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POVERTY ANALYSIS IN ZIMBABWE

EDITED BY

EDMORE MAHEMBE

and

GODFREY KANYENZE

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Information: zje.editor@gmail.com>

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CONTENTS

Contributors Biographies

Alex Bara is an economist with more than 15 years of experience in finance, banking, research and policy analysis. Currently, he is engaged to drive Group Research, Planning and Special Projects at a local financial services group. Has taught at a number of local universities at Master's level. He is a research supervisor and examiner for Master's programmes at local and international universities. He has a PhD in Economics from Nelson Mandela University, an MSc in Development Economics from the University of Oslo, and an MBA and BSc Economics from the University of Zimbabwe.

Miracle Benhura (n**é**e Ntuli) holds a PhD, MSc and BSc in Economics. She is an Associate Professor in the School of Economics and Finance at the University of the Witwatersrand, and a Research Fellow at the Institute of Labour Economics in Germany. At the regional level, she is a resource person who helps with capacity building at the African Economic Research Consortium. Her research interests are in labour and development economics with a particular focus on gender inequalities and vulnerable populations in Africa.

Nigel M.K. Chanakira began his career as an assistant economist at the Reserve Bank of Zimbabwe, after which he was an investment analyst and fund manager at Bard Discount House Ltd, where he was appointed a director at the age of 24. He is best known for his involvement in setting up Kingdom Securities Ltd with his partners in 1994. Nigel is affiliated with the Young Global Leaders of the World Economic Forum (WEF), of which he is an alumnus. He is the Founding Curator and active member since 2012 of the Global Shapers hubs of WEF in Zimbabwe, and is a former President of the Zimbabwe Economics Society.

Grown Chirongwe holds a BSc and MSc in Economics from the University of Zimbabwe. He has worked for the Central Statistical Office, Commercial Bank of Zimbabwe, National Discount House of Zimbabwe and is currently with the Zimbabwe National Statistics Agency, where he compiles national accounts, finance statistics and balance of payments statistics. He has also been involved in poverty data analysis, writing PICES reports and poverty mapping.

Arnold Mabasa Damba holds an MA in Economics Policy Management from the University of Zambia, and a BComm in Economics from Midlands State University. He worked for 12 years as a Chief Statistician with the Zimbabwe National Statistics Agency, and was a technical member of Zimbabwe Vulnerability Assessment Committee which conducts livelihoods assessment in urban and rural areas. Currently he is working as a private consultant in the field of social economics and statistics.

Tendai Gwatidzo is an Associate Professor at the University of the Witwatersrand. He holds a PhD in Economics from that university, an MA in Economics from Oslo University and a BA in Economics from the University of Zimbabwe. Tendai previously worked for

the ILO's Southern Africa Multidisciplinary Advisory Team in Zimbabwe. His research interests include applied microeconomics, access to finance, banking sector competition and efficiency, economy-wide modeling, social protection, financial economics, impact evaluation and development economics.

Farai Jena is a Senior Lecturer in Economics at the University of Sussex. Her research focuses on the economics of migration and remittances, poverty and welfare, and determinants of health, educational and food security outcomes in developing contexts. She holds a BA in Economics and Mathematics from Mount Holyoke College, and MSc and PhD degrees in economics from the University of Sussex, and has several years of undergraduate and postgraduate level teaching and research supervision in statistics, econometrics, and various applied development economics topics.

Godfrey Kanyenze the Director of the Labour and Economic Development Research Institute of Zimbabwe, before which he was an economist with the Zimbabwe Congress of Trade Unions and a statistician with the Central Statistical Office. He currently serves as Chairman of the Poverty Reduction Forum Trust and is a member of the Technical Committee of the Tripartite Negotiating Forum. He received his BSc in Economics from the University of Zimbabwe, his MA from the University of Kent at Canterbury, and completed his PhD in Development Studies at IDS, University of Sussex.

Edmore Mahembe is a Council member of the Zimbabwe Economics Society and Editor of the Zimbabwe Journal of Economics. He holds BComm and BSc degrees from the Universities of Pretoria and Zimbabwe respectively, and MComm and PhD degrees from the University of South Africa, His areas of research include development economics, panel data econometrics, poverty and economic growth.

Wellington J. Matsika holds BSc and MSc degrees in Economics from the University of Zimbabwe. He has more than 10 years of experience in socio-economic policy analysis and research. He was a Research Fellow at the Zimbabwe Economic Policy Analysis and Research Unit from 2012 to 2021, before moving to the African Wildlife Foundation where he currently works as a Policy and Partnerships Officer. Wellington has interests in macroeconomic policy, development policy, environmental economic accounting, wildlife economies and economy-wide modelling.

Fadzai Mhariwa holds a MSc in Fiscal Studies from the National University of Science and Technology, a BCom in Management and Economics from the University of Fort Hare, and is currently pursuing a PhD at Istanbul University. She has worked as a Principal Economist in Zimbabwe's Ministry of Finance and Economic Development. Her speciality is macroeconomic policy planning and coordination, as well as monitoring and evaluating the implementation of National Development Plans.

Tobias Mudzingwa holds an MSc in Renewable Energy from the University of Zimbabwe

and a BSc in Applied Physics from National University of Science and Technology. His 17 years working experience in the energy sector have involved electricity trading, power system operations, renewable energy, climate change, and energy policy. He is currently an engineer with the Zimbabwe Energy Regulatory Authority.

Malvern Mupandawana holds Master's and Bachelor's degrees in Agricultural Economics from the University of Zimbabwe, and an MS degree in Economics from the University of Kentucky. He has extensive experience in directing, managing and consulting on projects relating to agricultural development and health, and has been a lead consultant on several projects.

Tafadzwa Mupingashato holds a BComm from Midlands State University, an MComm from Great Zimbabwe University and is studying for a PhD in Economics at the University of the Witwatersrand. Tafadzwa teaches and conducts research in sub-disciplines of economics including international trade, capital flight, financial economics, applied econometrics, microeconomics, and macroeconomics at the IIE MSA.

Munjira Mutambwa is a Chief Systems Developer at Zimbabwe National Statistics Agency. His main focus is on poverty measurement and how it impacts on livelihoods and he was instrumental in the production of the first Zimbabwe Poverty Atlas in 2015. His other work centres on agriculture productivity, population census and household surveys and data analysis and anonymisation.

Vine Mutyasir holds a PhD in Agricultural and Natural Resource Economics from Colorado State University, and is a programme officer in policy quantitative modelling and data analytics at the Alliance for a Green Revolution in Africa. He is an agricultural economist with expertise in grant proposal development, project design, monitoring and evaluation, data analysis and report writing.

Pardon Njerere holds Master's degrees in International Trade Policy and Law, and Agricultural and Applied Economics. He is an experienced agricultural economist with a history of working in the food production industry. He has many years of experience in local and regional food and nutrition security, agricultural development, market analysis and climate change, and currently works as an investment and marketing expert at the African Union.

Handrea Njovo holds a Bachelor's Degree in Nutrition Sciences and a Master's in Public Health from the University of Zimbabwe. He has more than 16 years of experience in policy development and strategic planning for maternal, infant, and young child health and nutrition programmes from district up to the national level. He has also coordinated community-based assessments, surveys, and evaluations on nutrition and health.

Grace Nicholas Nkomo holds a BSc in Agri-Business from Solusi University and a

Master's Degree in Economics from Lund University, Sweden, and has more than 14 years of experience in agricultural sector planning, policy analysis and research, value chain analysis, agricultural trade policy and trade law and food security monitoring. She is an Acting Deputy Director, Monitoring and Evaluation with the Strategic Planning and Business Development Directorate in the Zimbabwe Ministry of Lands, Agriculture, Fisheries, Water and Rural Development.

Fortune Mazvita Nyajena is an economist with five years' experience of working on economic research papers. She is a freelance researcher with a strong interest in economic and social development issues.

Carren Pindiriri holds a BSc and PhD in Economics from the University of Zimbabwe and an MPhil in Environmental and Development Economics from the University of Oslo. He is a Senior Lecturer at the University of Zimbabwe, specialising in applied econometrics. His research interests include environmental and natural resource economics, development economics and agricultural economics.

Chenjerai Sisimayi holds a BSc in Statistics and an MSc in Clinical Epidemiology from the University of Zimbabwe, and is a PhD candidate with the University of Johannesburg. He is a Health Specialist with the World Bank and has had various consulting roles for the UN, bilateral agencies, NGOs, governments and the private sector with a focus on monitoring, evaluation, and research for public health initiatives. His professional interests include health financing, digital health and AI in health.

Thenjiwe Sisimayi holds a PhD in Public Health and an MSc in Clinical Epidemiology from the University of Zimbabwe, and has worked for 13 years in Health Systems Strengthening, Monitoring, Evaluation, Learning & Reporting, and Gender Equality with a cross-section of stakeholders, including children, women and young people in WASH, SRHR, Covid-19 and livelihood-related programmes.

FOREWORD

by the

PRESIDENT OF THE ZIMBABWE ECONOMICS SOCIETY

The Zimbabwe Journal of Economics **(ZJE)** is the flagship publication of the Zimbabwe Economics Society (ZES). It provides economists, academicians and those interested in economic development an exclusive forum for publishing their work on theoretical developments as well as empirical economic policy analysis. The journal covers the various fields of study in economics, including macro, micro, econometrics, financial, industrial, trade, infrastructure, human capital (education and health), agriculture, natural resources and the environment, public and institutional, labour, economic history, political economy, international trade and globalisation.

The ZJE is a peer reviewed journal which publishes original research and survey articles and book reviews on theoretical and empirical developments, as well as comparative economic analysis. It was originally published on a quarterly basis, however, since July 1984, it was produced semi-annually. Unfortunately, as ZES went into a hiatus, the ZJE ceased with v. 2, no. 1 (Jan. 1988). The revival of the ZJE was a top priority of the 2021/22 ZES Council, and is of particular significance given that since the last publication, the country has implemented far-reaching policy frameworks such as the Economic Structural Adjustment Programme (ESAP) (1991-96), has undergone a decade of crisis the so-called 'lost decade', 1997-2008, and the hyper-inflationary experience, adopted a multi-currency regime (2009-2019), reverting to a mono-currency (2019-2020), and the current dual currency system (2020-). In recent times, the economy has also experienced extreme weather patterns in the form of cyclones and droughts associated with climate change. Furthermore, the onset of COVID-19 since March 2020, and the measures implemented to mitigate its effects, including closure of borders, restricted movement and curfews, had a most profound impact on the economy.

The rapid removal of tariff protection during ESAP marked the beginning of a sustained process of de-industrialisation and informalisation. This trend was exacerbated by the fast-track land redistribution programme (FTLRP) that started in earnest in March 2000. As highlighted in the United Nations Development Programme's (UNDP) Comprehensive Economic Recovery Programme of 2008, the FTLRP had not taken into account the close linkages between agriculture and industry. The context was such that by the mid-1990s, over half the inputs into agriculture were supplied by the manufacturing sector, while 44% of agricultural output provided inputs into the manufacturing sector, 95% of which came from the commercial farming sector and the balance from small-scale communal farmers. As at the first quarter of 2022, 88% of total employment is informal.

While inflation had declined from a peak of 837.5% in July 2020 to 50.2% in August 2021, it has rebounded during the first half of 2022, reaching 256% by July. This upsurge was driven mainly by substantial exchange rate depreciation on both the official and parallel markets. The level of inequality as measured by the Gini-coefficient worsened from 0.45 in 2017 to 0.50 in April-May 2019, making the country among the most unequal in Sub-Saharan Africa. The population living in extreme poverty increased from 23% (3 million) in 2011 to 30% (4.6 million) in 2017, an estimated 42% (6.6 million) by end of 2019, and 49% (7.9 million people) by end of 2020.

However, due to the favourable weather conditions in 2020/21, and the attendant bumper harvest, easing of lockdown, and gradual resumption of economic activities, the extreme poverty rate declined to 43% in September-October 2021. Unfortunately, as highlighted by Zimbabwe National Statistics Agency (Zimstat) and the World Bank, only half of those living in extreme poverty were able to access at least one type of social protection intervention, including humanitarian assistance, in April/May 2019, and the amounts paid out were considered inadequate. Furthermore, the economy is in debt distress, with an external debt US$13.2 billion at end of June 2022..

