government policies and programs in agriculture which have generated a lot of controversies in recent years (see Parliamentary debates on land and agriculture of 2018 and 2019). It extends the study done by Gwatidzo and Muyengwa (2020) by looking at the poverty implications of input support schemes targeting poor households.

The article assesses the spatial distribution and targeting of agricultural free input support schemes and evaluates their association with rural households' input usage, food security, incomes and poverty in Zimbabwe. The questions are:

1. How are agricultural free input support resources spatially distributed (regional and by gender of household head of the receiving plot) in Zimbabwe?
2. Are government's free input support schemes properly targeted?
3. Does their impact vary according to province?
4. Do agricultural free input support schemes have an association with farmers' input usage, incomes, food insecurity and poverty?

2. Review of Agricultural Input Support Schemes in Zimbabwe

Zimbabwe together with other African countries such as Malawi, Kenya, Tanzania and Zambia pursued large scale universal agricultural input support schemes since the 1960s (Baltzer & Hansen 2011). Agricultural input subsidies continue to be implemented in Zimbabwe, despite the high default rate on these loans (above 35 percent), with strategic (IMF 2019). The subsidies are in the form of both loans and grants (free input support). Free input support schemes commonly target poor communal areas.

The agricultural sector since the land reform programme has faced substantial challenges including a sharp decline in commercial production. The restructured agricultural sector created both opportunities and challenges. The major challenges are reduced yields, limited markets and inadequate access to finance. As a result, private investment in the agricultural sector has sharply declined negatively affecting overall production and productivity. In order to ensure that the sector is adequately funded the Government has assumed the role of the Private Sector and has come in to support the sector at both the input and output market levels, as well as the provision of fiscal and non-fiscal incentives. The National Agriculture Policy Framework (2018-2030), Pillar 3 on the production and supply of agricultural inputs aims to increase the safe, sustainable and precise utilisation of productivity-enhancing agricultural inputs. This is to be achieved through promotion of policy actions that lower the costs of agricultural inputs; enhance farmers' capacity to buy adequate inputs by improving access to finance for farmers as well as the development of an efficient production, distribution and marketing system. It is government policy to promote the participation of the Private Sector but the major challenge is Policy inconsistency which causes unpredictability in the sector.

The period from 2000 to date has seen a deliberate government effort to support farmers through direct provision of inputs, necessitated by the need to prop up the new farmers created by the Fast Track Land Reform Programme (Govere et al. 2009). In the 2003/2004 farming season, Zimbabwe was hit by a drought which led to a 70% shortfall in food production to meet the annual national requirement. The cereal deficit for the 2003/2004 season was estimated at 1.65 million tonnes. In response to this, Government put in place a food security programme gazetted in Parliament in 2005. The Maguta/Inala programme, which costed over US$900 million, was an infrastructure development programme which focused on supporting the agrarian reform through the provision of farm machinery to farmers and an additional input pack to subsistence farmers. The Government Input Support Programmes were essentially a response to the needs of the new farmers under the FTLRP including the communal and old re-settlement farmers.

In 2011 the presidential inputs support scheme was introduced, chiefly targeting subsistence farmers, poverty stricken and food insecure households. In 2017, Seeds and fertilizers were distributed to about 1.4 million small-scale rural farms for grain and soya bean production (World Bank 2019). For cotton, farmers receive free inputs – fertilizers, planting seed and chemicals – sufficient for a hectare, with 155,000 farmers benefiting in the 2016/17 farming season, 385,000 farmers in 2017/2018, and 400,000 farmers targeted for 2018/19 (World Bank 2019). In 2016 the government spent US$42.7 million on the presidential inputs support scheme, and scaled it up substantially in 2017 and 2018, to US$125 million and US$263 million respectively (World Bank 2019). Although, there is no evidence to show whether the resources are properly targeted and effective, the presidential input scheme will continue to exist in the near future as indicated in the agricultural policy framework.

In the 2014/15 season, Zimbabwe experienced an "el nino" induced drought and the government responded by putting in place a Special Programme For Import Substitution, commonly known as the Command Agriculture Programme. The programme is a Public Private Partnership, the main role of government is to mobilise farmers, register them and to procure the output through GMB and the financier supplied the inputs. In the 2016/17 agricultural season to 2018/19 season, the Government implemented the command agriculture Programme which gobbled a significant portion of the national budget (exceeding 10 percent). The Programme targeted large and medium scale farmers with sufficient farm implements. Farmers were supported with seed, fertilizer & chemicals and fuel for maize and wheat production. The Programme was also extended to soya bean and livestock production. Command livestock aims to improve production and productivity of beef, dairy and small stock (goats, pigs, sheep, poultry etc.), rehabilitate and develop livestock infrastructure; and improve market access targeting all farming sectors with special emphasis on the southern region of the country. Farmers were, however, supposed to pay back using part of their harvested output.

For the 2019 national budget presented in December 2018, the Government acknowledged that expenditure on command agriculture was excessive and unsustainable and the Programme was redesigned to include the active role of the private credit markets (Ministry of Finance and Economic Development 2018). However, the government remained as guarantor for the loans. In addition, government's free input resources will be directed towards vulnerable farmers only. While the command programme targets large scale farmers, smallholder farmers receive free fertilizer and seed from the Presidential input scheme and input scheme for the vulnerable from social welfare. The two schemes targeting the vulnerable, support maize, small grains and cotton farmers with seed and fertilizer. The Presidential input scheme caters for all the small holder farmers, supporting approximately 1.6 million households (A1, SSC, ORA, CA), giving an input pack adequate to cover 0.4 Ha.

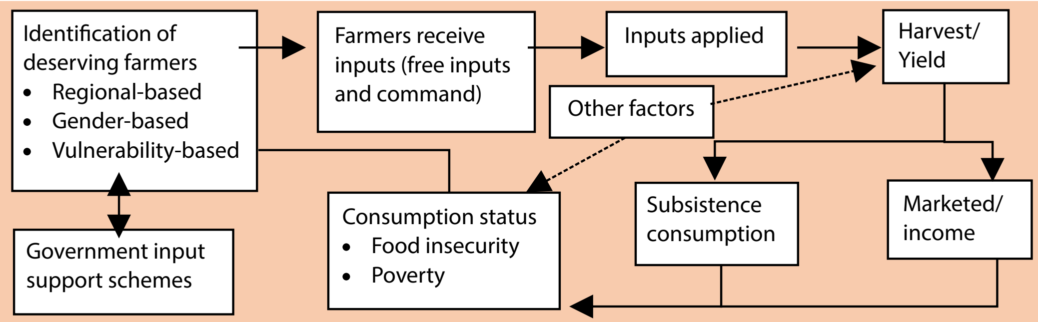
The main objective of the scheme is to improve food security and reduce poverty in poor rural communities.

3. Theoretical framework and literature review

The benefits and costs of an input subsidy are extensively discussed in economic theory. Conventional microeconomic theory suggests that subsidizing private goods such as agricultural inputs in a competitive market with no market failure distorts resource allocation. An input subsidy acts as a negative tax to farmers which reduces input price paid by the farmer and consequently raise the demand for the subsidised agricultural inputs. In this regard, the market price is distorted since a wedge is created between the price paid by the farmer and price received by input suppliers. Like a tax, a subsidy leads to a deadweight loss thereby violating Pareto efficiency (see Mas-Colell et al. 1995). However, in the presence of market failure, such as in situations where farmers' private costs of working capital for input purchase exceed the social cost of capital and where farmers do not have full knowledge regarding the benefits of inputs, an input subsidy may generate positive net economic return to a country (Siamwalla & Valdes 1986). Low usage of agricultural inputs such as fertilizer in African countries is assumed to be a result of lack of information regarding the benefits of fertilizer use and farmers' budget constraint (Baltzer & Hansen 2011). Hence, input subsidies have been considered as a tool to increase usage of these inputs and subsequently increase farmers' productivity through addressing market failure. At an individual level, a reduction in input prices increases farmers' expected profitability and their willingness to take risk, which in turn promotes production. The Abuja Declaration of June 2006 noted the strategic importance of fertilizer in achieving the African Green Revolution to end hunger and set a target to increase fertilizer usage from 8kg/ha to 50kg/ha by 2015 (FAO 2015).

While the dominant economic theory emphasises efficiency, the 2030 Agenda for sustainable development recognises the crucial role played by the Government as an agent of change (Razavi 2016). The theory of change in line with the 2030 Agenda, therefore, requires governments to play an active role in resource redistribution in order to achieve inclusive growth and eliminate poverty and hunger. In this regard, with market failure, input support schemes must be designed to achieve equity and stimulate consumption for vulnerable households. Hemming et al. (2018) argue that government intervention that provides free inputs to farmers will result in an increase in input usage which in turn is expected to stimulate yield and consumption for rural households. Since a significant number of rural households relies on what they produce (subsistence), any intervention that influences yield will therefore have a direct effect on their well-being or poverty. Figure 1 illustrates how government input support schemes are linked to household poverty. Input subsidy influences affordability and availability of inputs which in turn influences output. Output is either consumed or sold to generate revenue/income required by farmers to spend on purchased food and non-food items.

Figure 1: Input support and poverty linkages



Source: Authors' illustration

The framework in Figure 1 allows us to assess the spatial distribution of input support schemes, gender balance in distribution and whether vulnerable households receive government's free inputs. An effective input support Programme for the vulnerable households translates into reduced poverty for the receiving household. Hence, in the next cycle defined by the new agricultural season, the previous recipients must have moved out of the vulnerable group. If the same households continue to be classified as vulnerable or as poor despite receiving free inputs then it implies that free input schemes are not an effective tool for reducing poverty among vulnerable households. Continuous allocation of free inputs to the same households cultivates a dependency syndrome hence defeating the objective of the input subsidy. In addition to assessing the spatial distribution of input schemes, the framework also allows us to evaluate the impact of input support schemes on poverty and food security. However, the outcome variables (poverty and food insecurity) are not only affected by government policies such as input support by are influenced by other factors such as post-harvest storage and losses, climate variability and shocks, soils, farmer knowledge, among others.

One of the main advantages of using propensity score applied in this study is its ability to match individuals or households with similar characteristics. Hence, the use of locality such as the district variable helps to control for other factors such as climate variability and shocks, soil type differential, the nature of extension services and causes of post-harvest losses among others. Although not perfect generating the propensity scores based on locality as done in this study helps to control for these other factors. Households with similar characteristics receive the same score and, on this basis, we can compare poverty and food insecurity outcomes of a beneficiary of free input support with a non-beneficiary with the same propensity score.

Poverty refers to the lack of resources to afford basic needs such as food, shelter, clothing and water. In this study we define this form of deprivation in terms of income and consumption. While income can equally be used as a measure of welfare, it can be properly construed as a measure of welfare opportunity but consumption is more suitable because it is a measure of welfare accomplishment (Atkinson 1989; Haddad and Kanbur 1990). For income poverty, an individual or a household is defined as poor if its income falls below a given poverty line, say less than US$1.25 per day. In Zimbabwe, the poverty line is established by national statistical office, Zimbabwe National Statistics Agency (ZIMSTAT). Food security on the other hand food security is a multidimensional concept which broadly characterizes food availability (physical access to food), food accessibility (economic access to food), food utilization (absorption of nutrients into the body), and vulnerability (Mahadevan and Hoang 2015). For the purpose of this study, an index for measuring food security generated by Zimstat from the 2017PICES was applied. It is, however, important to note that these two measures (poverty and food security) are interconnected. If an individual does not have access to food (food insecure) then s/he is deprived of food (poor). Equally, a poor household is likely to be food insecure. The relationship between poverty and food insecurity is well discussed in Mahadevan and Hoang (2015).