On 31 January 2020, the Steering Committee of the Advanced Policy Focused-Poverty Analysis Project in Zimbabwe, a partnership between the Zimbabwe Economic Policy Analysis and Research Unit (ZEPARU) and the Zimbabwe Reconstruction Fund under the coordination of the World Bank, issued a call for research proposals to produce a series of high quality policy-focused papers on poverty related issues. The objective was to produce evidence-based policy papers that have clear policy messages, and influence the policy debate in the country. The call for research proposals was premised on the need to leverage the recently released anonymised Zimstat Poverty, Income, Consumption and Expenditure Survey (PICES) 2011/12, PICES 2017 and PICES/Agricultural Productivity Module (APM) 2017 data. The teams had to include one researcher, one ZIMSTAT staff, and one ministry staff.

On taking the work forward, the Technical Committee of the project agreed on a two-stage process for selecting the winning proposals involving issuing a Call for Concept Notes, followed by a request to the shortlisted writers to submit a full proposal. In response to the Call for Concept Notes, 60 applications had been received by the deadline of 7 March 2020. Out of the 60 applicants, 15 were selected for further development into full proposals. From the 11 full proposals submitted, seven were selected for funding on 5 May 2020. The research teams had to work under the guidance and mentorship of a Technical Committee of eight experts, with members of the latter assigned to each team on the basis of their expertise. The papers were peer reviewed by ZEPARU and the World Bank for purposes of quality assurance as well as strengthening the policy focus.

The seven policy papers that were finalised by January 2021 are as follows:

i. Do remittances and/or public transfers matter for agricultural investments and food security outcomes among rural households in Zimbabwe?
ii. Multi-dimensional poverty in Zimbabwe: A gender perspective
iii. Agricultural free input support schemes, input usage, food insecurity and poverty in rural Zimbabwe
iv. Energy and poverty: The efficacy of electricity subsidy in alleviating poverty in Zimbabwe
v. Remittances, consumption patterns and household investment: The case of Zimbabwe
vi. Assessing the multi-dimensional risk of stunting amongst children under five years in Zimbabwe
vii. Resilience capacity, food consumption and socio-economic status in Zimbabwe

Given that the main objective of the research papers is to influence the public debate and policy discussions in Zimbabwe, the ZES Council offered to use the relaunch of the ZJE as a platform to make them accessible to a broader audience. This is particularly important given that the papers provide advanced policy-focused poverty analysis in Zimbabwe, which is most relevant given the high levels of poverty in the country. As a result of the agreement with ZEPARU and the World Bank, the Editors approached the individual research teams, and six agreed to have their papers published under the revived ZJE.

The submitted papers underwent further editorial review and language editing before being published in this revived edition of the ZJE. On behalf of ZES, I would like to extend our gratitude and appreciation to ZEPARU and the World Bank for collaborating with us in availing these interesting scholarly and policy-oriented papers for wider readership, on the basis of which we are reviving the ZJE. It is therefore my pleasure and honour to submit this revived edition of the ZJE to you our valued members and all interested stakeholders. As ZES Council, we hope that the ZJE will henceforth be continuouly published on at least a bi-annual basis.

Nigel M.K .Chanakira
2021/22 ZES President

What is Poverty? Definition, Causes and Measurement of Poverty

Edmore Mahembe,

1 Introduction

In this inaugural issue of the Zimbabwe Journal of Economics (ZJE), a distant successor to the Rhodesian Journal of Economics (RJE) which started publishing in August 1967 and had its last issue in January 1988, the focus is on poverty in Zimbabwe. The word 'poverty' is commonly used, but there seems to be confusion about its meaning, the causes and how to measure the phenomenon. This introductory paper sets out to define poverty and traces the possible causes of poverty using a historical lens, highlights the main poverty measures, and concludes by profiling the poverty levels in Zimbabwe.

2 Definitions of poverty

When asked to define poverty, a poor man in Kenya said,

> Don't ask me what poverty is because you have met it outside my house. Look at the house and count the number of holes. Look at the utensils and the clothes I am wearing. Look at everything and write what you see. What you see is poverty (Todaro and Smith 2012:6).

Defining poverty in the South African context, Colin Bundy wrote:

> Poverty is material want, shabbiness, and squalor … clothes patched beyond repair; shoes literally down-at-heel; bedding stained and worn thin; furniture and fittings that sigh with exhaustion … housing without basic amenities, comforts or security that home life is supposed to afford (Bundy 2016:7).

A blind and poor woman in Moldova explained her experience of poverty, saying,

> For a poor person, everything is terrible – illness, humiliation, shame. We are

> cripples; we are afraid of everything; we depend on everyone. No one needs us. We are like garbage that everyone wants to get rid of (Todaro and Smith 2012:6).

From these three definitions, based on poverty experience, one can conclude that poor people suffer from undernutrition and poor health, have little or no literacy, live in environmentally degraded areas, hardly have any political voice, are excluded socially and economically, and earn meagre incomes. However, these definitions are too general and make poverty challenging to measure, thereby making it difficult to track progress in the fight against poverty.

The World Bank (1990:26) defines poverty as the inability to attain a minimal standard of living. Todaro and Smith (2012:2) qualify poverty and define 'absolute poverty' as 'a situation of being unable to meet the minimum levels of income, food, clothing, healthcare, shelter, and other essentials'. Most governments and development organisations tend to use this World Bank definition.

3 Causes of poverty

For centuries, various theories have been developed in attempts to explain the main causes of poverty. Depending on the understanding or assumed causes of poverty during those successive years, different policies and programmes were enacted to solve the problem of poverty.

According to Ravallion (2016:4), one of the earlier and influential schools of thought is that the (poor) individuals are responsible for their own poverty through substandard choices or negative behaviour. Poverty was thus attributed to the poor people themselves, who were deemed to be lazy, not hard-working enough, imprudent, or reluctant to take risks. Some variations of this theory attributed the cause of poverty to low intelligence and genetic issues of the poor. However, Ravallion (2016:4) argues that blaming poor people for their predicament has long afforded an excuse for public inaction against poverty. The argument then was that directly helping the poor would be counterproductive as it would encourage 'bad behaviour'. The solutions to combat poverty, based on this 'bad behaviour' theory, included initiatives to issue money to the working poor in the form of an earned income tax credit (EITC) as a way of motivating them to work. To address issues of lower intelligence or lower education, development strategies were formulated to help the poor to improve their education (Lipton and Ravallion 1993).

Another school of thought is that poverty is caused by cultural belief systems that support sub-cultures of poverty. This thinking is mainly attributed to Lewis (1959), an anthropologist who coined the term 'culture of poverty'. This theory postulates that a set of beliefs, values, and skills that are socially created but individually held can create poverty. According to Lewis (1998:7), 'people in the culture of poverty have a strong feeling of marginality, of

helplessness, of dependency, of not belonging. They are like aliens in their own country, convinced that the existing institutions do not serve their interests and needs.' People in a certain community, suburb, or region can thus hold the same 'culture of poverty' and pass it on to future generations. The solution would be to focus on cultural education programmes or individual families moving out of that neighbourhood.

An understanding of poverty based on these first two theories would lead to four approaches to poverty: acceptance, palliation, insurance, or theft (Lipton and Ravallion 1993:3). Poverty was accepted based on the belief that it was an unhappy way of life. Those who decided to act against poverty chose the palliative route, whereby the private sector, a charity, or Christians helped through almsgiving which was regarded as a religious duty. Chiefs or landlords collected some insurance fee in the form of grain or labour from the poor in return for military protection. Lastly, in the absence of palliation or insurance, theft was an ethically accepted cure for life-threatening poverty (ibid.).

The third theory of poverty is attributed to Juan Luis Vives (1492-1540),[1] who argued that poverty is caused by cumulative and cyclical interdependencies, and that poverty would generate costs for non-poor as well (Ravallion 2016). These costs include crime, disease, or the problem of having too many beggars (ibid.:4). Based on this argument and understanding, the rich and those in leadership positions began to establish anti-poverty policies.

Recent theories of poverty maintain that it is caused by economic, political, and social distortions or discriminations. The World Bank (2000:4) argued that one of the ways in which to explore the causes of poverty is to probe the dimensions highlighted by the poor themselves. These include (i) a lack of income and assets to attain basic necessities; (ii) a sense of voicelessness and powerlessness in the institutions of state and society; and (iii) vulnerability to adverse shocks linked to an inability to cope with them. An understanding now exists that the poor face some socio-economic constraints which limit them from accessing opportunities to improve their well-being. As a result of these constraints, the poor are excluded from the formal economy, institutions of support, markets and services from the government (Ravallion, 2016). This new thinking has placed the goal of poverty reduction at the core of international development and public policy. Domestically, governments are now increasingly measured on their effectiveness in eliminating poverty.

4. Measurement of Poverty

4.1 Basic approaches to measuring the prevalence of poverty

Lok-Dessallien (1999:1) states that the way in which poverty is measured reveals the fundamental assumptions made about the nature and causes of poverty. There are three basic approaches to measuring the prevalence of poverty in a household, community, country or

1 Juan Luis Vives is regarded as the founding father of modern psychology (Ravallion, 2016).

region. The first is termed the income or expenditure method, which is mainly based on the human basic needs approach (BNA). The BNA sets minimum absolute standards of (primarily material) needs in a number of measurable dimensions (Clunies-Ross et al. 2009:251). It is a consumption-oriented approach as it predominantly focuses on the minimum requirements for a decent life, such as health, nutrition and literacy. In this approach, poverty is defined as a lack of income or of consumption (Deaton 2006:9), and assumes that individuals or a group of people are poor if their income or consumption is below a particular level, usually defined as a minimum threshold or a 'poverty line'. Clunies-Ross et al. (2009:251) argue that the MDGs were developed using the BNA by listing the 'needs' that had to be met. The BNA leads to several poverty indicators, commonly referred to as monetary measures of poverty such as per capita gross national product (GNP), headcount index, poverty gap index (PG) and SPG.

The second method is called the human capabilities approach (CA) and is centred on the pioneering work of Amartya Sen during the 1980s and 1990s. This approach defines poverty as the absence of basic human capabilities to function at a minimally acceptable level within a society (Lok-Dessallien 1999:11, Deaton 2006:10). The CA looks at improving people's well-being by expanding their 'capabilities' so that they can look after themselves. The CA notion hypothesises that poverty is a result of a lack of capability to 'function' or to 'achieve' well-being (Wagle 2005:302). Well-being is defined as the 'ends', while capability is defined as the 'means' to achieve them (UNDP 2000).

The CA to poverty measurement tries to measure poverty by looking at poverty outcomes or 'ends', such as individuals' abilities and opportunities to live long, healthy, and enjoyable lives; to be literate; and to have the freedom to pursue what they value (Sen 1981, 1992 and 1999, Clunies-Ross et al. 2009). Based on this definition, it can be argued that the CA is a more comprehensive approach to poverty measurement compared to the BNA, as it places poverty within the broader context of human development (Lok-Dessallien 1999:11). The majority of the CA poverty indicators include non-monetary poverty measures or social indicators such as life expectancy, literacy rates, and malnutrition.

The third approach is a hybrid method, which recognises that poverty is a multidimensional phenomenon. There has been a realisation that even though income-based measures are simple and widely used, employing these types of measures alone would lead to the neglect of important features of poverty (Deaton 2006). Furthermore, Schaffner (2014:85) highlights that the choice between income and non-income measures has an effect on policy goals. As such, goals for reducing income poverty are not necessarily the same as those for reducing mortality rates, for example.

4.2 Non-monetary measures of poverty

As argued above, the human capability approach places emphasis on people's abilities and opportunities to enjoy long, healthy lives and to be literate and participate freely in

their society. Therefore, the poverty indicators under the CA would include, inter alia, life expectancy, literacy rates, and malnutrition. These indicators can be described as measures of well-being in terms of final outcomes, and they are normally collected by national statistical agencies. However, the main disadvantage of these indicators is that no perfect aggregates exist for some of them. Some are group measures and cannot be used to gauge household or individual well-being (e.g. life expectancy). Furthermore, some of the indicators are stock variables, which change slowly over time, thereby limiting their usefulness for short- and medium-term poverty monitoring (Lok-Dessallien 1999:12).

The second group of poverty indicators can be referred to as multidimensional poverty estimates, indices, or composite measures. It can be argued that the HDI of the UNDP is a combination of both the basic needs and the capacities approach. It is a mixed measure of three dimensions of human development, namely (i) a long and healthy life, as measured by life expectancy at birth; (ii) education or knowledge, measured by adult literacy and the gross enrolment ratio for primary, secondary, and tertiary institutions; and (iii) a decent living standard, which is proxied by the gross domestic product (GDP) per capita in PPP in U.S. dollars (UNDP 2005:214).