Despite the dearth of literature on impact evaluations of public policies in Zimbabwe, there exists vast literature on the impact of agricultural input subsidies in many countries including some African countries. Baltzer & Hansen (2011) indicate that large scale input subsidies have been applied in many African countries since the 1960s. Countries such as Zimbabwe, Kenya, Malawi, Zambia and Tanzania pursued universal input support schemes. However, as indicated by Lopez et al. (2017), there has not been any rigorous evaluation of the impact of these subsidies on farmers' productivity and incomes. Even with the existing studies, there is no consensus on the impact of subsidies on farmers' productivity and incomes. For instance, on one hand some researchers established subsidies as enhancing production. Dorward et al. (2010) found the Malawian Farm Input Support Programme (FISP) to have a substantial positive impact on maize production. The findings were further supported by Chibwana et al. (2010) who suggested that the FISP increased maize yields of recipient farmers by about 42 percent. Similar findings were established by the World Bank (2010) in Zambia where the Zambian Fertilizer Support Programme (ZFSP) was found to have increased total maize production by 89 percent in the 2007/8 season. However, the World Bank (2010) noted that some farmers who used to purchase inputs in the input market stopped doing so after the Programme. In Ghana, Yawson et al. (2010) established that the termination of universal input subsidies coincided with reduced fertilizer intensity from 22 kg/ha in 1978 to only 8 kg/ha in 2006.

On the other hand, there is strong evidence that subsidies may be costly. Baltzer & Hansen (2011) demonstrate that even in Malawi, Zambia, Tanzania and Ghana where subsidies were associated with increased output, the estimates are still uncertain and the costs of administration are too high. Input subsidies may directly benefit the farmer to improve productivity, output and incomes but the social cost might be difficult to justify. As a result, it is still unclear whether the input support schemes are beneficial. Anriquez et al. (2016) even suggest that transferring resources from subsidizing private inputs to public goods can substantially improve the agricultural sector in the long term. Lopez et al. (2017) indicate that in 2013 IARNA and FAUSAC applied propensity score matching technique to evaluate the impact of a fertilizer subsidy scheme in Guatemala and established that participation in the scheme rather reduced the average bean yields per hectare and had no impact on maize yields. Overally, the Programme had no impact on farmers' income and food security (see Lopez et al. 2017). Rigorous impact evaluation is therefore crucial for reducing these uncertainties inherent in estimates of subsidies impacts. In Zimbabwe, input subsidies continue to be pursued without any rigorous evaluation of their impacts, despite competing with meagre budgetary resources. Jayne & Rashild (2013) and Druilhe & Barreiro-Hurle (2012) point out that there is lack of rigorous impact evaluations of public policy in developing countries.

Non-functional credit markets and inadequate collateral constrain Zimbabwean communal farmers to access adequate inputs. The government can therefore bridge this gap through agricultural input support schemes. The main rational for agricultural input support schemes in Zimbabwe is to address non-functional credit markets and inadequate collateral constraining poor farmers in credit access.

4. Data Issues and Empirical Strategy

The data applied in this study is household level data collected by ZIMSTAT in collaboration with the Ministry of Lands, Agriculture and Rural Resettlement supported by the World Bank in 2017. The 2017 Poverty, Income, Consumption and Expenditure Survey (PICES) data will be used in this paper. We applied two modules, namely, the Poverty module and the Agriculture Productivity Module (APM). These data sets were merged in STATA 15. While the poverty module provides data aggregated at the household level, the APM module collected plot level data. So, within a household, there can be several plots. As a result, the merging in STATA was "one household to many plots" with the poverty module used as the master data set. The Agricultural Productivity Module (APM), is a nationally representative survey on agricultural productivity in Zimbabwe. The survey covers four smallholder farming sectors namely Communal Lands (CL), Small Scale Commercial Farms (SSCF), Old Resettlement Areas (ORA) and A1 Farms. The APM data is representative also at the land use sector level. However, a household head in ZIMSTAT surveys is the one who makes decisions on behalf of the household. As a result, he/she has control over received free inputs and can largely influence production plan for each plot. We therefore analysed gender at the household head level on the assumption that production plans in each plot for a given household are largely influenced by the household head. In other words, we assumed the household head to have control over the plots. This is a reasonable assumption for the communal areas of Zimbabwe where the household head takes ownership of the household and its assets.

PICES is a periodic household survey by ZIMSTAT which collects household data on poverty, consumption, incomes, expenditures and other demographic characteristics. In 2017, the survey was extended to cover agriculture (production, inputs, input support, crops, farm sizes, area planted and other agricultural attributes). The sampling frame for the PICES 2017 was based on the complete frame of Enumeration Areas (EAs) from the 2012 Zimbabwe Population Census. A stratified two-stage sample design was used for the survey, with EAs selected at the first sampling stage and households selected from a new listing in sampled

EAs at the second sampling stage. The first level of stratification corresponded to the 93 census districts of Zimbabwe, which are the geographic domains of analysis defined for the PICES. The rural and urban areas are domains at the national level. EAs were also stratified according to urban or rural. Only a total of 26,298 rural households from 62 administrative rural districts were, however, considered in this study because agriculture is mostly practiced in the rural areas of the country. At the national level, a total sample of 2,232 EAs with 31,248 households was selected of which over 50 percent were from rural districts. Both the poverty and assets modules are based on the whole PICES sample.

The Poverty, Income, Consumption and Expenditure Survey (PICES) 2017 was conducted by ZIMSTAT from January to December 2017. Data processing was carried out from January to June 2018. The PICES 2017 is based on a sample of 32,256 households which provides representative estimates at province and district levels. Out of a total of 32,256 sampled households, a total of 31,195 households successfully completed interviews. This gives a response rate of 96.7 percent of the sampled households. According to PICES 2017, Zimbabwe's population mainly resides in rural areas (69.2 percent) while 30.8 percent of the population resides in urban areas. Out of a total population of 13,888,196 people 9,610,632 people resided in rural areas. Out of a total of 31,195 households with completed interviews a total of 21,587 households resided in rural areas.

The Agricultural Productivity Module (APM), is a nationally representative survey on agricultural productivity in Zimbabwe. The data was collected from a sub-sample of the households that were interviewed in 2017 Poverty, Income, Consumption and Expenditure Survey (PICES). The APM is a survey of smallholder farming households. The survey covered four smallholder farming sectors namely Communal Lands (CL), Small Scale Commercial Farms (SSCF), Old Resettlement Areas (ORA) and A1 Farms. The APM data was collected in two rounds, that is, post-planting and post-harvest, designed to coincide with major periods of the main agricultural season in the country. The post-planting data collection was conducted between April and June 2017 while the post-harvest data collection occurred between September and November 2017. The sizes of all farm plots were measured using Global Positioning System (GPS). A total sample of 2,528 households was selected for the APM Survey from the PICES 2017 households. A total of 2,338 households were successfully interviewed giving a 92.5 percent response rate. Within these households, data were collected from over 13,378 plots in various parcels. These plots were owned by different farmers within a household. But some farmers had more than one plot.

With a total of 2,338 APM household responses, less than 4 percent of the households participated in command agriculture in the 2017 APM data. This number is too small to parametrically evaluate the impact of command agriculture in Zimbabwe. However, the assessment of command program may provide useful information regarding the recipients of command inputs. How command inputs are spatially distributed and what are the characteristics of the recipients? Are they in the working category, non-poor category and any other characteristics such as the gender distribution? The 2017 APM has some questions that are useful in evaluating the impact of input support schemes on food security and poverty.

Q8. Did your household use any FREE SEED for [CROP] on this [PLOT] during the agricultural season 2016/2017? The data indicate that about 18.3 percent of the 13,385 plots used free seed while 81.7 percent used purchased seed. The data show that the APM 2017 survey had a total of 13,385 plots which were cultivated, left fallow, rented in or rented out to other farmers. Out of these plots a total of 2,453 plots used free seeds. Additionally question 11 of the APM asks whether a household received free seeds during the agricultural season. The question was expressed as:

Q11. Did you receive this FREE SEED that you used for [CROP] on [PLOT] this agricultural season 2016/2017 as part of the following government programmes?

A. Presidential input support program	B. Vulnerable input support program	C. Other (specify)
Yes................	Yes	Yes ....
No................	No.......................	No.......................

The number of responses is fairly large to allow for a statistical evaluation of the impact of free seed on food security and poverty in addition to assessment of spatial distribution. A total of 2,531 out of 13,757 plots were under free seed. Table 1 illustrates the number of plots which used free seed under various Government and other programs during the APM 2017 while Table 2 presents the sources of free seed. Other sources include non-government sources such as non-state actors or well-wishers.

Table 1: Responses to input support

Program	Round 2		
	Total responses in plots	Recipient plots	Percentage of recipient plots
Presidential	975	609	62.4
Vulnerable	973	317	32.6
Other	973	49	5.0

Source: Zimstat (2019)

Table 2: Percent sources of free seed for households by sector

Area	Government/ Officers %	NGOs %	Agriculture Input Dealer %	Fellow Farmer %	Family Member %	Other %	Total
CL	42.4	10.6	1.4	18.0	22.3	5.3	100.0
A1 Farms	50.0	5.1	3.1	18.4	17.3	6.1	100.0
ORA	48.0	4.8	3.2	19.2	22.4	2.4	100.0
SSCF	54.5	4.5	0.0	31.8	9.1	0.0	100.0
Total	45.6	8.0	2.1	18.9	20.8	4.5	100.0

N.B. CL is Communal Lands, ORA= Old Resettlement Areas, SSCF= Small Scale Commercial Farms
Source: Zimstat (2019)

Despite the increase in government spending on input support schemes, extreme poverty rose to 29 percent in 2017 from 21 percent in 2011/12 with rural poverty reaching 40.9 percent of the population (Zimstat 2019). The question to be addressed is whether the resources are properly targeted and is this the most effective way to support the vulnerable households and allow them to escape poverty. Rural poverty for households slightly increased from 76 percent in 2011 to 76.9 percent in 2017 while urban poverty declined from 38.2 percent to 30.4 percent in the same period (ZIMSTAT 2019). The same source shows that individual poverty rose from 84.3 percent in rural areas in 2012 to 86 percent in 2017. Poverty in Zimbabwe remains more prevalent in rural areas. Therefore, we cannot talk of achieving SDGs of poverty and hunger elimination (SDGs 1 and 2), inclusive growth (SDG 8) and others without addressing rural poverty in the country.

The analysis was done in two phases. The first phase applied comprehensive descriptive statistics to assess the spatial distribution of the three agricultural free input support schemes. The other free input support from non-governmental institutions was also included in the analysis because it is a form of a subsidy. PICES data sets were supplemented with relevant information from the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCRR). The comprehensive descriptive analysis was done in terms of regional concentration, type of inputs and the characteristics of recipients. While studying regional concentration helps policy makers in achieving fairness in the process of devolution, the type of input support in each region was assessed in relation to climatic conditions of the region in order to inform policy makers about the more suitable input support type in each region. In addition, assessing the demographic characteristics of the recipients, in particular their sex, will help policy makers in their attempt to reduce the gender gap through fiscal policies. Furthermore, a Gini coefficient for free input quantity in each district was computed to provide useful information on regional variation in input support provision. **This aided information to compare regions in terms input support from government. Generally, the results of the first phase will help policy makers to**

design agricultural input support schemes that will achieve fairness in the process of devolution, design gender-sensitive input support schemes and design region-specific input-support schemes.

The second phase involved evaluating the impact of these agricultural input support schemes, in particular the poverty-related input support schemes, on some set of plot and household outcomes which include food insecurity and poverty, among others. Parametric methods were applied to evaluate the impact. The first part of this phase assessed the regional impact using a probit regression which accommodates the nature of the dependent variable. However, since the objective of free input schemes is to improve food security for the poor households, free seed may be directed to poor and food insecure households. Therefore, participants or recipient plots in free input support may be self-selected. This makes the usual probit estimators biased due to simultaneity bias. Under such circumstances, it is more appropriate to use techniques that address endogeneity. One of these techniques applied in this study is the Heckman's procedure. We specify the Heckman model by adding exogenous variables that influence the outcome variables and consider participation in the use of free seed as endogenous. In this model the outcome indicator was regressed on input support variable and the product of input support variable and regional dummies. The model is expressed as follows:

$$Prob(Q_i = 1|covariates) = \alpha + \lambda_1 S_i + \lambda_{2j} Prov_j S_i + \mathbf{Z}\boldsymbol{\theta} + e_i \qquad (1)$$

$$S_i^* = \boldsymbol{X\beta} + v_i \qquad (2)$$

$$S_i = 1 \text{ if } S_i^* > 0,\ S_i = 0$$

where $\boldsymbol{Q_i}$ is the outcome variable (food insecurity or poverty) of household i, α is an intercept term, $\boldsymbol{S_i}$ is agricultural free input support for household i, 〖Prov〗_j is province j, $\boldsymbol{Z}$ is an *n×k* vector of household characteristics, $\boldsymbol{\lambda_1}$,$\boldsymbol{\lambda_{2j}}$ and $\boldsymbol{\theta}$ are the estimated parameters and $\boldsymbol{e_i}$ is an error term which was assumed to be logistically distributed. $\boldsymbol{X}$ is an *n×k* vector of factors that influence the probability of receiving free seed support and $\boldsymbol{\beta}$ is a vector of estimated parameters. The term $\boldsymbol{Prov_j\ S_i}$ is an interaction term of province and free input support. Hence, the parameter $\boldsymbol{\lambda_{2j}}$ measures the regional or spatial impact of free input support schemes on the outcome variables relative to the base province. A robust $\boldsymbol{\lambda_{2j}}$ provides the regional differential impact of an input-support on outcome variables relative to the base region. Both food insecurity and poverty were measured as dummy variables, taking a value of 1 for a poor household (a household with monetary consumption below the poverty line) and a food insecure household (a household which cannot afford at least two decent meals per day) and zero otherwise.

The probability of receiving and applying free seed is endogenous if $\boldsymbol{v_i}$ is correlated with $\boldsymbol{e_i}$. Heckman suggests an instrumental variable (IV) estimation procedure to correct for this sample selection problem that assumes a joint normal error distribution. In the first step, the model is estimated using the Heckman probit technique that allows for the instrumentation of free input support. A variable V correlated with S, that is, Corr(S,V)≠0 and uncorrelated with e_i, that is, Corr(V,e_i)=0 can replace S in equation 1 as an instrumental variable. Finding a good instrument is not an easy process. Hence, the Heckman procedure is one way of generating an instrumental variable for S. Probability of receiving and applying free seed equation (2), which regresses the endogenous variable S on exogenous covariates X, generates a good instrument for S. We therefore combine PSM and the Heckman in this study. Triangulation of these techniques help in reducing the biases inherent in one technique. This phase helps policy makers to identify regions or provinces in which input support schemes are more effective. In other words, it provides the basis for the argument for or against regional differential subsidies.

Furthermore, with regards to empirical strategy, there has been increased realization of the importance of impact evaluations as an important tool of analyzing public policies (see Lopez et al., 2017). Impact evaluations estimate the causal effect of the input support schemes. Several strategies have been applied in previous studies of impact evaluations, with experimental and quasi-experimental studies becoming more popular (see for example Lopez et al. 2017; Pamuk et al. 2015; Carter et al. 2014; Duflo et al. 2011; Chibwana et al. 2010 and Dorward et al. 2010). Among these experimental and quasi-experimental studies, the Regression Discontinuity Design (RDD), Difference in Difference (DID) and Propensity Score Matching (PSM) have been the most commonly applied empirical strategies.

The provision of some of the input subsidies (Command inputs) in Zimbabwe has not been conditional upon defined certain households' characteristics. Hence, RDD is not appropriate since it requires a running variable or some form of assessment required when classifying households either as treated or untreated. Only recently has the Government indicated that future input support schemes will be based on the degree of household vulnerability. With this kind of assessment, RDD can possibly be applied in future studies of input support impact evaluation in Zimbabwe. With regards to DID, it requires at least two assessments of the same households under investigation. A baseline survey is required before the implementation of the Programme and other surveys are required after the implementation of the Programme (end line survey). The APM data is also designed to suit this strategy, that is, the survey follows the same households. The observations are not however enough for a DID strategy. Another major weakness of using the DID is that the two surveys were done in completely different seasons. Seasonal variations explain significant consumption changes among communal farmers. Hence, the PSM which can suit the design of PICES data was regarded a more appropriate strategy.

In order to measure the impact of free input support on input usage, incomes, food insecurity and poverty, we require the potential outcome of the rural household when given an input subsidy (observed outcome) and the potential outcome of the same household in the absence of the subsidy (counterfactual outcome). The inference is therefore counterfactual, an outcome that would have happened if the household was not subsidized. In other words, the impact of an input subsidy on input usage, productivity, incomes, food insecurity and poverty on the same household cannot be measured; a condition referred to as the problem of missing data (Dimara & Skuras 2003). Following Pindiriri (2018), let i be an index representing the i^th household and Si be a treatment indicator equals 1 if the i^th household received agricultural input support (treated household) and zero if the household did not receive any agricultural input support (untreated household). Further consider Qi0 and Qi1 to be the potential outcome that would occur when a household does not receive an input support (Si=0) and when a household receives an input subsidy (Si=1), respectively. Q is a vector of three outcomes, namely: income, food insecurity and poverty. Income is continuous while poverty and food insecurity are measured as binary variables. Hence, treatment effects with both continuous and binary outcomes were estimated using Propensity Score Matching (PSM).

The individual causal effect of household i is expressed as:

$$\tau_i = Q_{i1} - Q_{i0} \qquad (3)$$

Individual causal effect can be extended to measure the causal effect of all households, commonly known as the Average Treatment Effect (ATE) which can be written as:

$$E(\tau_i) = E(Q_1) - E(Q_0) \qquad (4)$$

The observed outcome (input usage, income, food insecurity and poverty) of the ***i^{th}*** household is there expressed as:

$$Q_i = S_i Q_{i1} + (1 - S_i) Q_{i0} \qquad (5)$$

$$Q_i \equiv Q_i(S_i) = \begin{cases} Q_{i1}\ if\ S_i = 1 \\ Q_{i0}\ if\ S_i = 0 \end{cases}$$

Equation (5) can equally be written as:

$$Q_i = Q_{i0} + (Q_{i1} - Q_{i0})S_i = b_i + \beta_i S_i \qquad (6)$$

where ***$bi=Q_{i0}$*** and ***$\beta_i=Q_{i1}-Q_{i0}$*** are the intercept and treatment effect for the ***i^{th}*** household, respectively. Since Q_{i0} (one of the components of *βi)* is not observable, the treatment effect, ***β_i***, is unidentified. However, Rubin (1977) demonstrates that with a randomized treatment assignment, an unbiased estimate of the average treatment effect can be obtained by simply taking the difference between the average outcomes of the treated households (those who receive input support) and average outcomes of households in the control group (untreated). Compactly, in the presence of random treatment, the expected outcome of treatment ***$(E(Q_i 1 | S_i=1))$*** is the same as the expected outcome of the untreated if the untreated had received subsidies ***$(E(Q_i 1 | S_i=0))$***. The reverse holds, that is, ***$E(Q_{i0} | S_i=0)=E(Q_{i0} | S_i=1)$.***

We estimated two useful measures of the impact of input support on outcome variables, namely the average treatment effect (ATE) and the average treatment effect on the treated (ATET):

$$ATE = E(\beta_i) = E(Q_{i1} - Q_{i0}) = \beta = E(Q_1 - Q_0) \qquad (7)$$

$$ATET = E[\beta_i | S_i = 1] = E[(Q_{i1} - Q_{i0}) | S_i = 1] \qquad (8)$$

ATE gives a measure of association between treatment and the outcome variable when outcome is regressed on the treatment variable alone. The PSM technique was then applied to estimate the effect of an input subsidy since this statistical technique reduces bias inherent in non-experimental research. As in Rosenbaum & Rubin (1983), we define the propensity score, ***e(X_i),*** as the conditional probability of a farmer getting treated, given a vector of known and observable pretreatment explanatory variables, X_i. The propensity score is written as:

$$e(X_i) = \Pr(S_i = 1 | X_i) = E(S_i | X_i) \qquad (9)$$

e(X_i) can equally be regarded as a balancing score which is a function of the covariates ***(X_i)*** given as ***φ(X)*** such that the conditional distribution of ***X*** given ***φ(X)*** is the same for the households who received input subsidies (treated) and those without input subsidies (control group). First, the conditional independence is assumed, that is, treatment is independent of potential outcomes when adjusting for observable pretreatment explanatory variables, $\{Q_{i1}, Q_{i0} S_i\} | X_i$. Second, we assume that the probabilities of being treated and that of not being treated are positive (the overlap assumption). With these assumptions, referred to as “strong ignorability” by Rosenbaum & Rubin (1983), the average treatment effect on the treated (ATET) presented in (8) can be expressed as:

$$ATET = E[E\{(Q_{i1} - Q_{i0}) | S_i = 1, e(X_i)\}] \qquad (10)$$

Since the study is non-experimental where propensity scores are known, propensity scores were estimated using the logit. In addition to demographic characteristics as education and gender, among other, the scores were generated using district dummies to account for regional characteristics such as climate variability and shocks and soil types. The estimated ATET gives the causal effect of agricultural input support schemes in Zimbabwe.

The PSM estimator was applied to evaluate the potential impact of directing input support to the vulnerable/poor households. Will it make a difference in household poverty and food insecurity if tax revenues are used to subsidize inputs of vulnerable houses? Estimators from impact evaluation help policy makers to check whether government policies, in this case fiscal policy, achieve their intended objectives. In addition, these evaluations provide some areas which require improvements in the design of these input support schemes. At the end of these evaluations, policy makers will have information on whether to stop subsidising households or to redesign the input support schemes and continue subsidising households.

The PSM has some weaknesses as in other empirical strategies such as in RDD. In the PSM, the conditional independence assumption (CIA) and the overlap assumption must hold. The CIA requires treatment status to be independent of potential outcomes after controlling for observable attributes. The overlap assumption requires sufficient overlap in characteristics of the treated and untreated units to find adequate matches (Gertler et al. 2011; Imbens and Kalyanaraman 2012). In the case of RDD, the treatment effect derivative (TED) must not be significantly different from zero, that is, households closer to the cutoff from below and above have similar characteristics and for this small group, the RDD line shows some form of continuity (Cerulli et al. 2016). These assumptions may, however, fail to hold. In our case where DID cannot be applied because of limited observations, we can combine PSM and other techniques such as the Heckman probit model. The results were also anchored by descriptive statistics.

Since Gwatidzo and Muyengwa (2020) evaluated the impact of command agriculture on productivity, in this study we, however, concentrated on the impact of input support schemes on food insecurity and poverty. The two studies differ in terms of input coverage and outcome variables. For the food insecurity variable, we used question 3 of section 20 of the APM which asked respondents the following question: "In the past 12 months, have you been faced with a situation where you did not have enough food to feed the household?" The answer was yes or no coded as 1 for "yes" and 2 for "no". In the estimation, we considered food insecurity as a dummy variable taking a value of 1 if the household has been faced with a situation without enough food to feed the household members over the past 12 months and 0 otherwise.

In terms of poverty measurement, a household was considered to be poor if monthly per capita consumption was below the person monthly poverty line. Three poverty lines were considered, namely; the food poverty line, the upper poverty line and the lower poverty line. We applied Zimstat's 2019 re-based poverty lines. The earlier monthly food poverty line of US$31.3 per person was rebased to US$29.8 per person; the upper was rebased from US$ 70.4 to US$66.1 while the rebased lower poverty line is US$45.6. Nevertheless, the analysis on poverty impact of free input schemes focused on the lower poverty line because of the simple reasons discussed in the Zimbabwe Poverty Trends Report 2017-2019 (Zimstat 2020) as summarized in the succeeding sentences. The advantages of using a lower poverty line over the upper are: 1) the lower-bound poverty line for Zimbabwe is commonly used by other countries of Zimbabwe's welfare status since its value in purchase power parity (PPP) is close to the international poverty line for lower-middle income countries; and 2) for policy analysis purposes it is helpful if the poverty line does not lead to poverty rates that are so high that nearly everyone is regarded as poor. This makes it hard to distinguish the neediest population groups that should be targeted by poverty reduction policies. In addition, per capita consumption was also used as a measure of poverty. Hence, poverty was also measured as a continuous variable in terms of household expenditures.