Another example is the Human Poverty Index (HPI) which was developed by the UNDP as a complementary measure to the HDI (UNPD 1997). The HPI combines basic dimensions of poverty, and the variables used are longevity (percentage of the people expected to die before age 40), adult illiteracy, access to health services and to safe water, and under five malnutrition rates (ibid.:14, Lok-Dessallien 1999:8). In 2010, the UNDP replaced the HPI with its new Multidimensional Poverty Index (MPI). This identifies the poor using dual cut-offs for levels and numbers of deprivations and then multiplies the percentage of people living in poverty by the percentage of weighted indicators for which poor households are deprived (Todaro and Smith 2012:215). The MPI uses a range of health, education and standard of living indicators, which are considered as important direct household indicators of deprivation (ibid.).

4.3 Monetary measures of poverty

As discussed above, the monetary measures, sometimes referred to as income or consumption measures, can also be regarded as an indirect way of measuring poverty (Alkire and Santos 2014). The income method has been implemented in official poverty measures for most countries of the world, and its indicators include per capita GNP, headcount index, PG, and SPG. Lok-Dessallien (1999) argues that per capita GNP is too gross and misleading, and that per capita personal income is therefore a better aggregate income indicator.

The World Bank (2000:16) traces the history of the monetary or income measures of poverty to Seebohm Rowntree's classic study of poverty in the English city of York in 1899. Deaton (2010:5), however, traces the recent World Bank poverty indicators to the work of Ahluwalia et al. (1979). The actual calculations of the international poverty indicators in

the World Development Report 1990 (World Bank 1990) are based on the research for that report which was later documented by Ravallion et al. (1991).[2] These poverty measures are founded on the international poverty line, popularly known as the 'dollar-a-day poverty line'. This was incorporated into international poverty discussions and policymaking through the promulgation of the MDGs (World Bank 1990, Ravallion et al. 1991, Ravallion et al. 2009, Deaton 2010). The first goal of the MDGs was to 'halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day' (Clunies-Ross et al. 2009:617, Deaton, 2010:5).

The international poverty line measures absolute or extreme poverty below which an individual is unable or barely able to meet the subsistence essentials of food, clothing, and shelter (Ravallion et al. 2009:163, Todaro and Smith, 2012:211). The development of this global poverty line occurred through three major steps: (i) collecting poverty lines (mainly based on national household income and expenditure surveys) from a group of developing countries, (ii) converting these poverty lines into international dollars using the PPP exchange rates from the International Comparison Project (ICP), and then (iii) estimating the international poverty line (Ravallion et al. 1991 and 2009, Chen and Ravallion 2010). The main advantages of the international poverty line are that it is simple, transparent, and easier to use when comparing poverty levels across countries and regions (Deaton 2010:5). However, it faces criticism based on disparities in survey designs, the reliability of the PPP, given economic disparities, and the actual calculation of the international poverty line, which was described by Deaton (ibid.:17) as a 'simple average' of poor countries' poverty lines.

Through successive revisions, the international poverty line of 'US$1 a day' was revised upwards to US$1.08, US$1.25, and recently US$1.90, based on new price surveys by the ICP. The current poverty measures from the World Bank's PovcalNet Online database[3] are updates of global poverty rates from 1981 to 2013 based on the 2011 PPP from the ICP. The new poverty estimates combine PPP exchange rates for household consumption with data from more than 1,000 household surveys across 138 countries in 6 regions and 21 other high-income countries. According to the World Bank (2016), over two million randomly sampled households were interviewed for the 2013 estimate, representing 87% of the population of the developing world.

Once the international poverty line has been determined, a class of poverty measures could be decomposed following the work of Foster et al. (1984), which is illustrated as follows:

$$P_{\propto} = \frac{1}{N}\sum_{i=1}^{N^p}\left(\frac{G_i}{Z}\right)^{\propto} \qquad [2.1]$$

2 See Ravallion et al. (2009) for more details.

3 See World Bank (2016).

where $\propto$ is the sensitivity of the index to poverty, or a measure of 'poverty aversion' (Foster et al. 1984:763); N^p represents the number of poor people; Z is the poverty level; and G_i is the poverty gap.[4] The three poverty measures used in this paper are the poverty headcount index, the PG, and the SPG (Schaffner 2014).

According to Alvi and Senbeta (2012:960) and Schaffner (2014), when $\alpha = 0$, the expression in Equation 2.1 corresponds to the headcount index; $\alpha = 1$ corresponds to the PG; and $\alpha = 2$ corresponds to the SPG. The headcount index or the poverty rate measures the proportion of households in a population with incomes per person below the poverty line. Therefore, it measures the prevalence of poverty in terms of its spread within the population. Although the headcount index is the most popular measure used by researchers, its main disadvantage is that it does not offer an indication of the depth of poverty (Schaffner 2014).

The PG measures this depth of poverty, and it considers the dispersal of the poor. It averages the proportional income gaps across everyone in the population against the poverty line. According to Schaffner, the PG can be understood as the cost per person for eliminating poverty in an entire country:

> The PG can be interpreted as the cost per person in the entire economy of eliminating poverty (if money could be targeted perfectly and costlessly), expressed as a share of the poverty line. A PG of 0.05, for example, indicates that bringing the incomes of the poor up to the poverty line would require a per capita expenditure of 5% of the poverty line (Schaffner 2014:89).

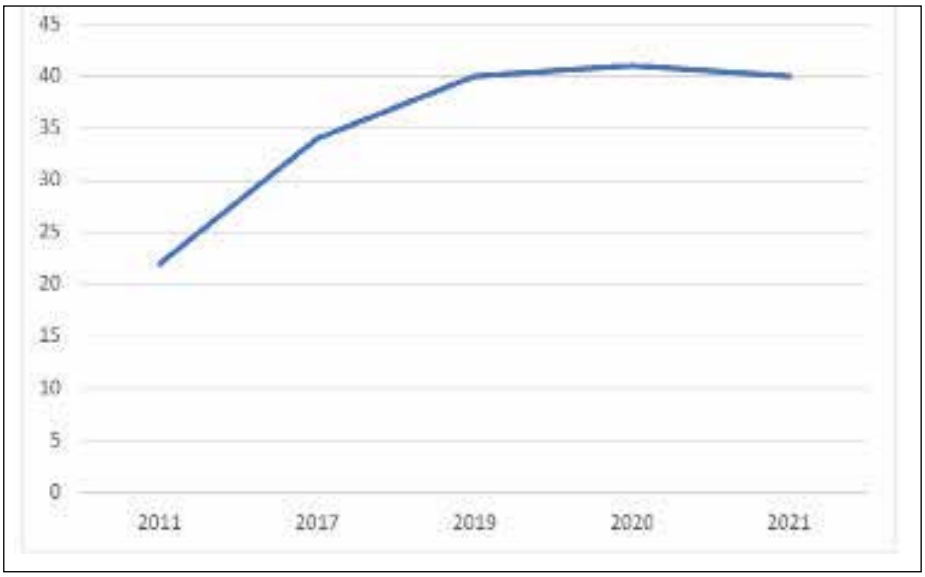
The SPG, on the other hand, is sensitive to both global prevalence and the average depth of poverty, as well as the occurrence of deep poverty among the poor. Given its wider reach, the index is also referred to as the poverty severity index. It is argued that the squaring of the poverty gap or shortfall magnifies 'the contribution to the overall measure of the income deficits experienced by those in deepest poverty' (Schaffner 2014:89, Alvi and Senbeta 2012).

5. Poverty in Zimbabwe

World Bank (2022) statistics show that extreme poverty rates increased sharply between 2011 and 2020. The proportion of people living on less than US$1.90 per day increased from around 22% in 2011 to 40% in 2019 and steadily rose 41% in 2021 before marginally decreasing to 40% in 2022 (see Figure 1). Inequality has also been increasing over the past decade, with the Gini coefficient increasing from 42 in 2011 to 50.3 in 2019, which is now among the highest in the world (World Bank 2022).

4 According to Alvi and Senbeta (2012), Gi = Z − Xi, where Xi is the per capita income and N is the population size.

Figure 1: Zimbabwe's poverty rate at $1.90 a day (2011 PPP) (% population)



Source: World Bank (2022)

UNICEF Zimbabwe (2021) analysed child poverty in Zimbabwe using the Multiple Overlapping Deprivation Analysis (MODA) methodology and found that an estimated 60.7 per cent of all children in Zimbabwe were multidimensionally poor in 2019. Multidimensional child poverty was also found to be significantly higher in rural areas than in urban areas (69.2% and 37.6%, respectively) and the province with highest rate of multidimensional child poverty (73.4%) was Matabeleland North.

The World Bank (2022) attributes the increase in poverty levels to the two decades of economic crisis, poor rains and natural disasters such as cyclone Idai, high levels of unemployment, limited and low coverage of social security or assistance programmes, and recent economic closures and restrictions due to Covid-19, which continue to affect employment, incomes, and livelihoods of urban residents.

6. Conclusion

Our understanding on what is poverty, and its possible causes, has evolved over the years, and the response from government authorities has been dependent on this understanding. From this discussion, it can be argued that poverty is man-made, and that the poor face socio-economic constraints which hinder them from accessing opportunities to improve their well-being. Therefore, poverty reduction should be a principal goal of governments and international development agencies, and they should be measured on their effectiveness in addressing it.

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Do remittances and/or public transfers matter for agricultural investments and food security outcomes among rural households in Zimbabwe?

Farai Jena, Vine Mutyasira,
Pardon Njerere, Munjira Mutambwa

Abstract

This study investigates whether private transfers, specifically, migrant remittances, and public transfers, matter for agricultural and food security outcomes of rural households in Zimbabwe, using descriptive statistical methodologies on a recent household survey. The findings reveal agriculture-related public transfers have a positive association with crop diversification. There is also a notable positive association between agriculture-related public transfers and the use of modern agricultural inputs, particularly inorganic fertilizer and improved/hybrid seed. The results show that food-related public transfers are rightly channelled towards the poorest households. Also, households headed by men are more likely to diversify crop production, use modern agricultural inputs, and own livestock of higher value, relative to female-headed households. International migrant remittances are found to not have any statistically significant relationship with the agricultural outcomes of rural households, perhaps owing to the small number of households receiving them. Domestic remittances are shown to have a negative association with crop diversification but a positive association with the use of modern agricultural inputs, particularly inorganic fertilizer and herbicides. Thus, domestic remittances seem to have an opposing effect to public transfers when it comes to crop production, but complement public transfers when it comes to input use. On average, the results suggest no relationship between the receipt of public transfers or remittances and the dietary diversity of households, highlighting the need to further explore how better nutritional outcomes can be achieved in rural Zimbabwe.

Key words:

Remittances; public transfers; agricultural investments; food security

1. Introduction

The agricultural sector in Zimbabwe is dominated by smallholder farming which is regarded as a key driver of pro-poor economic growth and sustainable development, poverty reduction, employment creation, and food and nutrition security (FAO 2016). The Transitional Stabilisation Programme (GoZ 2018a) highlights that the contribution of agriculture to Zimbabwe's GDP is anticipated to grow from 12.4% to 16.4% between 2018 and 2020 due to strategic and innovative policy and practice interventions under the banner of 'Smart Agriculture'. This growth sets the right pathway for a positive economic and food security outlook given the poor performance of the Zimbabwean agricultural sector in recent years (AfDB 2019). Various constraints have inhibited this performance, including limited access by rural households to agricultural finance, and consequently quality inputs and modern technology. Food security thus remains a policy concern. The African Development Bank (2019) postulates that putting in place mechanisms that improve access to finance by smallholder farmers has a multiplier effect on increased crop input use, adoption of agriculture technologies, and crop diversification.

Following a prolonged liquidity crisis in Zimbabwe, financial flows towards agricultural growth have weakened, resulting in low agricultural production and high food insecurity. Thus, the government has directed its policy towards improving access to agricultural finance under the Transitional Stabilisation Programme and new National Agricultural Policy Framework (2018-2030) (Go Z 2018b) which identify public, private and diaspora remittances as key funding sources to support the growth of the agricultural sector. Key programmes under public support include Command Agriculture and the Presidential Input Support Programme. On the other hand, private funding has focused on commercial bank financing and contract farming.

Migrant remittances have also contributed significantly towards agriculture development in Zimbabwe. Remittances are generally acknowledged to contribute significantly to poverty alleviation in recipient countries (Bracking and Sachikonye 2006, 2010), and have become Zimbabwe's second largest source of national income after exports of goods and services. However, there is limited consensus on the exact relationship between remittances, agricultural outcomes, and food security.

Against this backdrop, this study analyses the contribution of remittances and public transfers in promoting household agricultural and food security outcomes in Zimbabwe. The research considers whether migrant remittances and public transfers matter for: (i) agricultural input use, (ii) crop diversification/specialisation, and (iii) the value of livestock owned. The research also explores remittance receipts, public transfers, and the food security of rural households using dietary diversity scores and the share of the household budget allocated towards food as proxies for food security.

The findings of the research suggest that public transfers correlate positively with input

use. In particular, agriculture-related public transfers have a strong and positive correlation with inorganic fertilizer use and improved/hybrid seed use. Agriculture-related public transfers also have a strong and positive correlation with crop diversification. On the other hand, food-related public transfers have a negative correlation with crop diversification. Food-related public transfers are also shown to be received by the poorest households, those with a large share of their expenditure allocated to food consumption. This is in contrast to remittances from abroad which are seen to be received by richer households. Domestic remittances are shown to have a negative association with crop diversification but a positive association with modern input use, particularly inorganic fertilizer and herbicides.

The paper proceeds as follows: Section II lays out the theoretical framework and provides a brief review of the literature. Section III presents and briefly discusses the data and summary statistics for the key variables used in the econometric analysis. In section IV the econometric methodologies used to undertake the analysis are discussed. Section V presents and discusses the empirical results. Finally, Section VI provides some concluding remarks and policy recommendations.

2. Theoretical framework and literature review

Several theories have been postulated to create a framework for understanding the effects of migration and remittances on smallholder agricultural households. Most of these have attempted to model how losses in labour and the impact on agricultural productivity can be partly offset by remittance income from the migrant members of the rural households. Our theoretical framework is based on the New Economics of Labor Migration (NELM) (Stark and Bloom 1985, Taylor 1999) which helps decode the complex relationship between migration, remittances and their impact on rural households. The NELM considers migration to be a household decision used strategically to diversify income. Thus, incentives and the consequences of migration are interlinked (Taylor and Martin 2001). Remittances received by rural farming communities can help alleviate credit constraints (Rozelle et al. 1999), but increased out-migration can potentially exacerbate labour constraints, especially when production systems are not mechanized. We use the NELM theoretical framework to capture how remittances potentially shape smallholder farmers' agricultural decisions.

Various empirical studies have examined the effects of remittances on agricultural productivity. There is evidence that remittances promote agricultural asset accumulation and general investments in production (Böhme 2015, Damon 2010) thereby enhancing agricultural productivity. However, other studies observe that migration can result in falling productivity (Damon 2010, Rozelle et al. 1999, Sauer et al. 2015). This is because it may be difficult to replace experienced household labour, especially when farm labour markets are missing or incomplete. Also, households may attempt to cope with the labour losses by shifting from labour-intensive commercial cash crops to subsistence food crops

(Böhme 2015). However, the negative effects of migration on productivity can be offset by the increased liquidity provided by remittances (Kapri and Ghimire 2020). In this study we investigate how remittances affect input use, livestock accumulation, production diversification, and food security outcomes.

Our study makes a distinction between public and private transfers and examines whether the source of income matters for agricultural and food security outcomes. Public support in the form of agricultural input subsidies has regained popularity among policymakers in many African countries (Holden 2018). A recent study found that the spending on input subsidy programmes in ten African countries ranges from $0.6 to $1.0 billion per year or 14% to 26% of public expenditure on agriculture (Jayne et al. 2018). Other public transfers not specifically tied to agriculture may also impact agricultural outcomes and food security. For example, income transfers to poor households may promote short-term food security (Gilligan and Hoddinott 2007). However, some researchers argue that transfers targeted towards agriculturally productive investments may prove to be more effective than general income transfers (Hoddinott et al. 2012). For instance, it could be argued that public support for investments in agriculture may have greater potential benefits than income transfers by more effectively addressing the root causes of food insecurity (ibid.). Thus, when designing social protection programmes there may be trade-offs between those that address short-term food security needs and longer-term sustainable food security improvements.

3. Data and summary statistics

The data used come from the 2017 Poverty, Income, Consumption and Expenditure Survey (PICES), including the pre- and post-harvest Agricultural Productivity Module (APM). The unit of observation is the household and we restrict the analysis to the sample of households located in rural areas and that feature in both PICES and APM datasets. Our agricultural outcome variables of interest are:

Crop diversity/specialisation

Three indicators are used to measure crop diversity: crop count; Simpson index (SI); Entropy index (EI). Crop count is simply a count of the number of crops that were grown by the household. The SI is computed as , $1 - \sum P_i^2$, where $P_i = \frac{A_i}{\sum A_i}$ is the proportion of the the activity in acreage. If SI is near zero it indicates that the zone or region is near to specialisation in the growing of a particular crop, and if it is close to one, then the zone has full crop diversity. The EI is a direct measure of diversification having a logarithmic character and is given by:, $\sum_{i=1}^{N} P_i * \log(\frac{1}{P_i})$, where P_i represents the acreage proportion of the th crop in total cropped area. The EI increases with diversification. It approaches zero when the farm is specialised and equals one (perfect specialisation) and takes a maximum value when there is perfect diversification.

Input use in agriculture

Five dummy variables are used to capture input use. The inputs captured are organic fertilizer, inorganic fertilizer, herbicide, pesticide, and improved/hybrid seed use. These assume a value of 1 if the input was used, and 0 otherwise.

Value of livestock owned

This dependent variable represents the self-reported value of livestock owned by the household in US dollars.

Our two food security outcome variables are:

Dietary Diversity Score

The dietary diversity score of the household is created using FAO (2010) guidelines and ranges from 0 to 12. It is a sum of scores for the consumption of 12 categories of food that constitute the food pyramid. Table 1 lists the 12 food categories and the proportion of households who report having consumed any of the food from each category in the seven days prior to the survey. A score of one is assigned if a household has consumed food from a certain food group, and zero otherwise. The dietary diversity score is computed by adding up the scores across all the food categories. Thus, a household which only consumed staple starch and vegetables over the seven-day period is assigned a score of 2 out of 12. Figure 1 provides a histogram for the dietary diversity score.

Table 1: Proportion of Households Consuming Food Group in Past Seven Days

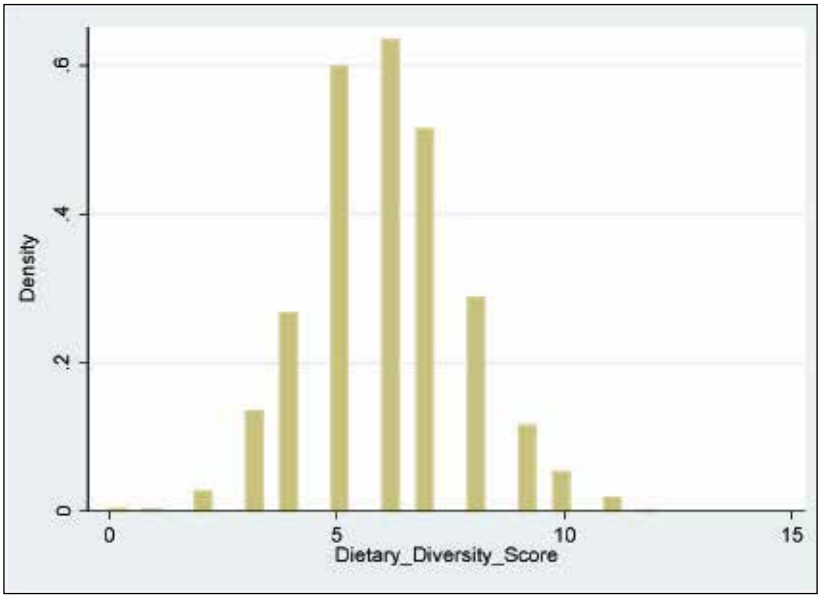
Food group	**Proportion**
Staple starch	99%
Tea and salt	98%
Fats	87%
Vegetables	84%
Sugar	73%
Beans and nuts	37%
Meat	30%
Fruit	24%
Milk	20%
Fish	17%
Eggs	11%
Potatoes and starch	11%

*Notes to the table:*The values in the table show the proportion of households who report to have consumed any of the food from the group in the seven days prior to the survey.

Share of the budget spent on food

The second measure of food security is constructed as the share of total annual expenditure allocated to food. From an Engel curve perspective, because food is an essential commodity, as total expenditure increases (that is, as the household becomes better off) the share of the budget allocated to food is expected to decline. Households with relatively low food budget shares are expected to be more food secure as it is relatively easy for them to respond to rising food prices by reducing the consumption of non-food items. On the other hand, households with higher food budget shares are regarded as less food secure.

Figure 1: Dietary Diversity Score Histogram



The main explanatory variables of interest to the study are:

International remittance receipt

This variable assumes the value of one if the household received any international cash remittances.

Domestic remittance receipt

This variable assumes the value of one if the household received any domestic cash remittances.

Food-related public transfer receipt

This variable captures the receipt of any food-related public transfers by the household. Specifically, whether the household received transfers under any of the following programmes: food mitigation programme, food for work public works programme, other

social welfare food benefits (e.g., disaster relief).

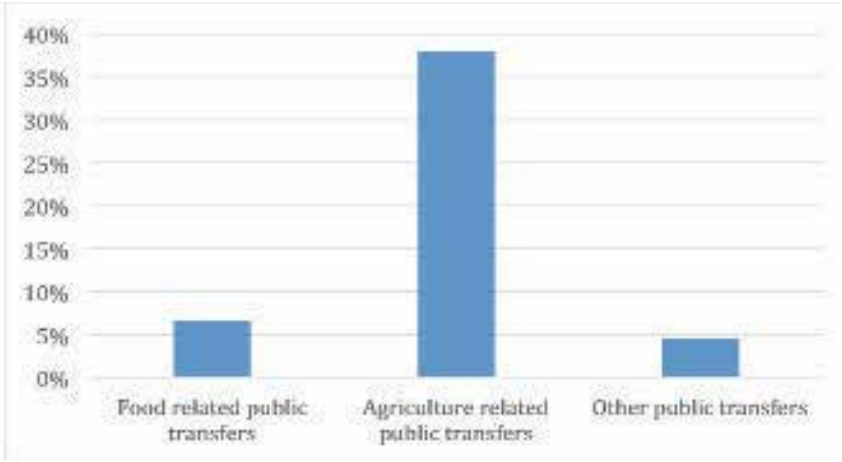
Agriculture-related public transfer receipt

This variable is indicative of the household receiving any agriculture-related public transfers such as smallholder farm input support, free seed from the government, and the receipt of any agriculture input as part of government input support programmes such as presidential input support or vulnerable input support.

Other public transfer receipt

This variable captures the receipt of any other public transfers by the household. Specifically, primary or secondary basic education assistance, harmonised social care transfer, general public assistance, medical transfer order, pauper burial, support to children in difficult circumstances, maintenance of disabled persons, maintenance of older persons, community recovery and rehabilitation programme, street children, public works programme (cash for work), health cash and in-kind social welfare benefit, education in cash and in-kind social welfare benefit, public early retirement package, public pension benefits, social security benefits, and other public transfers.

Figure 2: Proportion of households in the sample receiving specific types of public transfer



Agriculture-related public transfers have the highest proportion of recipient households with 39.7% of households in receipt of such support. The sample shows 6.2% of households are in receipt of food-related public transfers, and 4.3% in receipt of other types of public transfer.

Table 2 presents summary statistics of the agricultural outcome and food security measures, and select explanatory variables for the full sample and for households receiving remittances and public transfers, and those not in receipt.