5. Empirical findings of the study

5.1 Descriptive statistics, distribution and targeting of government input support

The mean plot size from about 13,785 plots is about 0.73 Hectares (ha) with a minimum of 0 and a maximum of 1,295 Hectares. The difference between the mean and the maximum is an indication of the presence of outliers. Only 0.6 percent of the 13,785 plots are larger than 4 Hectares. These are large commercial farming and pastoral areas which can distort the findings. Since the study's objective is to examine poverty implications of seed support for smallholder farmers, the insignificantly few plots larger than 4 hectares were, therefore, dropped from the study. Hence, only 13,710 plots were investigated with a mean of 0.4 Hectares. A total of 18.4 percent of the plots applied free seed received from Government, Non-Governmental Organisations (NGOs), relatives and seed dealers, among others. Out of the 975 plot responses on free seed, 62.4 percent applied seed input from the Presidential input support scheme, 32.6 percent from input support for the vulnerable, and 5 percent from NGOs and other providers (see Table 1 in the preceding section). About 10.6 percent of the 11,194 plot responses applied for the Command agriculture programme. The findings show that 7.8 percent of the 1,788 farmers indicated that their households applied for participation in the command agriculture. However, only 30 out of the 139 applicants reported to have received inputs from the Programme. The provincial distributions of Government Input Support schemes are presented in Tables 3 and 4.

Table 3: Plot, gender and free seed distribution by province

	AG8 - Did you use any FREE SEED for [CROP] on this [PLOT]?			
Province	**Total number of plots**	**Number of recipient plots**	**Percent of recipient plots**	**Percent of recipient plots under female-headed households**
Manicaland	2411	451	18.7	53.3
Mashonaland Central	1410	259	18.4	27.0
Mashonaland East	3028	369	12.2	44.7
Mashonaland West	1483	202	13.6	28.6
Matabeleland North	700	171	24.4	39.2
Matabeleland South	1341	439	32.7	54.7
Midlands	1238	186	15.0	29.9
Masvingo	2070	442	21.4	40.4
Total	13681	2519	18.4	43.6

Note that the APM is nationally representative at land use sector and the provincial figures are only indicative.
Source: Authors' computations from APM

Table 4: Plots under free seed from the Presidential, Vulnerable, NGOs and other input support

Province	Total number of plots under free seed from input support schemes	Percent of plots under free seed from input support for vulnerable	Percent of plots under free seed from the Presidential input support	Percent of plots under free seed from NGOs and other programmes
Manicaland	203	68.0	30.0	2.0
Mashonaland Central	154	48.1	52.9	0.7
Mashonaland East	74	59.5	27.0	12.2
Mashonaland West	86	76.7	18.6	2.3
Matabeleland North	66	51.5	53.0	0.0
Matabeleland South	165	72.7	18.8	8.5
Midlands	119	54.6	28.8	16.1
Masvingo	108	63.0	36.1	0.0
Total	975	62.5	32.5	5.0

Source: Authors' computation from APM

The findings presented in Tables 3 and 4 show that there are variations across provinces, regarding the government's free input support schemes. Free input support programmes are more concentrated in Matebeleland South, Matebeleland North and Masvingo. For instance, Table 3 shows that 32.7 percent of the total plots in Matebeleland South received free inputs in the 2016/17 farming season compared to only 12.2 percent in Mashonaland East. The Presidential input support and the input support for the vulnerable are the major free input support schemes. However, NGOs and other providers such as input dealers also play a significant role, particularly in Mashonaland East, Midlands and Matebeleland South.

The Presidential input support scheme and input support for the vulnerable are more concentrated in Manicaland, Matebeleland South and Mashonaland Central while input support scheme for the vulnerable households is predominant in Matebeleland North, Mashonaland Central and Masvingo. Out of the 609 plots which applied the Presidential seed input, 22.7 percent were from Manicaland, 19.7 percent from Matebeleland South and 12.3 percent from Mashonaland Central. Similarly, the largest share of plots which received free seed for the vulnerable is from Mashonaland Central (25.6 percent of the 317 plots) and Manicaland (19.2 percent of the 317 plots). However, the mean quantity of seed from input support programmes is smaller in the Southern region of the country (Masvingo, Matebeleland South and Manicaland) compared to Mashonaland provinces and Midlands. The findings therefore suggest that free inputs are just widely spread across farmers in the Southern part of the country. In the Mashonaland region, less farmers get free inputs but in relatively larger quantities. In terms of equality, free inputs are more fairly distributed in Midlands (with a coefficient of variation 0.93) and Mashonaland Central (with a coefficient of variation 1.4).

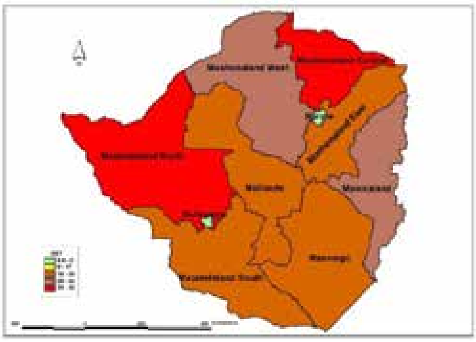
The largest variability in quantity of free inputs was reported in Mashonaland East with a coefficient of variation equivalent to 12.2, followed by Manicaland with a coefficient of variation of 4.8. Midlands reported the least variability with a coefficient of variation of 0.93. Only 178 (3.4 percent) plots out of 5,312 plots were under the command input scheme[1]. A majority of the 178 plots under command agriculture in the 2016/17 season were from Manicaland (36.5 percent), Mashonaland West (23 percent), Mashonaland East (14 percent) and Midlands and Mashonaland Central both at 8.4 percent. The Southern dry region of the country reported a very small number of plots under command agriculture. For instance, Matebeleland North reported only 0.6 percent, Matebeleland South 3.9 percent and Masvingo 5.1 percent. The results reveal that the command input support scheme was skewed and it largely benefited farmers located in Manicaland and Mashonaland provinces. The beneficiaries were mainly located in natural regions I to III (about 82.6 percent of the beneficiaries were in regions I, II and III) with good rainfalls. However, this regional discrepancy is an outcome of deliberate policy design as the command input scheme targeted A2 large scale maize producers that were considered capable of achieving target yields of 5 tonnes/ha to reduce the maize production deficit for national food security purposes.

Unlike the command input scheme, the Presidential and vulnerable input schemes are predominant in regions IV and V. The largest share of plots receiving free seed is in agro-ecological regions IV and V with 22.7 percent and 29.7 percent, respectively. About 53.4 percent of the plots under the Presidential input scheme were in natural regions IV and V. These are dry regions where most of the vulnerable households are located. Despite targeting vulnerable farming households in the drier regions IV and V, the Presidential input support and input support for the vulnerable households supported farmers with maize seed in over 50 percent of the plots. The major weakness, that might cause the ineffectiveness of the support schemes, is the unsuitability of maize cropping in these regions. The free input support schemes have not been conditional on natural region characteristics and soil type. These are critical factors that can define the effectiveness of input support schemes in reducing poverty for vulnerable households.

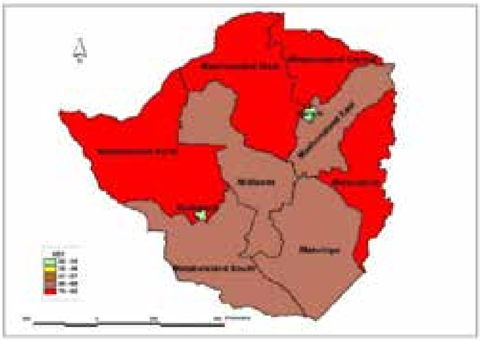
[1]It is important to note that the results on the command input scheme are statistically weak because of the small sample size. Only 178 plots in smallholder farming areas reported to have benefited from the programme. Since the APM did not cover large scale A2 farming areas where the bulk of Command Agriculture beneficiaries are, the findings on anything relating to Command Agriculture should be treated with caution. The findings in this paper are therefore mainly centered on the other input schemes.

While the provincial results demonstrate that free input support schemes target the poor, it is crucial to note that the APM survey was not representative at province level. Hence, the data on the distribution of free input support was superimposed on the poverty map at district level. The Zimbabwe poverty maps presented in Figure 2 show that extreme poverty is highest in Mashonaland Central and Matebeleland North while Mashonaland West and Manicaland add to these provinces with the largest number of poor households. The poorest districts in these provinces include among others: Muzarabani, Mbire, Mudzi, Mt Darwin and Rushinga in Mashonaland Central, Umguza, Hwange, Binga, Lupane and Bubi in Matebeleland North, and Nyanga, Chipinge and Chimanimani in Manicaland.

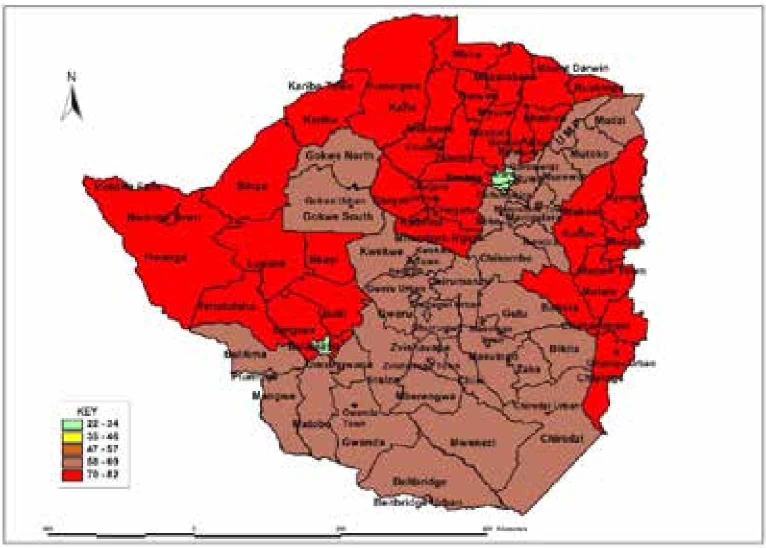
Figure 2: The poverty maps of Zimbabwe



(a) Household extreme poverty map by Province



(b) Household poverty prevalence map by Province



(c) Household poverty prevalence map by District

Source: ZIMSTAT (2019)