Table 2: Summary statis s

	Full sample		I		II		III		IV	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Crop Count	3.69	2.06	3.27	2.00	3.78	2.06	3.82	2.09	3.58	2.03
Simpson Index	0.48	0.28	0.42	0.30	0.49	0.28	0.50	0.28	0.47	0.28
Entropy Index	0.76	0.48	0.63	0.48	0.79	0.48	0.80	0.49	0.73	0.47
Organic Fertilizer Use	0.50	0.50	0.48	0.50	0.51	0.50	0.49	0.50	0.51	0.50
Inorganic Fertilizer Use	0.63	0.48	0.62	0.49	0.63	0.48	0.65	0.48	0.61	0.49
Herbicide Use	0.07	0.25	0.09	0.29	0.06	0.24	0.07	0.25	0.07	0.25
Pesticide Use	0.02	0.14	0.02	0.15	0.02	0.13	0.02	0.14	0.02	0.14
Improved/Hybrid Seed	0.81	0.39	0.81	0.40	0.82	0.39	0.88	0.33	0.76	0.43
Value of Livestock	740.83	792.44	790.18	842.49	730.46	781.39	790.45	811.19	696.99	773.25
Total foods	6.01	1.70	6.06	1.64	6.00	1.71	5.95	1.63	6.06	1.77
Food share	49.56	16.02	47.45	15.78	50.00	16.04	50.04	16.23	49.13	15.83
=1 if received domestic remittances	0.15	0.36	0.87	0.34			0.15	0.36	0.15	0.36
=1 if received int'l remittances	0.03	0.16	0.16	0.37			0.03	0.16	0.03	0.17
=1 if received food public transfers	0.10	0.30	0.09	0.28	0.11	0.31	0.22	0.41	0.00	0.00
=1 if received agriculture public tran	0.38	0.48	0.35	0.48	0.38	0.49	0.80	0.40		
=1 if received other public transfers	0.06	0.24	0.11	0.31	0.05	0.22	0.13	0.33		
Total cropped area (acres)	11.04	95.15	18.74	179.25	9.42	64.84	11.53	82.55	10.60	105.07
Total consumption expenditure	221.72	153.43	256.79	199.32	214.35	140.88	224.30	158.97	219.44	148.41
Household size	4.98	2.16	5.10	2.29	4.95	2.14	5.09	2.21	4.87	2.12
=1 if head is aged below 30	0.09	0.28	0.08	0.27	0.09	0.29	0.05	0.21	0.13	0.33
= 1 if head aged 30 to 44	0.33	0.47	0.27	0.44	0.34	0.47	0.28	0.45	0.38	0.48
= 1 if head aged 45 to 59	0.26	0.44	0.24	0.43	0.26	0.44	0.27	0.45	0.24	0.43
= 1 if head aged 60plus	0.33	0.47	0.41	0.49	0.31	0.46	0.40	0.49	0.26	0.44
=1 if head male	0.64	0.48	0.58	0.49	0.65	0.48	0.61	0.49	0.67	0.47
= 1 if head no education	0.01	0.09	0.01	0.08	0.01	0.09	0.01	0.08	0.01	0.10
= 1 if head has primary education	0.47	0.50	0.51	0.50	0.46	0.50	0.51	0.50	0.44	0.50
= 1 if head has secondary education	0.40	0.49	0.35	0.48	0.40	0.49	0.35	0.48	0.43	0.50
= 1 if head has tertiary education	0.03	0.17	0.03	0.18	0.03	0.16	0.02	0.13	0.04	0.19
Manicaland	0.14	0.34	0.11	0.31	0.14	0.35	0.12	0.32	0.15	0.36
Mashonaland Central	0.12	0.33	0.03	0.18	0.14	0.35	0.12	0.32	0.12	0.33
Mashonaland East	0.13	0.34	0.08	0.27	0.15	0.35	0.10	0.30	0.17	0.37
Mashonaland West	0.13	0.34	0.18	0.39	0.12	0.33	0.14	0.35	0.12	0.33

Mashonaland North	0.11	0.31	0.22	0.42	0.09	0.28	0.12	0.32	0.10	0.31
Mashonaland South	0.12	0.32	0.05	0.23	0.13	0.34	0.15	0.35	0.09	0.29
Midlands	0.11	0.31	0.18	0.38	0.10	0.29	0.11	0.32	0.11	0.31
Masvingo	0.14	0.35	0.14	0.35	0.14	0.35	0.14	0.35	0.14	0.35
=1 if SSCFA	0.04	0.20	0.09	0.28	0.03	0.18	0.04	0.19	0.05	0.22
=1 if ORS	0.28	0.45	0.26	0.44	0.28	0.45	0.26	0.44	0.29	0.45
=1 if Communal Land	0.50	0.50	0.40	0.49	0.52	0.50	0.53	0.50	0.47	0.50
=1 if A1 land	0.18	0.39	0.25	0.44	0.17	0.37	0.18	0.38	0.19	0.39
N	1,923		334		1,589		902		1,021	

Table 3: OLS Regression Estimates

VARIABLES	Crop Count	Simpson Index	Entropy Index	Organic Fertil zer Use	Inorganic Fertil zer Use	Herbicide Use	Pes cide Use	Improved/ Hybrid Seed	Value of Livestock
=1 if received domestic remittances	-0.301**	-0.0333*	-0.116***	-0.0227	0.0553**	0.0355**	-0.00646	-0.000771	-84.07*
	(0.121)	(0.0190)	(0.0305)	(0.0312)	(0.0261)	(0.0172)	(0.00949)	(0.0246)	(49.69)
=1 if received int'l remittances	0.212	0.0753**	0.0833	0.0849	-0.00969	-0.00789	0.0175	0.00323	102.1
	(0.246)	(0.0372)	(0.0654)	(0.0706)	(0.0525)	(0.0260)	(0.0258)	(0.0615)	(117.9)
=1 if received food public trans	0.152	0.0411**	0.0421	-0.00671	-0.100***	-0.0110	-0.00647	-0.0887***	-121.6**
	(0.136)	(0.0196)	(0.0343)	(0.0365)	(0.0334)	(0.0153)	(0.00816)	(0.0314)	(55.00)
=1 if received agricultural public transfer	0.286***	0.0227*	0.0621***	-0.0206	0.148***	0.00850	0.00891	0.190***	24.89
	(0.0892)	(0.0124)	(0.0219)	(0.0228)	(0.0201)	(0.0117)	(0.00692)	(0.0159)	(35.47)
=1 if received other public transfer	-0.0211	-0.00624	-0.0158	-0.0152	0.0309	-0.00951	-0.000667	0.0219	145.3*
	(0.169)	(0.0255)	(0.0462)	(0.0470)	(0.0402)	(0.0186)	(0.0125)	(0.0359)	(86.75)
Total cropped area (acres)	0.000622**	-0.00019***	-0.0003***	0.000150***	5.24e-05	-1.32e-05	-2.59e-07	9.8e-05***	0.376***
	(0.000262)	(6.95e-05)	(0.000108)	(5.49e-05)	(9.61e-05)	(9.63e-06)	(4.52e-06)	(3.69e-05)	(0.0815)
Total consumption expenditure	0.000556*	1.32e-05	8.05e-05	0.000167**	0.000139**	7.20e-05	4.94e-05	7.71e-05	0.831***
	(0.000305)	(4.05e-05)	(6.91e-05)	(7.50e-05)	(6.21e-05)	(4.46e-05)	(3.32e-05)	(5.22e-05)	(0.146)
Household size	0.0507**	0.00505*	0.0127**	0.0111**	0.00150	-0.000896	-0.00203	0.00185	9.608
	(0.0211)	(0.00297)	(0.00525)	(0.00528)	(0.00453)	(0.00285)	(0.00174)	(0.00388)	(8.597)
=1 if head is aged below 30	-0.916***	-0.0741***	-0.152***	-0.250***	-0.122***	0.000619	0.0270	-0.0326	-485***
	(0.156)	(0.0242)	(0.0402)	(0.0434)	(0.0380)	(0.0246)	(0.0166)	(0.0356)	(67.98)
= 1 if head aged 30 to 44	-0.482***	-0.0516***	-0.104***	-0.159***	-0.0527**	-0.00870	0.00200	-0.0819***	-448***
	(0.117)	(0.0166)	(0.0287)	(0.0296)	(0.0263)	(0.0141)	(0.00711)	(0.0237)	(45.72)

= 1 if head aged 45 to 59	-0.151	-0.0254	-0.0436	-0.0737**	-0.0134	0.00397	0.0116	-0.0460**	-268***
	(0.116)	(0.0163)	(0.0281)	(0.0295)	(0.0259)	(0.0151)	(0.00878)	(0.0224)	(50.47)
= 1 if head male	0.293***	0.00881	0.0521**	0.0892***	0.0491**	0.0254**	0.0110**	0.0588***	136.3***
	(0.0925)	(0.0135)	(0.0232)	(0.0239)	(0.0207)	(0.0103)	(0.00469)	(0.0194)	(37.90)
= 1 if head no formal education	-0.304	-0.0411	-0.0237	-0.218**	0.0330	-0.0461*	-0.0109	-0.00826	-230.2
	(0.389)	(0.0715)	(0.114)	(0.111)	(0.126)	(0.0270)	(0.00953)	(0.0868)	(188.7)
= 1 if head secondary education	-0.0134	0.0274**	0.0206	0.0529**	0.0904***	0.00218	-0.00418	0.0606***	2.311
	(0.0970)	(0.0139)	(0.0239)	(0.0251)	(0.0218)	(0.0127)	(0.00719)	(0.0198)	(39.59)
= 1 if head tertiary education	-0.854***	-0.107**	-0.185***	-0.0251	0.185***	0.0486	0.0456	0.107**	-98.97
	(0.244)	(0.0416)	(0.0623)	(0.0754)	(0.0572)	(0.0425)	(0.0328)	(0.0461)	(113.9)
= 1 if small scale commercial farming land	-0.385*	-0.0482	-0.115**	0.138**	0.151***	0.0464	0.0434	0.0517	168.6
	(0.215)	(0.0303)	(0.0522)	(0.0609)	(0.0410)	(0.0430)	(0.0336)	(0.0361)	(111.9)
= 1 if old resettlement scheme	-0.478***	-0.0281	-0.0850***	0.110***	0.0398	-0.0505**	-0.0310***	-0.0121	87.82
	(0.133)	(0.0186)	(0.0316)	(0.0335)	(0.0292)	(0.0203)	(0.0120)	(0.0244)	(57.25)
= 1 if communal land	-0.355***	-0.0122	-0.00809	0.0933***	-0.0354	-0.0787***	-0.0305***	-0.0976***	-198***
	(0.121)	(0.0167)	(0.0290)	(0.0307)	(0.0270)	(0.0177)	(0.0104)	(0.0242)	(49.96)
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,917	1,917	1,917	1,923	1,923	1,923	1,923	1,923	1,923
R-squared	0.238	0.166	0.162	0.146	0.311	0.155	0.084	0.133	0.171

4. METHODOLOGY

The research undertakes descriptive analyses using Ordinary Least Square (OLS) regression and Linear Probability Model (LPM) analysis to estimate factors that determine the agricultural outcomes of rural households using the 2017 Poverty, Income, Consumption, Expenditure Survey, including the pre- and post-harvest Agriculture Productivity Module of the survey. Given that the majority of dependent variables are binary in nature, the LPM model is mostly employed.

The following relationship is estimated:

$$Y_i = \alpha + \gamma_j DR_i + \hat{\partial}_j IR_i + \lambda_j FT_i + \tau_j AT_i + \eta_j OT_i + z_i'\gamma_j + \varepsilon \quad (1)$$

where is the dependent variable and captures the agricultural outcome. The three main agricultural outcome variables as discussed in section III above are: Input use in agriculture; Crop diversity/specialisation, and Value of livestock owned. In the food security model, captures two food security variables: the dietary diversity score and the share of the total household budget allocated towards food.

The explanatory variables in equation (1) are which is a dummy variable capturing the receipt of domestic migrant remittances by the household, which is a dummy variable capturing the receipt of international migrant remittances by the household, capturing the receipt of food-related public transfers by the household, capturing the receipt of agriculture-related public transfers by the household, capturing the receipt of other public transfers by the household, a vector of household and other characteristics, and an error term. We note that the aforementioned variables are likely to be endogenous. However, accounting for the potential endogeneity of transfers is reserved as an agenda for future research. Therefore, the results obtained are interpreted as associations, rather than causal.

5. EMPIRICAL FINDINGS

In this section we discuss the empirical results that are obtained when the various specifications of equation (1) are estimated in determining the relationship between private transfers, public transfers and the agricultural and food security outcomes of rural households.

1.1 The relationship between remittances, public transfers and agricultural outcomes

Table 3 presents results from OLS models with the following agricultural outcomes: crop diversification, input use and livestock value. Some observations stemming from the findings as follows:

1.2 Households receiving agriculture-related public transfers are more likely to diversify crop production.

Table 3 reveals a positive and statistically significant association between the receipt of agriculture-related public transfers and crop diversification.

1.3 Households receiving agriculture-related public transfers are more likely to use modern agricultural inputs.

The receipt of public transfers is associated with a 14.8% increase in inorganic fertilizer use and a 19% increase in the use of improved/hybrid seed, on average and *ceteris paribus.*

The positive relationship between agriculture-related public transfers and crop diversification as well as inorganic fertilizer and improved/hybrid seed use may stem from the nature of transfers provided. Specifically, free seed and inorganic fertilizer are amongst the various types of input provided under the presidential input support and the vulnerable input support programmes.

1.4 Households receiving food-related public transfers are less likely to use modern agriculture inputs.

Table 3 reveals negative and statistically significant associations between the receipt of public transfers and inorganic and improved/hybrid seed use.