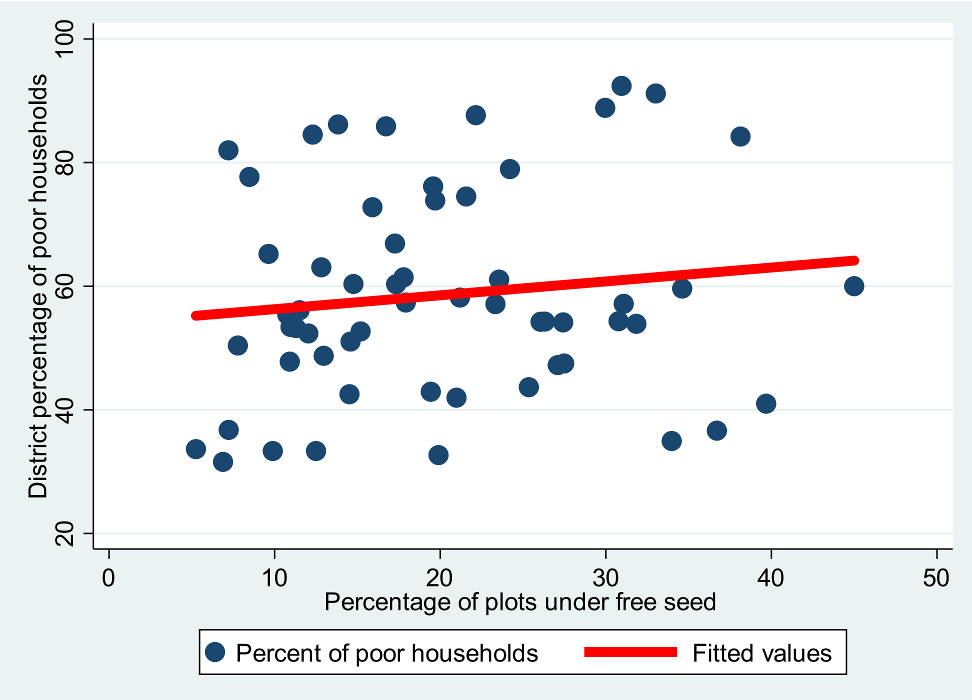
These poorest Districts with also the highest poverty prevalence are located in drier ecological regions IV and V which have the largest number of plots (over 50 percent) receiving the Presidential input support and input support for the vulnerable. For instance, Mbire, Rushinga, Muzarabani, Hwange rural, Umguza, Nkayi and Binga are among the top fifteen districts with the largest proportion of plots which applied free seed from the Presidential and vulnerable input support schemes. The same districts are among the top 20 poorest districts in Zimbabwe. Mbire, the second district with largest proportion of plots under free seed input support (38.1 percent) is ranked number 8 in poverty using the lower poverty line and number 10 using the extreme poverty line. In Manicaland, Chimanimani classified as a poor district, had 31.8 percent plots under free input support. In general, the poorest districts are the largest beneficiaries of input support schemes, in particular, free seed support. Districts with the largest share of plots under free seed support from the Presidential and vulnerable input support schemes are illustrated in Table 5. Superimposing these Districts on the poverty maps, show that they are all in high poverty areas.

Table 5: Poor districts with the largest share of plots under free input support

District	Percentage of plots under free seed	Percent of poor house-holds
Mangwe	57.3	50
Hwange Rural	45	60
Gwanda Rural	39.7	41
Mbire	38.1	84
Kariba	34.6	60
Rushinga	33	91
Chimamimani	31.8	54
Umguza	31.1	57
Muzarabani	31	92
Matobo	30.8	54
Mudzi	30	89
Gokwe South	22	88
Mount Darwin	17	86
Murehwa	14	86

The findings reveal that free input support, in particular, the Presidential input support and input support for the vulnerable are properly targeted. They target poor households; hence they are more dominant in poor districts. The positive correlation between the percentage of plots under free input seed and the percentage of poor households is further reinforced by the scatter graph presented in Figure 3. The findings in Figure 3 demonstrate a positive association between the percentage of poor households and the percentage of plots which received and applied free seed during the 2016-17 agricultural season. This is an issue of self-selection or endogenous treatment in both the poverty and food insecurity models. In other words, getting free input from the input providers is dependent on the poverty or food security status of the district. The probability of a plot receiving free input depends on the district in which the plot is located. In the poverty and food insecurity models, district dummies are exogenous. A district dummy can be a good instrument for free input support since it influences the outcome variables (poverty and food security) through input support. Therefore, in addition to endogenous treatment of input support scheme, the descriptive statistics justify the suitability of the Heckman two stage procedure for the correction of endogeneity. Although the Heckman technique is sensitive to model specification and distributional assumptions, it is robust even under small samples (Bolwig et al. 2009).

Figure 3: Scatter plot of free seed recipient plots against district poverty



Although 52 percent of the population in Zimbabwe are female as in Census 2012, the findings reveal that more plots under male-headed households receive free inputs from government input support Programmes than plots under female-headed households. The results in Table 3 indicate that about 43.6 percent of the recipients of government's free inputs were plots under the ownership of female-headed households while 56.4 percent of the plots under free seed were under the ownership of male-headed households. In all provinces (indicative only) except Manicaland and Matebeleland South, there are less plots in women-headed households receiving free inputs than in male-headed households. For example, only 27 percent of the recipients of free inputs in Mashonaland Central were for plots in female-headed households while 73 percent were under male-headed households. Similarly, in Mashonaland West only 28.6 percent of the plots under free input were under female-headed households and in Midlands, 29.9 percent of recipients were under female-headed households. Generally, the findings point to an important policy implication regarding gender. Women farmers have continued to be disadvantaged in government Programmes, despite the recognition of SDG 5 on gender equality and SDG 8 on inclusive growth. The input support schemes, in particular, the Presidential input support and input support for the vulnerable households need to be re-designed to improve female-headed households' share of plots targeted by these schemes in each province. With SDG 5 in mind, we expect more plots under female-headed households to benefit from free inputs than plots under male-headed households.

Table 6(a) presents Provincial yield variability in kilograms per ha and percentage of the poor while Table 6(b) presents yield variability in kilograms per ha and percentage of the poor by land use. Table 6(c) presents poverty and yield by resettlement type. The main advantage of the descriptive statistics presented in Tables 6(b) and 6(c) is that the APM survey is nationally representative at the land use sector. Table 6(a) shows that yield per ha and the percentage of poor households vary significantly across provinces. Mashonaland East and Masvingo have the largest coefficients of variation in yield per ha, 31.9 and 31.8, respectively. The other provinces with highly volatile yield are Mashonaland Central, Matebeleland South and North and Midlands. Manicaland and Mashonaland West have a relatively low degree of volatility in yield per ha. Using the lower poverty line of US$45.6, Mashonaland provinces are the poorest, followed by Matebeleland North. Poverty levels are very high in the communal and resettlements areas.

Table 6(a): Provincial poverty status and yield variability measured by coefficient of variation (CV)

Province	Obs	Percent of plots under extremely poor households (extreme line)	Percent of plots under poor households (lower poverty line)	Yield variability (CV)	Variability of free input quantity (CV)
Manicaland	2412	27.7	57.9	3.9	4.8
Mashonaland Central	1350	43.9	70.4	11.3	1.4
Mashonaland East	2905	34.2	63.8	31.9	12.2
Mashonaland West	1446	33.7	62.2	7.6	1.64
Matabeleland North	692	28.2	59.5	9.1	1.19
Matabeleland South	1308	20.0	51.0	11.8	1.17
Midlands	1227	26.0	53.4	10.0	0.93
Masvingo	2062	14.9	46.4	31.8	1.13
Total	13402	28.5	58.1	34.3	13.4

Obs is the number of observations.
Source: Authors' computations from APM

Table 6(b): Poverty status and yield by land use

Land use sector	Obs	Percent of plots under extremely poor households (extreme line)	Percent of plots under poor households (lower poverty line)	Percent of plots under free seed	Yield (kg/ha)
Communal areas	7,040	14.6	29.4	9.4	37225.7
SSCA	317	0.1	0.5	0.3	6143.6
LSCA	149	0.3	0.6	0.2	3903.6
Resettlement areas	6,024	13.3	27.7	7.1	11273.6
Pearson p-value		0.0277**	0.008***	0.004***	
Total	13,530	28.3	58.2	17.0	9,865.6

Land use is nationally representative. SSCA and LSCA means Small Scale Commercial Area and Large-Scale Commercial Area, respectively while Obs stands for the number of observations. Yield is quantity in kilograms (kgs) per ha.
Source: Authors' computations from APM.

Table 6(c): Poverty status and yield by type of resettlement

Resettlement	Obs	Percent of plots under extremely poor households (extreme line)	Percent of plots under poor households (lower poverty line)	Percent of plots under free seed	Yield (kg/ha)
Old resettlement	2,943	5.97	11.7	3.23	12,782
A1	2,724	6.49	13.3	3.26	10,433.3
A2	22	0.03	0.04	0.01	2,946.2
Pearson p-value		0.894	0.963	0.0769*	
Total	13,710	28.5	58.3	16.9	24,378.4

Resettlement is nationally representative. Obs stands for the number of observations and kgs for kilograms.
Source: Authors' computations from APM.

Out of the 58 percent plots under poor households, 29.4 percent are in communal areas and 27.7 percent in resettlement areas (see Table 6(b)). Less than one percent (0.5 percent) of the plots in small scale commercial areas belong to poor households while only 0.6 percent of the plots in large scale commercial areas belong to poor households. The Pearson statistic for the measure of association rejects the hypothesis that poverty and land use are independent. Alternatively, the Pearson results show that there is a significant association between land use sector and poverty. Furthermore, the findings in Table 6(b) demonstrate that the main recipient plots of free seed are in communal and resettlement areas. Only less than one percent of the plots, in both small and large commercial areas, benefited from free seed input support. The Pearson measure of association also shows that free input support is associated with land use sector. The results reveal high poverty levels in land use sectors with the largest proportion of plots under free seed input support. This further provides additional evidence of a positive association between poverty and free seed input support. Similarly, the findings in Table 6(c) show that there are more plots under poor households in old and A1 resettlement areas than in A2 resettlement areas. However, the Pearson statistic indicates no significant association between resettlement type and poverty. One of the most interesting finding from Tables 6(b) and (c) is that yield in larger plots (commercial and A2 farming areas) is significantly lower than yield in communal and A1 farming areas. This is an indication of under-utilization of large farms.

Although the survey was not representative at district level, there are indications that input support Programmes are not equally balanced. For instance, with regards to free seed, all districts reported at least one plot under free seed. The Presidential input support and input support for the vulnerable cover a wider area of Zimbabwe. Only 5 districts out of 62 rural districts reported no plots under the Presidential input support scheme. Despite wide coverage, the distribution of free inputs varies significantly within regions. The Gini coefficient for free seed quantity is 0.96 for Seke, 0.89 for Mutoko, 0.70 for Uzumba, 0.63 for Masvingo rural, and 0.60 for Makonde, among others. The Gini coefficient is over 50 percent in most of the districts, an indication of a skewed distribution in free seed input support in these districts. The high Gini coefficients indicate that there is inequality in the distribution of inputs within the district Some of the districts with the largest share of plots under free seed, reported the largest proportion of poor households. For example, Muzarabani, Nkayi and Rushinga are some of the poorest districts and reported at least 24 percent of plots receiving free seed support from the government.

The descriptive findings demonstrate that the design of the command agriculture scheme promote self-selection of applicants. Most of the participants of the Programme are located in natural ecological regions II and III and in farms surrounding large urban centers. Whereas the Presidential input support and input support for the vulnerable households cover a wider area and one of their strength is their target. The indication is that poor areas have been properly targeted as they reported more plots under free seed. There are, however, some areas which require attention in the design of these programmes. First, there is need for a regional (provincial and district) balance. Second, the Programmes need to be designed with gender in mind. Third, it is important to consider regional and soil characteristics in order to provide suitable input support. The Presidential input support, which mainly support farmers with maize seed, requires regional diversification. For example, supporting farmers with small grains seed in drier regions such as the southern part of the country. In addition, the quantity of the Presidential and vulnerable inputs must be at least above inputs required for subsistence level, which is dependent on household size.

5.2 Provincial differential impact of free input support on poverty and food insecurity

The findings from the Heckman probit regressions are presented in Table 7. Free seed support was instrumented using district dummies as illustrated in Appendix A. District dummies make a good instrument for free seed support since the support targeted poor districts and districts are exogenous in both the poverty and food insecurity models. In the Heckman probit results, we are more interested in studying the regional effect of free input support on food insecurity and poverty. The coefficients of the provincial interaction term (parameter $\boldsymbol{\lambda}_{2j}$ or the coefficient of the variable province*free seed), which measure the regional or spatial impacts of input support schemes on the outcome variables relative to the base province, are statistically significant in some cases. This shows that free input support has differential impact on food insecurity and poverty, that is, the association between free seed and the probability of being food insecure varies across provinces. For example, in Table 7 using Manicaland as base province, free seed has a lower association with food insecurity in the drier regions such as Masvingo, Matebeleland North and Matebeleland South than in Manicaland and Mashonaland East. Since the association between free seed support and poverty and food insecurity is positive, these findings imply that in drier provinces, the positive association is smaller indicating that free input support is associated with relatively lower poverty levels in these provinces.