1.5 Households receiving domestic remittances are less likely to diversify their crops

Table 3 shows negative and statistically significant associations between the receipt of domestic remittances and crop diversification for all the three indicators of crop diversification used in the study.

1.6 Households receiving domestic remittances are more likely to use modern agricultural inputs

The receipt of domestic remittances is associated with a 5.5% and 3.6% increase in the use of inorganic fertilizer and herbicides, respectively.

1.7 International remittances do not appear to have any significant correlation with agricultural outcomes.

There are largely no statistically significant effects for the international remittances coefficients in Table 3.(p.20)

1.8 The gender of the household head has a significant relationship with agricultural outcomes

Table 3 reveals that the gender of the household head has a positive and statistically significant relationship with most of the agricultural outcomes employed in the current study. In particular, male-headed households are more likely to diversify their crop production, relative to female-headed households; they are also more likely to use modern

inputs. Specifically, there is a 0.3% increase in crop count and a 0.05: increase in the entropy index for male-headed households. The probability of using organic and inorganic fertilizer is 8.9% and 4.9% higher for households with male heads while herbicide and pesticide use is 2.5% and 1.1% higher, respectively. The value of livestock owned is USD136 higher in male-headed households than in female-headed ones on average, and *ceteris paribus*. This finding is unsurprising for the Zimbabwe context as males are customarily more likely to own livestock.

Other findings in Table 3 show that households on small scale commercial farming, old resettlement scheme, and communal land are all less likely to diversify their crop production and more likely to use organic fertilizer relative to households on A1 land. Small scale commercial farming households are more likely to use inorganic fertilizer relative to A1 households. Old resettlement scheme and communal households are less likely to use herbicides and pesticides and improved seed. Households on communal land are less likely to use herbicides, pesticides, and improved/hybrid seed, relative to A1 households. The value of livestock owned by households on communal land is USD198 less than that of households on A1 land on average, and *ceteris paribus.* Thus, there seem to be heterogeneities in the relationship between remittances, public transfers, and agricultural outcomes. To explore this further, we run separate regression estimates by land type.

1.9 The relationship between public transfers, remittances, and agricultural outcomes varies by land ownership

Table 4 provides separate estimates for regressions by land type. We see that the receipt of agriculture-related public transfers is associated with an increase in crop diversification and an increase in inorganic fertilizer and improved/hybrid fertilizer use for households on communal land. Domestic remittances are associated with a decrease in crop diversification and an increase in inorganic fertilizer use for communal households. International remittances seem to increase crop diversification for communal households. No significant effects are found for households on A1 land for either domestic or international remittances. Agriculture-related public transfers are shown to have a positive correlation with inorganic fertilizer and pesticide use. For households on old resettlement scheme land, domestic remittances seem to have a negative correlation with crop diversification while the receipt of agriculture-related public transfers has a positive association with inorganic fertilizer and improved/hybrid seed use. For small scale commercial farming households, the receipt of remittances or public transfers does not appear to have a notable correlation with agricultural outcomes.

1.10 The relationship between public transfers and agricultural outcomes varies by agro-ecological zone

Next, it could be argued the use of remittances for agricultural inputs may be more likely in more dynamic agricultural settings where land quality and rainfall are generally sufficient to induce an input-based response. For example, households located in isolated and poor-quality

Table 4: OLS Regression Estimates by Land Type

Communal Land									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertilizer Use**	**Inorganic Fertilizer Use**	**Herbicide Use**	**Pesticide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if received domestic remittances	-0.450**	-0.0581**	-0.17***	-0.096**	0.0989**	0.0137	-0.00387	-0.0257	-108.1*
	(0.190)	(0.0295)	(0.0488)	(0.0487)	(0.0426)	(0.0164)	(0.00248)	(0.0415)	(58.57)
=1 if received international remittances	0.747**	0.0686	0.157*	0.0941	0.0404	0.00786	-0.00461	0.101	216.9
	(0.380)	(0.0475)	(0.0891)	(0.101)	(0.0804)	(0.00629)	(0.00621)	(0.0824)	(161.7)
=1 if received food public transfers	0.104	0.0220	0.0338	-0.0275	-0.084**	-4.83e-05	-0.00661	-0.0910**	-68.61
	(0.169)	(0.0234)	(0.0425)	(0.0448)	(0.0423)	(0.0142)	(0.00450)	(0.0420)	(63.86)
=1 if received agriculture public transfers	0.490***	0.0696***	0.132***	-0.0216	0.178***	0.0152	0.000865	0.252***	8.993
	(0.127)	(0.0173)	(0.0312)	(0.0325)	(0.0307)	(0.0107)	(0.00337)	(0.0247)	(44.98)
=1 if received other public transfers	0.172	0.00900	0.00516	0.0492	0.0823	0.0203	-0.00330	0.0628	5.528
	(0.240)	(0.0313)	(0.0623)	(0.0665)	(0.0575)	(0.0231)	(0.00229)	(0.0480)	(89.27)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	952	952	952	957	957	957	957	957	957
R-squared	0.250	0.156	0.184	0.155	0.291	0.108	0.028	0.160	0.143

A1 Land									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertilizer Use**	**Inorganic Fertilizer Use**	**Herbicide Use**	**Pesticide Use**	**Improved Seed**	**Value of Livestock**
=1 if received domestic remittances	0.335	-0.00752	0.0107	-0.0321	-0.0537	0.0378	-0.0154	-0.0156	-133.9
	(0.276)	(0.0370)	(0.0658)	(0.0701)	(0.0547)	(0.0508)	(0.0352)	(0.0542)	(124.4)
=1 if received international remittances	-0.174	0.0389	0.0786	0.136	-0.0831	-0.0775	0.0540	-0.144	47.30
	(0.393)	(0.0757)	(0.135)	(0.135)	(0.0572)	(0.102)	(0.0968)	(0.130)	(269.8)
=1 if received food public transfers	-0.353	0.0182	-0.0580	0.146	-0.103	-0.106*	-0.0848***	-0.162*	-457.8***
	(0.299)	(0.0514)	(0.0800)	(0.0912)	(0.0688)	(0.0625)	(0.0257)	(0.0845)	(124.5)
=1 if received agriculture public transfers	0.0966	-0.00998	0.0172	-0.0443	0.0983**	-0.0229	0.0122	0.143***	141.3
	(0.191)	(0.0271)	(0.0491)	(0.0582)	(0.0417)	(0.0420)	(0.0328)	(0.0375)	(106.0)
=1 if received other public transfers	-0.0325	0.0184	0.00874	-0.114	-0.0716	-0.0250	-0.0227	-0.0154	278.6

	(0.369)	(0.0526)	(0.101)	(0.0979)	(0.0779)	(0.0462)	(0.0218)	(0.0877)	(224.3)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	353	353	353	353	353	353	353	353	353
R-squared	0.404	0.359	0.303	0.156	0.510	0.223	0.116	0.116	0.209

Old Resettlement Scheme

VARIABLES	Crop Count	Simpson Index	Entropy Index	Organic Fertilizer Use	Inorganic Fertilizer Use	Herbicide Use	Pesticide Use	Improved Seed	Value of Livestock
=1 if received domestic remittances	-0.431*	-0.0160	-0.134**	0.0166	0.0553	0.0292	-0.00647	0.0189	23.22
	(0.228)	(0.0406)	(0.0565)	(0.0598)	(0.0502)	(0.0313)	(0.00405)	(0.0458)	(112.2)
=1 if received international remittances	0.0481	0.00593	0.0373	-0.0714	-0.110	-0.0300	0.00846	-0.0209	-70.89
	(0.511)	(0.110)	(0.151)	(0.158)	(0.184)	(0.0187)	(0.00815)	(0.112)	(197.4)
=1 if received food public transfers	0.820**	0.110**	0.165**	-0.112	-0.171*	-0.0730***	-0.0127	-0.0120	-87.34
	(0.338)	(0.0533)	(0.0820)	(0.0935)	(0.100)	(0.0269)	(0.0133)	(0.0456)	(175.5)
=1 if received agriculture public transfers	0.0876	-0.0240	0.0130	-0.0114	0.151***	0.0208	0.00623	0.131***	-25.63
	(0.170)	(0.0251)	(0.0413)	(0.0431)	(0.0354)	(0.0237)	(0.0101)	(0.0277)	(70.42)
=1 if received other public transfers	-0.402	-0.0271	-0.0566	-0.110	0.000102	0.00878	-0.00246	-0.0474	291.3
	(0.381)	(0.0807)	(0.114)	(0.104)	(0.0922)	(0.0409)	(0.00391)	(0.0849)	(219.9)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	528	528	528	529	529	529	529	529	529
R-squared	0.302	0.178	0.193	0.191	0.326	0.070	0.036	0.159	0.197

Small Scale Commercial Farming Area

VARIABLES	Crop Count	Simpson Index	Entropy Index	Organic Fertilizer Use	Inorganic Fertilizer Use	Herbicide Use	Pesticide Use	Improved Seed	Value of Livestock

=1 if received domestic remittances	-0.261	0.0904	0.0321	0.0529	0.0436	0.0153	-0.100	0.0781	-161.4
	(0.485)	(0.0552)	(0.102)	(0.188)	(0.0887)	(0.0942)	(0.0852)	(0.0650)	(267.3)
=1 if received international remittances	-0.375	0.296***	-0.260*	0.581***	0.176	-0.0763	0.0187	-0.226	-824.7
	(0.983)	(0.0789)	(0.155)	(0.172)	(0.175)	(0.107)	(0.0746)	(0.276)	(498.7)
=1 if received food public transfers	1.173	0.255***	0.280*	0.106	-0.182*	-0.0162	0.0385	-0.0330	-95.84
	(0.753)	(0.0836)	(0.162)	(0.268)	(0.0997)	(0.157)	(0.138)	(0.0877)	(377.7)
=1 if received agriculture public transfers	-0.557	-0.111**	-0.203**	-0.0472	0.123*	-0.0313	0.101	0.0630	165.6
	(0.435)	(0.0518)	(0.0885)	(0.139)	(0.0701)	(0.0967)	(0.0688)	(0.0524)	(266.6)
=1 if received other public transfers	-1.130*	-0.00420	-0.0549	-0.263	-0.0830	-0.166	0.574**	0.00248	219.0
	(0.568)	(0.0512)	(0.0971)	(0.334)	(0.234)	(0.144)	(0.265)	(0.108)	(519.3)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	84	84	84	84	84	84	84	84	84
R-squared	0.470	0.673	0.568	0.183	0.571	0.507	0.448	0.455	0.400

Table 5: OLS Regressions by Natural Region

Natural Region 1									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertil zer Use**	**Inorganic Fertil zer Use**	**Herbicide Use**	**Pes cide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if receive remittances	-1.047	-0.0502	-0.272*	0.0330	-0.212	0.0504	Ψ	-0.282	-30.62
	(0.688)	(0.174)	(0.159)	(0.279)	(0.215)	(0.0673)		(0.227)	(297.1)
=1 if receive international remittances	-0.154	0.353	0.406	0.108	0.402**	-0.0484	Ψ	0.277	281.6
	(0.839)	(0.226)	(0.347)	(0.393)	(0.169)	(0.0622)		(0.207)	(348.5)
=1 if receive transfers	-0.0279	-0.0705	-0.0242	-0.449	0.0972	0.0910	Ψ	-0.290	-343.9
	(0.783)	(0.168)	(0.261)	(0.290)	(0.195)	(0.0707)		(0.182)	(345.7)
=1 if receive public transfers	-0.232	-0.0522	-0.0878	-0.132	0.358*	0.112	Ψ	0.281*	196.0
	(0.560)	(0.121)	(0.171)	(0.208)	(0.194)	(0.0934)		(0.155)	(322.9)
=1 if receive public transfers	0.158	-0.116	-0.139	0.0243	-0.0794	-0.142	Ψ	-0.497*	-824.3**
	(0.845)	(0.228)	(0.334)	(0.451)	(0.241)	(0.112)		(0.245)	(365.9)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Observations	54	54	54	54	54	54		54	54
R-squared	0.256	0.357	0.328	0.401	0.549	0.261		0.595	0.525

Natural Region 2									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertil zer Use**	**Inorganic Fertil zer Use**	**Herbicide Use**	**Pes cide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if receive remittances	-0.0228	-0.0292	-0.0771	0.00684	0.00932	0.132**	-0.00335	0.00273	133.6
	(0.256)	(0.0387)	(0.0588)	(0.0680)	(0.0331)	(0.0599)	(0.0380)	(0.0552)	(107.5)
=1 if receive international remittances	-0.0995	0.0775	-0.0267	-0.161	-0.0612	-0.104	0.0813	-0.165	-261.1
	(0.435)	(0.0720)	(0.116)	(0.122)	(0.0972)	(0.118)	(0.127)	(0.154)	(233.2)
=1 if receive transfers	-0.290	0.0375	-0.0749	0.114	-0.0893	-0.104	-0.0344	-0.0817	-135.4
	(0.300)	(0.0564)	(0.0815)	(0.0907)	(0.0607)	(0.0750)	(0.0420)	(0.0783)	(140.2)
=1 if receive public transfers	0.0713	0.00193	0.0280	0.0433	0.0567**	0.0333	0.0222	0.138***	38.38
	(0.176)	(0.0248)	(0.0408)	(0.0473)	(0.0238)	(0.0378)	(0.0244)	(0.0328)	(75.53)
=1 if receive public transfers	-0.731*	-0.0447	-0.112	-0.120	0.0883***	0.00527	-0.0105	-0.0102	103.9
	(0.374)	(0.0702)	(0.0831)	(0.136)	(0.0308)	(0.103)	(0.0566)	(0.116)	(211.8)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixe effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	480	480	480	480	480	480	480
R-squared	0.152	0.175	0.136	0.218	0.077	0.197	0.134	0.102	0.142

Natural Region 3									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertilizer Use**	**Inorganic Fertilizer Use**	**Herbicide Use**	**Pesticide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if received domestic remittances	-0.123	0.0151	-0.0475	-0.0311	0.0546	-0.00152	-0.0149*	-0.0317	-113.4
	(0.258)	(0.0384)	(0.0587)	(0.0662)	(0.0504)	(0.0246)	(0.00849)	(0.0515)	(94.61)
=1 if received international remittances	-0.393	0.0818	-0.0474	-0.0940	-0.328*	-0.143	-0.0216	0.146*	-643.1***
	(0.778)	(0.200)	(0.216)	(0.223)	(0.191)	(0.132)	(0.0294)	(0.0836)	(194.6)
=1 if received food public transfers	0.539	-0.0307	0.0950	0.452***	-0.135	-0.228***	-0.0117	-0.0713	72.76
	(0.751)	(0.0972)	(0.168)	(0.0696)	(0.182)	(0.0876)	(0.0138)	(0.139)	(226.4)
=1 if received agriculture public transfers	0.382**	0.0252	0.0818*	-0.0320	0.132***	0.0106	0.0177	0.108***	93.06
	(0.181)	(0.0247)	(0.0422)	(0.0460)	(0.0345)	(0.0234)	(0.0134)	(0.0328)	(70.91)
=1 if received other public transfers	0.0273	-0.0118	-0.126	0.0458	0.0120	-0.0372	-0.0194*	0.0156	302.7
	(0.418)	(0.0675)	(0.0958)	(0.122)	(0.100)	(0.0252)	(0.0117)	(0.0763)	(250.9)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	441	441	441	441	441	441	441	441	441
R-squared	0.425	0.247	0.302	0.177	0.172	0.241	0.046	0.077	0.262

Natural Region 4									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertilizer Use**	**Inorganic Fertilizer Use**	**Herbicide Use**	**Pesticide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if received domestic remittances	-0.288	-0.0251	-0.111**	-0.0561	0.0306	-0.00187	-0.0137*	-0.0107	-155.1**
	(0.181)	(0.0287)	(0.0503)	(0.0466)	(0.0452)	(0.0124)	(0.00738)	(0.0366)	(78.20)
=1 if received international remittances	0.589*	0.0860	0.144	0.236***	-0.0547	0.00306	-0.00657	0.0112	323.5**
	(0.338)	(0.0537)	(0.0898)	(0.0891)	(0.0722)	(0.00617)	(0.00648)	(0.0812)	(164.3)
=1 if received food public transfers	0.281	0.0442	0.0695	-0.120**	-0.0682	-0.00363	-0.00599	-0.0533	-84.58
	(0.185)	(0.0269)	(0.0473)	(0.0467)	(0.0496)	(0.0145)	(0.00505)	(0.0404)	(80.36)
=1 if received agriculture public transfers	0.0201	0.00931	-0.00709	-0.0213	0.247***	0.0201*	0.00794	0.238***	-33.66
	(0.147)	(0.0221)	(0.0384)	(0.0379)	(0.0390)	(0.0118)	(0.00731)	(0.0269)	(62.78)
=1 if received other public transfers	0.00739	0.00374	-0.00154	-0.0106	0.0368	0.00230	0.0143	0.0709	115.3
	(0.234)	(0.0351)	(0.0675)	(0.0635)	(0.0581)	(0.0169)	(0.0159)	(0.0435)	(123.0)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	694	694	694	696	696	696	696	696	696
R-squared	0.262	0.206	0.204	0.233	0.224	0.076	0.055	0.184	0.202

Natural Region 5									
VARIABLES	**Crop Count**	**Simpson Index**	**Entropy Index**	**Organic Fertilizer Use**	**Inorganic Fertilizer Use**	**Herbicide Use**	**Pesticide Use**	**Improved/ Hybrid Seed**	**Value of Livestock**
=1 if received domestic remittances	0.675	-0.0356	0.0100	-0.254	0.175	Ψ	Ψ	-0.0760	-29.88
	(0.573)	(0.0662)	(0.167)	(0.156)	(0.144)			(0.134)	(323.9)
=1 if received international remittances	0.773	-0.0145	0.109	-0.0926	0.132	Ψ	Ψ	0.0745	17.63
	(0.912)	(0.131)	(0.287)	(0.225)	(0.182)			(0.138)	(243.6)
=1 if received food public transfers	0.0860	0.0262	0.0391	0.122	-0.0290	Ψ	Ψ	-0.0704	-158.0
	(0.287)	(0.0392)	(0.0704)	(0.0896)	(0.0663)			(0.0819)	(114.6)
=1 if received agriculture public transfers	0.477*	0.0585*	0.156**	-0.0385	0.231***	Ψ	Ψ	0.323***	-39.99
	(0.254)	(0.0311)	(0.0628)	(0.0679)	(0.0608)			(0.0536)	(86.63)
=1 if received other public transfers	0.298	0.0215	0.115	-0.0149	-0.0116	Ψ	Ψ	0.0692	52.73
	(0.458)	(0.0497)	(0.107)	(0.106)	(0.102)			(0.0993)	(178.9)
Other control variables	Yes	Yes	Yes	Yes	Yes			Yes	Yes
Province level fixed effects	Yes	Yes	Yes	Yes	Yes			Yes	Yes
Observations	246	246	246	250	250			250	250
R-squared	0.472	0.428	0.409	0.144	0.213			0.312	0.208

areas may receive remittances as a means of survival, rather than for use towards agricultural production. We therefore explore whether there are heterogeneities in the relationship between public and private transfers by the agro-ecological zone. The five agro-ecological zones in Zimbabwe represent unique combinations of homogenous agro-climate, ecology, soil units and agricultural activities. Agricultural suitability is highest in region 1 and least in region 5. To investigate such heterogeneities, we estimate separate regressions for each of the five zones and report these in Table 5. There do not appear to be any notable correlations between remittances, public transfers and agricultural households in natural region 1. However, we note the small sample size of households in this region. In natural region 2, domestic remittances are positively associated with herbicide use. Agriculture-related transfers have a positive correlation with inorganic fertilizer and improved/hybrid seed use in regions 2, 3, 4, and 5. In addition, agriculture-related transfers also have a positive association with crop diversification in regions 3 and 5.

2. The relationship between remittances, public transfers and food security

We now investigate the relationship between public and private transfers and food security.

2.1 Food-related public transfers are received by poorer households; international remittances are received by less poor households

Table 6 shows that neither remittances nor public transfers have a statistically significant association with dietary diversity score. This is with the exception of food-related transfers which seem to have a negative, albeit small, association with dietary diversity. The receipt of food-related public transfers is shown to have a positive association with the share of the household budget allocated towards food. This suggests food-related public transfers are received by poorer households, as expected. On the other hand, international remittances have a negative association with the share of the budget allocated towards food. That is, households that are less poor are likely to receive international remittances. Again, this comports with expectations. Agriculture-related and other types of public transfers appear not to have any statistically significant association with the food security of households.

Table 6: OLS regressions

Variables	Dietary Diversity	Food Budget Share
=1 if received domestic remittances	-0.0426	-1.307
	(0.0991)	(1.001)
=1 if received international remittances	0.188	-6.381***
	(0.207)	(2.074)

VARIABLES	Dietary Diversity	Food Budget Share
	(0.207)	(2.074)
=1 if received food public transfers	-0.191*	2.063*
	(0.113)	(1.133)
=1 if received agriculture public transfers	-0.0130	0.483
	(0.0758)	(0.736)
=1 if received other public transfers	0.119	-1.297
	(0.163)	(1.531)
Total cropped area (acres)	0.000152	-0.00604***
	(0.000390)	(0.00139)
Total consumption expenditure	0.00187***	-0.0217***
	(0.000284)	(0.00283)
Household size	-0.0314*	0.986***
	(0.0184)	(0.175)
=1 if head is aged below 30	-0.546***	1.155
	(0.142)	(1.392)
= 1 if head aged 30 to 44	-0.543***	1.368
	(0.0992)	(0.977)
= 1 if head aged 45 to 59	-0.195*	0.759
	(0.101)	(0.960)
= 1 if head male	0.219***	0.0934
	(0.0796)	(0.765)
= 1 if head has no formal education	-0.563*	-2.259
	(0.317)	(3.680)
= 1 if head has secondary education	0.388***	-1.583*
	(0.0844)	(0.826)
= 1 if head has tertiary education	0.997***	-9.868***
	(0.247)	(2.299)
= 1 if small scale commercial farming land	0.289*	-7.424***
	(0.165)	(1.579)

VARIABLES	Dietary Diversity	Food Budget Share
= 1 if old resettlement scheme land	0.0541	-5.878***
	(0.114)	(1.071)
= 1 if communal land	-0.353***	-3.142***
	(0.104)	(0.993)
Province level fixed effects	Yes	Yes
Observations	1,923	1,923
R-squared	0.167	0.128

Notes to the table: (i) Standard errors are reported in parentheses. (ii) *, **, *** represent the statistical significance of the differences for the 10 per cent, 5 per cent and 1 per cent significance levels respectively. (iii) All control variables included in regressions reported in Table 3 are included in all specifications. (iv) Ten province level fixed effects are included in all the specifications.

2.2 Male-headed households have more diverse diets

The finding that male-headed households tend to have more diverse diets corroborates the finding discussed in 1.7. that male-headed households are more likely to have more diverse crop production, to employ modern agricultural inputs, and to own livestock of higher value.

2.3 The relationship between remittances, public transfers, and food security varies by land ownership

In Table 7, for households located on communal and A1 land, richer households are more likely to receive international remittances. The receipt of food-related public transfers has a negative correlation with dietary diversity for households on A1 land. Food-related public transfers are shown to be received by poorer households for households located on old resettlement scheme land.

Table 7: OLS regressions by land type

Communal Land		
VARIABLES	**Dietary Diversity**	**Food Budget Share**
=1 if received domestic remittances	0.0758	-0.0569
	(0.154)	(1.583)
=1 if received international remittances	0.272	-7.227**
	(0.289)	(2.901)

=1 if received food public transfers	-0.204	1.164
	(0.148)	(1.392)
=1 if received agriculture public transfers	0.0247	1.268
	(0.108)	(1.083)
=1 if received other public transfers	0.151	-2.639
	(0.249)	(2.247)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	957	957
R-squared	0.178	0.102

A1 Land

VARIABLES	Dietary Diversity	Food Budget Share
=1 if received domestic remittances	-0.159	-2.014
	(0.219)	(1.913)
=1 if received international remittances	0.283	-10.58***
	(0.425)	(3.551)
=1 if received food public transfers	-0.525**	0.380
	(0.258)	(2.576)
=1 if received agriculture public transfers	0.133	1.083
	(0.178)	(1.692)
=1 if received other public transfers	-0.137	0.772
	(0.301)	(3.265)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	353	353
R-squared	0.155	0.259

Old Resettlement Scheme

VARIABLES	Dietary Diversity	Food Budget Share
=1 if received domestic remittances	-0.0192	-2.439
	(0.197)	(2.042)
=1 if received international remittances	0.0462	-0.0900
	(0.488)	(6.838)
=1 if received food public transfers	-0.179	8.592**
	(0.323)	(3.428)
=1 if received agriculture public transfers	-0.152	-2.628*
	(0.157)	(1.420)
=1 if received other public transfers	0.414	-0.357
	(0.386)	(3.469)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	529	529
R-squared	0.181	0.099

Small Scale Commercial Farming Area

VARIABLES	Dietary Diversity	Food Budget Share
=1 if received domestic remittances	-0.362	-1.339
	(0.359)	(3.576)
=1 if received international remittances	-0.150	-3.458
	(0.520)	(4.190)
=1 if received food public transfers	0.604	1.699
	(0.572)	(4.662)
=1 if received agriculture public transfers	0.237	6.734*
	(0.340)	(3.442)

=1 if received other public transfers	0.351	-10.30
	(0.536)	(6.763)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	84	84
R-squared	0.428	0.546

Notes to the table: (i) Standard errors are reported in parentheses. (ii) *, **, *** represent the statistical significance of the differences for the 10 per cent, 5 per cent and 1 per cent significance levels respectively. (iii) All control variables included in regressions reported in Table 3 are included in all specifications. (iv) Ten province level fixed effects are included in all the specifications.