Table 7: Heckman probit results on the differential impact of free seed on food insecurity and poverty

	(1)	(2)	(3)	(4)
VARIABLES	Food insecurity	Food insecurity	Poverty	Poverty
Household size	0.024***	0.024***	0.186***	0.186***
	(0.009)	(0.009)	(0.011)	(0.011)
Plot size	-0.020	-0.020	0.021*	0.021*
	(0.014)	(0.014)	(0.012)	(0.012)
Gender of hh head	0.003	0.003	0.022	0.022
	(0.040)	(0.040)	(0.032)	(0.032)
No education	base	0.262	0.268**	0.268**
		(0.164)	(0.119)	(0.119)
Pre-school education	-0.071	0.190***	-0.069	-0.069
	(0.174)	(0.072)	(0.051)	(0.051)
Primary education	-0.262	base	base	base
	(0.164)			
Secondary education	-0.198	0.063	-0.022	-0.022
	(0.165)	(0.040)	(0.031)	(0.031)
Tertiary education	-0.772***	-0.510***	0.373***	0.373***
	(0.198)	(0.106)	(0.066)	(0.066)
Natural region I	-0.381***	-0.381***		
	(0.127)	(0.127)		
Natural region II	base	base		
Natural region III	-0.318***	0.318***		
	(0.065)-	(0.065)		
Natural region IV	-0.099	-0.099		
	(0.073)	(0.073)		
Natural region V	-0.314***	-0.314***		
	(0.084)	(0.084)		
Manicaland*free seed	base	0.160*	0.187**	0.213***

	(1)	(2)	(3)	(4)
VARIABLES	Food insecurity	Food insecurity	Poverty	Poverty
		(0.083)	(0.081)	(0.056)
Mash central*free seed	-0.160*	base	0.448***	0.474***
	(0.083)		(0.091)	(0.071)
Mash east*free seed	-0.096	0.064	0.527***	0.552***
	(0.076)	(0.082)	(0.083)	(0.059)
Mash west*free seed	-0.158*	0.002	0.448***	0.473***
	(0.088)	(0.092)	(0.092)	(0.072)
Mat north*free seed	-0.364***	0.204*	base	0.025
	(0.101)-	(0.106)		(0.080)
Mat south*free seed	-0.272***	-0.112	-0.288***	-0.263***
	(0.082)	(0.093)	(0.082)	(0.058)
Midlands*free seed	-0.197**	-0.037	0.327***	0.352***
	(0.091)	(0.097)	(0.093)	(0.072)
Masvingo*free seed	-0.206**	-0.047	-0.025	base
	(0.083)	(0.090)	(0.080)	
Constant	1.730***	1.309***	0.458***	0.432***
	(0.177)	(0.103)	(0.086)	(0.067)
Wald chi	115.01***	115.01***	551.07***	551.07***
rho	-0.840***	-0.840***	-0.990***	-0.990***
Total observations	13,603	13,603	13,603	13,603
Censored	11,162	11,162	11,162	11,162

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

The association between free seed and food insecurity is larger in some provinces such as Manicaland compared to provinces such as Masvingo. The type of input influences its effectiveness. Maize input support is likely to have a larger impact on outcome variables in drier regions. The Presidential input scheme, which mostly provides maize input support, can be more effective in regions suitable for maize growing while ineffective in drier regions such as Masvingo and Matebeleland. The descriptive statistics results in sub-section 5.1 reveal that the bulk of plots under free input support are maize plots. In this sub-section, it is revealed that free seed support has a relatively smaller impact on poverty in Masvingo and Matebeleland South. This may be explained by the unsuitability of larger parts of these provinces for maize production. The main implication from these findings is that a uniform subsidy across provinces may not be a good strategy for poverty reduction. Provincial characteristics such as climatic conditions and soil must be considered when designing an input support Programme for the vulnerable communities.

The main drivers of poverty and food insecurity in Zimbabwe as demonstrated in table 7 are household size, plot size, education and agricultural ecological location. Household size increases the probability of being poor and food insecure. Although a larger household size is a source of labour for farmers, it does not guarantee increase in productivity. In fact, a larger household size decreases per capita consumption, hence promoting poverty. A larger plot size is associated with reduced probability of being poor and food insecure. The implication is that larger plots are an income asset for rural farmers and the main input in production. The other factor which influence rural poverty is education. Improvement in education reduces the probability of being poor and food insecure.

5.3 Free input impact on outcome variables using treatment effects

The impact of command agriculture on productivity and input usage has already been evaluated using propensity score matching by Gwatidzo and Muyengwa (2020). The findings show no evidence of increased productivity from the command Programme, that is, no significant difference in maize yield between CA and non-CA farmers. In this section we present results of the impact of free seed (Presidential input support and input support for the vulnerable) on input usage, poverty, food insecurity and income. The findings are presented in Table 8. The ATE coefficients are all positive in the two outcome models (input use and income) but statistically insignificant. However, the ATE coefficients are statistically significant for poverty and food security outcomes. They demonstrate that recipients of free seed are poorer and more food insecure that non-recipients. Per capita consumption is $2 lower in recipient households than that of non-recipients. Similarly, using dummy variables for poverty and food insecurity, the findings still show a positive association between free seed and these outcomes (poverty and food insecurity). Since the outcomes in Table 8 are only regressed on the treatment variable instrumented using district dummies, the ATE coefficients are just measures of association between the outcome and treatment. The positive association between poverty and free seed may be a result of the schemes' target of poor and food insecure households. The findings, therefore, support the descriptive statistics that there is a positive association between free seed input support and poverty and food insecurity or equivalently a negative association between free seed input support and household per capita consumption.

The ATET coefficients in Table 8 reveal insignificant impact of free seed input support on seed application, income and poverty. The coefficients for input use (seed intensity), income and poverty are all statistically insignificant. Whereas the ATET coefficients for food insecurity and per capita consumption are statistically significant. The results show that recipient of input support among the treated have a lower per capita household consumption and are more food insecure than non-recipients. The results buttress the initial finding that free input support schemes properly target the poor and food insecure districts. However, with their current design, these schemes do not have the capacity to move rural households out of poverty and food insecurity. The findings further reinforce the previous findings by Gwatidzo and Muyengwa (2020) that agricultural subsidies in Zimbabwe are ineffective although they examined a different type of input support. In the case of poverty and food insecurity, there is only evidence to appraise that free input support schemes positively associated with poverty and food insecurity in poor communities. There are two possible explanations for the failure of free input schemes to move households out of poverty and food insecurity. First, while the free input support schemes properly target poor districts, they may be inadequate to have an impact on poverty and food insecurity. For instance, the average quantity of free seed is only 9.5 kilograms which is not even enough for half a hectare. In addition to the inadequacy of seed quantity provided through the free input support schemes, over 60 percent of recipients of free input support only get seed without fertilizer. Second, unlike in the case of purchased seed where farmers work towards recovering cost, the zero cost of free seed may lead to reduced effort in production. When farmers continue to receive free inputs and food from government, they consider provision of free inputs as a variable in their planning. Hence, they put less effort in anticipation of receiving free inputs from government in the future. This may even promote poverty and dependency among poor communities.

Free input programmes need to be designed into a complete package that does not only end at giving farmers inputs. But a package combined with training in farming, planning, marketing and capitalization. Giving vulnerable households inadequate inputs is not sufficient to drive these households out of poverty and food insecurity. We, however, treat the impact findings in this study with caution because of two major reasons: The first concern is that the APM survey is not representative at district level and the second is the problem of identification of the variable representing free seed receipt in the poverty and food insecurity models since the survey is non-experimental. In this regard, we base our conclusions on the descriptive statistics and the association between free input support and the outcome variables. In addition, we present suggested areas for further research to improve evaluation of input subsidy impact.

Table 8: Impact of free seed on input use, poverty, food insecurity and income (ATE and ATET)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Input use (seed intensity)	Income	Food insecurity	Poverty	Per capita consumption
ATE (1 vs 0)	87.3	14.95	0.090***	0.027 *	-2.002***
	(200.6)	(26.0)	(0.015)	(0.014)	(0.746)
ATET (1 vs 0)	-36.6	55.1	0.082***	0.019	-1.913***
	(125.6)	(37.9)	(0.0001)	(0.011)	(0.541)

*Standard errors in parentheses. *, ** and *** means the coefficient is statistically significant at 10 percent, 5 percent and 1 percent, respectively. The treated are recipients of free seed labelled 1 and the non-treated are labelled 0.*

For robustness checks, we checked the quality of matching and tested the balancing property. The results for the quality of matching are presented in Appendix B. The findings show that the quality of matching using district dummies and other covariates is fairly good since Rubin's B=7.3 is less than 25 and Rubin's R=1.31 is within the required limit of between 0.5 and 2. For the rest of the covariates, B=10.1 and R=1.18). Rubin (2001) recommends that B be less than 25 and that R be between 0.5 and 2 for the samples to be considered sufficiently balanced. After matching, the t-statistics for the difference in covariates means between the treated and control are not statistically significant; an indication of good matching.

6. Conclusion, policy implications and recommendations

6.1 Conclusion

Firstly, we began this research by assessing the nature of free seed input and command input distribution. These descriptive statistics also provided supported why the study of poverty implications of free input support is more worth studying than command poverty implications in Zimbabwe. The descriptive statistics show that free inputs and command inputs are not equally distributed across provinces and within provinces and districts. In some provinces the inputs are spread over a larger number of plots compared to other provinces; inequality in free seed distribution is very high within districts as demonstrated by a Gini coefficient in excess of 50 percent in most of the districts. In terms of quantities of free seed, the mean quantity varies across provinces and districts. For example, the findings demonstrate that most of the participants of the Command Programme are located in natural ecological regions II and III and in farms surrounding large urban centers. Whereas the Presidential input support and input support for the vulnerable households cover a wider area. Although free seed support target poor households, the provision falls short of equality principles. For instance, the proportion of recipient plots under female-headed households is smaller than that under male-headed households. In addition to skewed distribution, maize dominates the provision of free seed input and has not been conditional on ecological and soil characteristics of the regions. The findings, therefore, suggest that in the case of continuation of free input provision for poor households, the current design require a radical change in order to achieve the intended objectives of poverty reduction and improving food security. An inclusive design for free input support schemes, which is sensitive to gender, regionalization/devolution, soil quality, seed type and quantity and agricultural ecological conditions may be crucial to change the situation of vulnerable households. The Presidential input support, which mainly support farmers with maize seed, requires regional diversification. For example, supporting farmers with small grains seed in drier regions such as the southern part of the country.

Secondly, we asked the question on whether the free inputs are properly targeted by the government. The answer to this question is that majority of plots under free seed input are found in the poorest districts, that is, the recipients of free inputs are found in poor areas. Hence, one of the major strengths of free input support schemes is that they are properly targeted and they benefit the deserving poor communities. This finding is also supported by the positive correlation between the probability of receiving free seed and the probabilities of being poor and food insecure. The major implication of this finding is that any concerns regarding free input distribution should be on other issues rather than area targeting.

Thirdly, we asked the question on whether the impact of free seed on food insecurity and well-being of smallholder farmers is province specific. The answer to this question from Heckman probit model shows that there are significant variations of the correlation between poverty and free seed support across provinces. In some provinces free seed has a larger positive association with poverty and food insecurity compared to other provinces. The most sensitive area with a smaller positive association is the southern part of the country. The main policy implication derived from this finding is that a “one size fits all” free input scheme strategy is not beneficial to poor households and the country. Free input schemes need to consider diversification across provinces and districts. Each province and district must have its uniquely designed support scheme. For instance, plots in ecological regions IV and V may not require maize seed input support but small grains or groundnuts that grow in drier weather conditions.

Fourthly, we asked the question on the association between free seed and outcomes such as seed intensity, income, food insecurity and well-being of rural households. The findings from the treatment effects using PSM demonstrate that free seed is positively associated with being poor and food insecure. In other words, the findings show that free input support schemes properly target poor and food insecure households. While the government expects the provision of free seed to improve condition of the vulnerable farmers, there is no evidence to show that. In fact, there is an indication that the free input support schemes are failing to move poor households out of poverty and food insecurity.

6.2 Policy implications

The main policy implications of the findings are that the continuation of free seed support in its current design is likely to leave the poverty status of these households unchanged thereby giving the Government a permanent responsibility to support them year after year. Providing free and inadequate input support to vulnerable farmers is not a sufficient strategy to move these farmers out of poverty and food insecurity. In fact, with rational behaviour, consistent provision of free inputs such as done by the Presidential input support can promote reliance on the free good by farmers. In cases where free inputs only come later after the onset of the rain season, these farmers may seriously be affected and continue to be food insecure. Furthermore, the Government's free input scheme which only provides at most one 10-kilogram bag of seed and two 50-kilogram bags of fertilizer for each poor household is not enough for even one hectare. Given an average household size of five members in Zimbabwe, the insufficient free inputs can only keep the recipient households at most at the subsistence level if they rely on these free inputs. To be sufficiently large enough to promote food security, the available little resources should be given to fewer households. So, the implication is that if the Government wants to move the target population out of poverty and food insecurity, it has to forgo the political dividend arising from distributing the meagre resources over a larger population.

6.3 Recommendations

In conclusion, the results demonstrate that free input support schemes in Zimbabwe properly target the poor or the deserving districts. Targeting poor districts is what is required in promoting food security and reducing poverty. For these reasons, the study recommends to following:

- Free input support schemes should be re-designed. Free inputs must be provided as a composite package consisting of other services like training in crop and livestock production, farming planning, income generation, marketing, and capital acquisition, among others. Input quantities that must be large enough to allow a five-member household to produce a surplus. Because of limited resources, the scheme could target a reduced number of households each year and also given adequate extension support. This policy option will improve the living conditions of the vulnerable and reduce government expenditures on procuring inputs for the vulnerable once the intervention is able to move a larger number out of poverty.

- Targeting of recipients must be gender sensitive and the type of input support must be dependent upon agro-ecological characteristics.

- Recipients in dry regions such as regions IV and V must receive small grains seed while maize seed must only target farmers in regions II and III.

- Free input support should be combined with strengthened extension services.

- There is need for the generation of data suitable for an experimental research design that will measure the actual impact of input support schemes without facing the problem of identification. This future research must first look at generating a proper experimental design with properly identified treated and non-treated sub-samples and start to collect improved data from both groups. In addition, future research must look at generating time series data suitable for estimating poverty duration models in the presence of free input support schemes.

- Last but not least, all the activities under the proposed new look scheme must be continuously monitored e.g. through rapid feedback loops from beneficiaries e.g. through telephone surveys or through the existing extension services and crop assessment activities. Investment in agricultural technologies can go a long way in monitoring these schemes and their effectiveness.

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Appendix A: Instrumenting free seed provision

```
Probit model with sample selection              Number of obs     =     13,603
                                                Censored obs      =     11,162
                                                Uncensored obs    =      2,441

                                                Wald chi2(19)     =     115.01
Log likelihood = -7571.355                      Prob > chi2       =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
food_insecurity						
nat_reg						
I	-.380742	.1266693	-3.01	0.003	-.6290092	-.1324748
III	-.3176089	.0645858	-4.92	0.000	-.4441948	-.1910231
IV	-.0995037	.072921	-1.36	0.172	-.2424262	.0434188
V	-.3138553	.0835616	-3.76	0.000	-.477633	-.1500777
NOT STATED	4.926115	7508.806	0.00	0.999	-14712.06	14721.92
hhsize	.0239111	.0086462	2.77	0.006	.0069648	.0408574
pov_malehd	.0032359	.0399235	0.08	0.935	-.0750128	.0814845
pov_hdlevel						
Preschool	-.0714105	.1735246	-0.41	0.681	-.4115124	.2686914
Primary	-.261808	.1641037	-1.60	0.111	-.5834453	.0598294
Secondary	-.1984003	.1649516	-1.20	0.229	-.5216994	.1248989
Tertiary	-.7723191	.1984342	-3.89	0.000	-1.161243	-.3833953
plot_size	-.0203609	.0142814	-1.43	0.154	-.0483519	.00763
prov_support						
2	-.1600779	.0834255	-1.92	0.055	-.3235888	.003433
3	-.0961787	.0759732	-1.27	0.206	-.2450834	.0527261
4	-.1576332	.0880351	-1.79	0.073	-.3301788	.0149124
5	-.3644731	.1005492	-3.62	0.000	-.5615459	-.1674003
6	-.2722754	.0816182	-3.34	0.001	-.4322442	-.1123067
7	-.1973597	.0909214	-2.17	0.030	-.3755624	-.019157
8	-.206802	.083401	-2.48	0.013	-.3702649	-.0433391
_cons	1.730872	.1770516	9.78	0.000	1.383857	2.077887

free_seed						
district						
Chimamimani	.4162255	.1030891	4.04	0.000	.2141746	.6182764
Chipinge	.2098105	.1141677	1.84	0.066	-.0139541	.4335751
Makoni	-.2982487	.1080526	-2.76	0.006	-.5100279	-.0864694
Mutare Rural	-.0793358	.1064053	-0.75	0.456	-.2878864	.1292147
Mutasa	-.1956513	.1418806	-1.38	0.168	-.473732	.0824295
Nyanga	-.0909417	.0993547	-0.92	0.360	-.2856733	.1037899
Bindura Rural	-.2940312	.1317877	-2.23	0.026	-.5523303	-.0357321
Muzarabani	.2606359	.1594131	1.63	0.102	-.0518081	.5730798
Guruve	-.3064361	.1328171	-2.31	0.021	-.5667528	-.0461194
Mazowe	-.2470601	.1494994	-1.65	0.098	-.5400736	.0459533
Mountt Darwin	-.1458647	.117827	-1.24	0.216	-.3768013	.0850719
Rushinga	.3357537	.1466169	2.29	0.022	.0483899	.6231175
Shamva	-.0143784	.1192343	-0.12	0.904	-.2480733	.2193165
Mbire	.4948578	.1409782	3.51	0.000	.2185457	.7711699
Chikomba	-.6453271	.13249	-4.87	0.000	-.9050027	-.3856515
Goromonzi	-.3543265	.1453619	-2.44	0.015	-.6392307	-.0694223
Hwedza	-.2360567	.1115057	-2.12	0.034	-.4546039	-.0175095
Marondera	-1.508931	.2710074	-5.57	0.000	-2.040096	-.9777667
Madzi	.3741463	.1102427	3.39	0.001	.1580746	.590218
Murehwa	.0002906	.1613371	0.00	0.999	-.3159243	.3165056
Mutoko	-.4729653	.1009803	-4.68	0.000	-.6708832	-.2750475
Seke	-.3694588	.1162787	-3.18	0.001	-.5973609	-.1415566
UMP	.0254213	.1124939	0.23	0.821	-.1950627	.2459053
Chegutu Rural	-.5702471	.1384801	-4.12	0.000	-.8416631	-.2988311
Hurungwe	-.2876561	.1370887	-2.10	0.036	-.556345	-.0189672
Mhondoro-Ngezi	-.0642749	.1129438	-0.57	0.569	-.2856406	.1570908
Kariba	.6853253	.1775969	3.86	0.000	.3372419	1.033409
Makonde	-.367607	.1180297	-3.11	0.002	-.5989409	-.136273
Zwinba	-.0393431	.1240278	-0.32	0.751	-.2824331	.2037469
Sanyati	-.4022044	.1738555	-2.31	0.021	-.7429549	-.0614538
Binga	.3101368	.1861389	1.67	0.096	-.0546887	.6749623
Bubi	-.2663941	.1564432	-1.70	0.089	-.5730171	.0402289
Hwange Rural	.8230239	.1969589	4.18	0.000	.4369915	1.209056
Lupane	.0580135	.1387696	0.42	0.676	-.2139698	.3299969
Nkayi	.1991882	.1513938	1.32	0.188	-.0975382	.4959147
Tsholotsho	.2814665	.1484499	1.90	0.058	-.0094899	.572423
Umguza	.3911496	.1294252	3.02	0.003	.137481	.6448183
Beitbridge Rural	.5412544	.1544747	3.50	0.000	.2384896	.8440191
Bulilima	.1939375	.1281536	1.51	0.130	-.0572388	.4451139
Mangwe	1.130265	.1281564	8.82	0.000	.879083	1.381447
Gwanda Rural	.6477096	.1181671	5.48	0.000	.4161064	.8793128
Insiza	.205057	.1081978	1.90	0.058	-.0070068	.4171208
Matobo	.4626461	.1316725	3.51	0.000	.2045728	.7207195
Umzingwane	.2018736	.1104202	1.83	0.068	-.0145461	.4182933
Chirumhanzu	.0890243	.120097	0.74	0.459	-.1463614	.32441
Gokwe North	.4179353	.163222	2.56	0.010	.098026	.7378446
Gokwe South	.2159231	.1290741	1.67	0.094	-.0370575	.4689037
Gweru Rural	-.451432	.3301551	-1.37	0.172	-1.098524	.1956602
Kwekwe Rural	-.363429	.1576076	-2.31	0.021	-.6723342	-.0545238
Mberengwa	-.5877357	.1588491	-3.70	0.000	-.8990743	-.2763971
Shurugwi	-.5509097	.136039	-4.05	0.000	-.8175412	-.2842782
Zvishavane	-.1390744	.1264436	-1.10	0.271	-.3868994	.1087506
Bikita	.2655818	.1096196	2.42	0.015	.0507312	.4804324
Chiredzi	.1293276	.1076211	1.20	0.229	-.0816059	.340261

Chivi	.1627915	.1043022	1.56	0.119	-.0416371	.3672202
Gutu	-.1798689	.1072994	-1.68	0.094	-.3901718	.030434
Masvingo Rural	-.0652723	.1284258	-0.51	0.611	-.3169823	.1864377
Mwezeni	.0548127	.1210022	0.45	0.651	-.1823473	.2919728
Zaka	.1999757	.1227571	1.63	0.103	-.0406238	.4405752
_cons	-.902368	.0818201	-11.03	0.000	-1.062732	-.7420036
/athrho	-1.222197	.1566326	-7.80	0.000	-1.529191	-.9152022
rho	-.8403009	.0460335			-.910286	-.7236198

LR test of indep. eqns. (rho = 0): chi2(1) = 63.05 Prob > chi2 = 0.0000

Appendix B: Testing for matching quality

```
. psmatch2 free_seed i.district, kernel k(biweight) out(pov_poor_low)

Probit regression                               Number of obs     =     13,373
                                                LR chi2(59)       =     787.69
                                                Prob > chi2       =     0.0000
Log likelihood = -5974.6297                     Pseudo R2         =     0.0618
```

free_seed	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
district						
Chimamimani	.3804176	.1120104	3.40	0.001	.1608813	.5999539
Chipinge	.131763	.1250818	1.05	0.292	-.1133928	.3769187
Makoni	-.3762216	.1188324	-3.17	0.002	-.6091288	-.1433143
Mutare Rural	-.2022103	.1177836	-1.72	0.086	-.4330619	.0286413
Mutasa	-.2824216	.155267	-1.82	0.069	-.5867393	.0218961
Nyanga	-.0658793	.1078704	-0.61	0.541	-.2773013	.1455428
Bindura Rural	-.3571501	.1436653	-2.49	0.013	-.6387288	-.0755714
Muzarabani	.3389855	.1722895	1.97	0.049	.0013043	.6766667
Guruve	-.4208418	.1476053	-2.85	0.004	-.7101428	-.1315407
Mazowe	-.3430246	.1651463	-2.08	0.038	-.6667054	-.0193439
Mountt Darwin	-.1531076	.1279126	-1.20	0.231	-.4038118	.0975965
Rushinga	.4217677	.1557743	2.71	0.007	.1164557	.7270797
Shamva	-.082883	.1289323	-0.64	0.520	-.3355856	.1698196
Mbire	.571804	.1574872	3.63	0.000	.2631348	.8804732
Chikomba	-.7688751	.1454194	-5.29	0.000	-1.053892	-.4838584
Goromonzi	-.2602387	.1536048	-1.69	0.090	-.5612987	.0408212
Hwedza	-.1910948	.1175536	-1.63	0.104	-.4214957	.0393061
Marondera	-1.749832	.3533135	-4.95	0.000	-2.442313	-1.05735
Madzi	.3270921	.117649	2.78	0.005	.0965043	.5576799
Murehwa	-.2355035	.1838664	-1.28	0.200	-.595875	.124868
Mutoko	-.5311849	.1090304	-4.87	0.000	-.7448804	-.3174893
Seke	-.4096501	.1265805	-3.24	0.001	-.6577434	-.1615569
UMP	.0253648	.1211068	0.21	0.834	-.2120001	.2627298
Chegutu Rural	-.6320974	.1501962	-4.21	0.000	-.9264765	-.3377183
Hurungwe	-.2694054	.1509016	-1.79	0.074	-.5651671	.0263562
Mhondoro-Ngezi	-.0045187	.1187045	-0.04	0.970	-.2371753	.2281379
Kariba	.4567697	.1994246	2.29	0.022	.0659048	.8476347
Makonde	-.3785953	.1264507	-2.99	0.003	-.626434	-.1307565
Zwinba	-.1249311	.1376137	-0.91	0.364	-.394649	.1447867
Sanyati	-.6080361	.1993549	-3.05	0.002	-.9987647	-.2173076
Binga	.0656499	.2156261	0.30	0.761	-.3569695	.4882694
Bubi	-.3587371	.1726104	-2.08	0.038	-.6970472	-.020427
Hwange Rural	.7268337	.2174448	3.34	0.001	.3006496	1.153018
Lupane	-.0912035	.1533601	-0.59	0.552	-.3917838	.2093768
Nkayi	.1529485	.166082	0.92	0.357	-.1725662	.4784631
Tsholotsho	.4395019	.154972	2.84	0.005	.1357623	.7432415
Umguza	.4086337	.1408665	2.90	0.004	.1325404	.6847271
Beitbridge Rural	.584538	.1746314	3.35	0.001	.2422668	.9268092
Bulilima	.1438223	.1392112	1.03	0.302	-.1290265	.4166712
Mangwe	1.0376	.1375086	7.55	0.000	.7680879	1.307112
Gwanda Rural	.6104473	.1286656	4.74	0.000	.3582673	.8626273
Insiza	.211017	.1154244	1.83	0.068	-.0152106	.4372446
Matobo	.3258285	.1465481	2.22	0.026	.0385995	.6130576
Umzingwane	.2469661	.1182482	2.09	0.037	.0152039	.4787282
Chirumhanzu	.045454	.1292531	0.35	0.725	-.2078775	.2987855
Gokwe North	.1890448	.1838335	1.03	0.304	-.1712622	.5493519
Gokwe South	.0829308	.1430972	0.58	0.562	[illegible]	.3633962

Gokwe South	.0829308	.1430972	0.58	0.562	-.1975345	.3633962
Gweru Rural	-.2978543	.3396046	-0.88	0.380	-.9634671	.3677584
Kwekwe Rural	-.3863993	.1712884	-2.26	0.024	-.7221185	-.0506802
Mberengwa	-.606457	.1706321	-3.55	0.000	-.9408897	-.2720242
Shurugwi	-.5757345	.1468606	-3.92	0.000	-.863576	-.2878929
Zvishavane	-.0709617	.1347243	-0.53	0.598	-.3350164	.193093
Bikita	.2479097	.1176182	2.11	0.035	.0173823	.478437
Chiredzi	.1245817	.1164993	1.07	0.285	-.1037526	.3529161
Chivi	.1500667	.1118874	1.34	0.180	-.0692286	.369362
Gutu	-.2047536	.1156343	-1.77	0.077	-.4313927	.0218854
Masvingo Rural	-.2019774	.1420537	-1.42	0.155	-.4803975	.0764427
Mwezeni	-.0096175	.1326238	-0.07	0.942	-.2695553	.2503203
Zaka	.0071277	.136013	0.05	0.958	-.2594529	.2737082
_cons	-.852495	.0882399	-9.66	0.000	-1.025442	-.679548

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
pov_poor_low	Unmatched	.599591837	.577497025	.022094812	.011026654	2.00
	ATT	.599591837	.581647066	.017944771	.011425021	1.57

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.062	787.69	0.000	6.5	5.5	62.9*	0.81	.
Matched	0.001	6.50	1.000	0.6	0.3	7.3	1.31	.

* if B>25%, R outside [0.5; 2]

```
. psmatch2 free_seed hhsize pov_malehd mincome pov_hdactivity pov_hdsecondary plot_size nat_r
> eg resettlement_area pov_hdlevel pov_hdprimary pov_ny_child irrigation, kernel k(biweight)
> out(pov_poor_low)

Probit regression                               Number of obs     =     13,301
                                                LR chi2(12)       =     345.94
                                                Prob > chi2       =     0.0000
Log likelihood = -6162.9951                     Pseudo R2         =     0.0273

------------------------------------------------------------------------------------
          free_seed |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------------+---------------------------------------------------------------
             hhsize |  -.0198294   .0071251    -2.78   0.005    -.0337942   -.0058645
         pov_malehd |   -.155927   .0279089    -5.59   0.000    -.2106274   -.1012266
            mincome |   .0000125   8.56e-06     1.47   0.143    -4.22e-06    .0000293
     pov_hdactivity |   .0182691   .0110479     1.65   0.098    -.0033845    .0399226
    pov_hdsecondary |  -.0881386   .0441221    -2.00   0.046    -.1746163   -.0016609
          plot_size |   .0166865   .0107463     1.55   0.120    -.0043759    .0377489
            nat_reg |   .1658798   .0124146    13.36   0.000     .1415477    .1902119
  resettlement_area |   .0155898   .0036028     4.33   0.000     .0085285     .022651
        pov_hdlevel |   -.037266   .0185601    -2.01   0.045    -.0736431   -.0008889
      pov_hdprimary |  -.1141557   .0405176    -2.82   0.005    -.1935687   -.0347426
       pov_ny_child |   .0140679   .0167993     0.84   0.402    -.0188583     .046994
         irrigation |  -.0403952   .0646055    -0.63   0.532    -.1670196    .0862292
              _cons |  -1.279165   .0884598   -14.46   0.000    -1.452543   -1.105787
------------------------------------------------------------------------------------

----------------------------------------------------------------------------------------
        Variable     Sample |    Treated     Controls   Difference         S.E.   T-stat
----------------------------+-----------------------------------------------------------
    pov_poor_low  Unmatched | .599671862     .5768204   .022851463   .011056231     2.07
                        ATT | .599671862    .55573922   .043932643   .011167647     3.93
----------------------------+-----------------------------------------------------------
Note: S.E. does not take into account that the propensity score is estimated.

           | psmatch2:
 psmatch2: |   Common
 Treatment |  support
assignment | On suppor |     Total
-----------+-----------+----------
 Untreated |    10,863 |    10,863
   Treated |     2,438 |     2,438
-----------+-----------+----------
     Total |    13,301 |    13,301
```

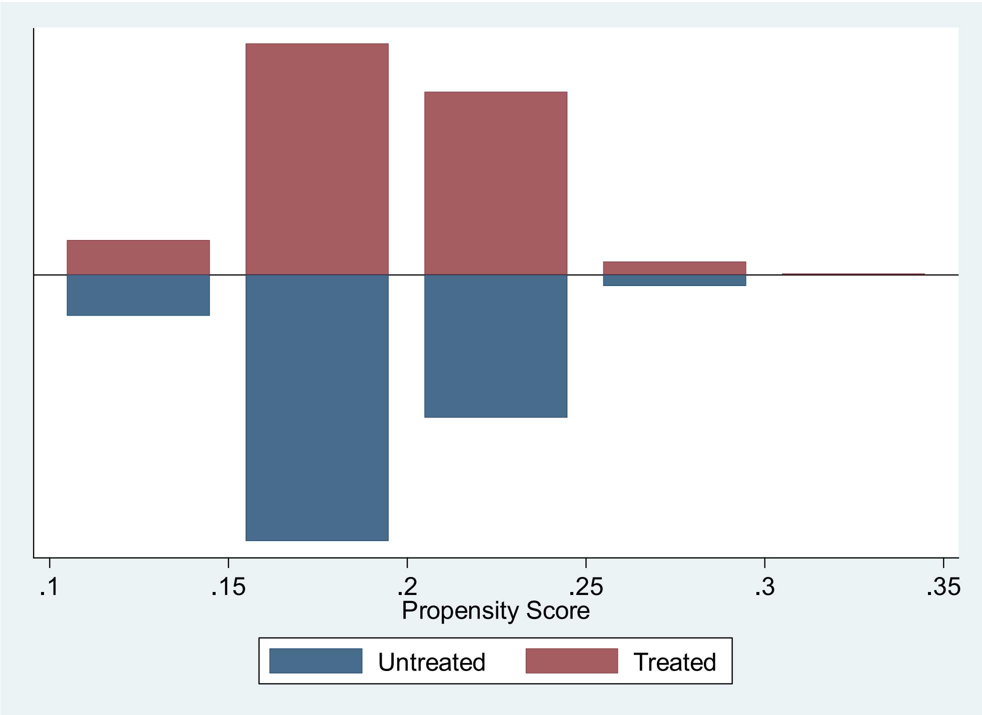
```
. pstest
```

Variable	Mean Treated	Mean Control	%bias	t-test t	t-test p>|t|	V(T)/V(C)
hhsize	4.8996	4.9547	-2.5	-0.89	0.375	0.98
pov_malehd	.56408	.59751	-6.9	-2.37	0.018	.
pov_hdsecondary	.36735	.38075	-2.8	-0.97	0.332	.
plot_size	.99612	.95835	3.0	1.06	0.289	1.23*
pov_hdprimary	.48857	.49802	-1.9	-0.66	0.509	.

* if variance ratio outside [0.92; 1.08]

Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
0.002	12.60	0.027	3.4	2.8	10.1	1.18	50

* if B>25%, R outside [0.5; 2]



```
. pstest, both
```

Variable	Unmatched Matched	Mean Treated	Mean Control	%bias	%reduct |bias|	t-test t	t-test p>|t|	V(T)/ V(C)
hhsize	U	4.8996	5.0546	-7.1		-3.15	0.002	0.96
	M	4.8996	4.9547	-2.5	64.5	-0.89	0.375	0.98
pov_malehd	U	.56408	.65339	-18.4		-8.33	0.000	.
	M	.56408	.59751	-6.9	62.6	-2.37	0.018	.
pov_hdsecondary	U	.36735	.40401	-7.5		-3.35	0.001	.
	M	.36735	.38075	-2.8	63.4	-0.97	0.332	.
plot_size	U	.99612	.93313	5.1		2.35	0.019	1.25*
	M	.99612	.95835	3.0	40.0	1.06	0.289	1.23*
pov_hdprimary	U	.48857	.4799	1.7		0.78	0.438	.
	M	.48857	.49802	-1.9	-9.0	-0.66	0.509	.

* if variance ratio outside [0.92; 1.08] for U and [0.92; 1.08] for M

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.007	87.83	0.000	8.0	7.1	21.0	1.07	50
Matched	0.002	12.60	0.027	3.4	2.8	10.1	1.18	50

* if B>25%, R outside [0.5; 2]

Zimbabwe Economic Policy Analysis and Research

55 Mull Road, Belvedere, Harare, Zimbabwe

P. O. Box CY 244

Causeway, Harare

Tel: +263 242 778 423 / 785 926/7

Fax: +263 242 778 415

Email: administration@zeparu.co.zw

www.zeparu.co.zw