2.3 The relationship between remittances and food security varies by agro-ecological zone

As we did previously, we also explore whether there are heterogeneities in the association between remittances, public transfers and food security based on agro-ecological zone. In Table 8 we see a negative association between remittance receipt and food budget shares in natural regions 1, 2 and 5. We also see a positive association between food budget share and food-related public transfers on natural region 4. In region 5, the receipt of domestic remittances is shown to have a negative association with dietary diversity.

Table 8: OLS regressions by natural region type

Natural Region 1

VARIABLES	Dietary Diversity	Food Budget Share
=1 if received domestic remittances	-0.425	2.197
	(1.014)	(5.055)
=1 if received international remittances	0.213	-11.49**
	(0.549)	(4.279)
=1 if received food public transfers	-0.0435	6.909
	(0.696)	(6.705)
=1 if received agriculture public transfers	0.226	6.685
	(0.672)	(5.019)
=1 if received other public transfers	-0.593	-3.618
	(0.868)	(5.324)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes

Observations	54	54
R-squared	0.292	0.528
Natural Region 2		
VARIABLES	**Dietary Diversity**	**Food Budget Share**
=1 if received domestic remittances	-0.0911	-2.292
	(0.203)	(2.255)
=1 if received international remittances	0.257	-10.35**
	(0.550)	(4.407)
=1 if received food public transfers	-0.191	-4.056
	(0.276)	(2.561)
=1 if received agriculture public transfers	-0.182	-1.525
	(0.174)	(1.555)
=1 if received other public transfers	-0.0121	-4.492
	(0.373)	(3.179)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	480	480
R-squared	0.110	0.155
Natural Region 3		
VARIABLES	**Dietary Diversity**	**Food Budget Share**
=1 if received domestic remittances	0.322	-0.825
	(0.206)	(1.992)
=1 if received international remittances	-0.123	-7.023
	(0.702)	(8.587)
=1 if received food public transfers	-0.335	6.420
	(0.646)	(5.120)
=1 if received agriculture public transfers	-0.173	-0.00398
	(0.133)	(1.393)
=1 if received other public transfers	0.111	0.703
	(0.415)	(3.675)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	441	441
R-squared	0.190	0.200
Natural Region 4		
VARIABLES	**Dietary Diversity**	**Food Budget Share**

=1 if received domestic remittances	-0.120	-1.192
	(0.153)	(1.538)
=1 if received international remittances	0.172	-2.946
	(0.256)	(2.915)
=1 if received food public transfers	-0.195	2.923*
	(0.156)	(1.636)
=1 if received agriculture public transfers	0.152	0.164
	(0.133)	(1.281)
=1 if received other public transfers	0.327	1.412
	(0.233)	(2.223)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	696	696
R-squared	0.200	0.147
Natural Region 5		
VARIABLES	**Dietary Diversity**	**Food Budget Share**
=1 if received domestic remittances	-1.107***	4.089
	(0.423)	(4.429)
=1 if received international remittances	-0.404	-11.87**
	(0.616)	(5.086)
=1 if received food public transfers	0.00442	4.435
	(0.283)	(2.757)
=1 if received agriculture public transfers	0.104	2.990
	(0.218)	(2.096)
=1 if received other public transfers	-0.550	-6.496
	(0.343)	(3.996)
Other control variables	Yes	Yes
Province level fixed effects	Yes	Yes
Observations	250	250
R-squared	0.354	0.204

Notes to the table: (i) Standard errors are reported in parentheses. (ii) *, **, *** represent the statistical significance of the differences for the 10 per cent, 5 per cent and 1 per cent significance levels respectively. (iii) All control variables included in regressions reported in Table 3 are included in all specifications. (iv) Ten province level fixed effects are included in all the specifications.

Lastly, we undertake sensitivity checks to see whether the relationships discussed above are sensitive to differences along the quantile distribution by estimating quantile regressions. The estimated effects largely comport with results obtained using OLS and LPM regressions.

6. Conclusions and policy recommendations

The findings of our research reveal that the type of public transfer received by households matters for their agricultural outcomes. Specifically, agriculture-related public transfers have a positive association with crop diversification and the use of modern agriculture inputs, particularly inorganic fertilizer and improved/hybrid seed. On the other hand, households receiving food and other types of public transfer tend to specialise rather than diversify their crop production. There are no statistically significant associations between food- and other types of public transfer and agriculture input use and other outcomes.

The evidence obtained shows international remittances appear to be largely unrelated to the agricultural and food security outcomes of rural households. This is likely a result of the small number of rural households in receipt of international remittances. On the other hand, unlike agriculture-related public transfers, domestic remittances are associated with a decrease in crop diversification. But, similar to agriculture-related public transfers, domestic remittances seem to enable households to use more modern agricultural inputs, particularly inorganic fertilizer and herbicides. This may suggest that domestic remittances and public-transfers have different roles while also being complementary. That is, domestic remittances seem to promote homogenous crop production while agriculture-related public transfers seem to promote crop diversification. Both transfers, however, seem to promote the use of modern agricultural inputs.

Other specific findings show that households headed by men are more likely to diversify crop production and to use modern agricultural inputs. The value of their livestock is also higher than that of female-headed households. This ties in with the finding that male-headed households are more food secure than female households as they have more diverse diets.

We also find evidence that food-related transfers are received by poorer households. Furthermore, we find the receipt of international remittances to be accruing to less poor households. This is possibly a result of richer households being better placed to send household members abroad.

It is notable that despite public transfers having a positive association with crop diversification, this does not seem to translate to an increase in nutritional intake as measured by dietary diversity. This is also the case for domestic and international remittances.

The findings also reveal heterogeneities in the relationship between remittances and public transfers, and agricultural outcomes and food security depending on the agro-ecological zone. The use of remittances by rural households also seems to vary by zone. Therefore, the role of remittances in contributing towards agricultural productivity and food

security varies depending on the location of recipient households.

In light of the above findings, the study recommends the continuation of targeted public transfers. Specifically, agriculture specific government interventions such as the Command Agriculture and Presidential Input Support Programme have a positive correlation with crop diversification and the use of modern agricultural inputs. It also shows that government food security interventions are accruing to poorer households and presents a case for the continuation of such support.

To the extent that public and private transfers are complementary, the study suggests a role for public policy to better understand and facilitate this complementarity in order to maximise the benefit for the agricultural outcomes of rural households. For example, there could be a role for policy in the harmonisation of public and private transfers to ensure public transfers are channelled towards inputs that are most needed. The study advocates for space to be created in Zimbabwe's policy arena to better understand and explore the interaction between private and public transfers.

Moreover, given the prominence that remittances are given in the National Development Policy framework and the recognition by the government of the need to support the growth of the agricultural sector, the findings suggest that the role of remittances in supporting the agricultural sector should be more explicitly considered and supported. In addition, a proposed agenda for future research is to examine the role of in-kind remittances to determine to what extent they interplay with the agricultural outcomes of rural households.

Another policy recommendation is for the government to prioritise female-headed households in providing food relief and other agricultural interventions given their vulnerability to food insecurity.

The fact that both public and private transfers do not have an association with dietary diversity showcases the lack of diverse nutritional intake by rural households and calls for a better understanding of how this can be achieved. Perhaps policymakers may wish to consider offering more diverse foods when providing food-related public transfers, and/or more diverse seed input, in order to promote the diversification of the diets of rural households.

Lastly, we propose that government interventions that support agricultural productivity and food security should not be homogenous but rather take into account variations in agro-ecological zone.

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Multidimensional Poverty in Zimbabwe: A Gender Perspective

Miracle Benhura
Fadzai Mhariwa

Abstract

This study investigates whether male-headed households (MHHs) and female-headed households (FHHs) in Zimbabwe experience multidimensional poverty differently using data for 2011/12 and 2017. Results do not present evidence of a gender gap in 2011, but in 2017 FHHs had a higher multidimensional poverty incidence than MHHs. This outcome was more pronounced among rural than urban households. De jure FHHs were however poorer than de facto FHHs. Generally, households headed by widowed/divorced men and women were poorer than those headed by their married/single counterparts. They also incurred a temporal increase in poverty while others had a decline. In both periods, low asset base, lack of access to electricity, unclean sources of fuel for cooking and low per capita consumption expenditure were key contributors to poverty for both MHHs and FHHs. Therefore strategies to address multidimensional poverty in Zimbabwe should be gender sensitive and consider the diversity among FHHs as well as among rural and urban households. The policy actions can benefit from incorporating the distinguished contributory factors.

Key words:

Multidimensional poverty; recovery period; Zimbabwe Gender Household

1. Introduction

Zimbabwe has historically been grappling with non-trivial levels of poverty. The problem has been closely following the country's socio-economic developments where three unique economic phases have be identified: a stable period (1980-1997), a crisis period (1999-2008) and a subsequent recovery period (Stoeffler et al. 2016). Regardless of the recovery period, extreme money-metric poverty remains high at both individual and household levels. In 2011, 22.5% of individuals in Zimbabwe were extremely poor which worsened to 29.3% in 2017. This also applied to 16.2% of households in 2011 which increased to 21.9% in 2017 (Zimstat 2019).

When considered by sex of the household head, male-headed households (MHHs) were generally poorer than female-headed households (FHHs) in 2017 (Zimstat 2019, Rogan 2016, Liu et al. 2017). However, this conclusion is based on a unidimensional assessment of well-being which necessitates complementary studies that view well-being from a gender sensitised multidimensional perspective. This is important as the foremost sustainable development goal (SDG) has a set target for countries to at least halve the proportion of men, women and children that suffer from multidimensional poverty (UNDP 2019). In line with SDG 5, achieving this would serve to promote gender equity which is a prerequisite for economic development (Klasen and Lamanna 2009, FAO 2017).

Currently, there is a dearth of recent Zimbabwean literature that measures the multidimensional gender gap in poverty, especially in the economic recovery period, to check progress. Yet such studies are useful for designing relevant social assistance policies. Available studies on multidimensional poverty include Stoeffler et al. (2016) and Bérenger (2017) who focussed on temporal changes at the national level, for 2001-2011 and 2005-2015 respectively. Musiwa (2019) investigated multidimensional child poverty considering gender and location. Horrell and Krishnan (2007) compared the situation of de facto and de jure FHHs to that of MHHs using 2001 survey data. More recently, Thobejane and Nyathi (2018) focused on poverty among FHHs in one rural province (Matabeleland South Province). While these studies enlighten us on the existence of multidimensional poverty in Zimbabwe, they do not educate us on a more recent picture of the situation by sex of the household head, across all provinces and over time. Hence, this study fills this gap in the literature, which is important for informing poverty eradication policies.

It is noteworthy that there is no universally accepted definition of household headship. However, Brown and van de Walle (2020) note that MHHs constitute the majority and culturally expected household type in sub-Saharan Africa, while FHHs are mostly an aftermath of marital shocks such as widowhood or divorce. As such, headship can be useful for identifying poor households in African countries such as Zimbabwe, regardless of recent calls to abandon this dimension of welfare comparisons. Standard welfare comparisons for MHHs and FHHs, nonetheless, require a consideration of two confounding factors which

are particularly correlated to poverty in FHHs: marital status and household characteristics (ibid.).

In light of the above, our study has three objectives. First, we investigate whether there were differences in experiences of multidimensional poverty between FHHs and MHHs in Zimbabwe during 2011-2017, and whether this changed over time. Second, we analyse whether there were heterogeneities in gendered household poverty experiences by geographic area and marital status of the household head. Specifically, we explore multidimensional poverty experiences of MHHs and FHHs within rural/urban areas. We also separately compare the situation of de facto and de jure FHHs to that of MHHs, given that MHHs are the 'norm' in sub-Saharan Africa. We subsequently compare the situation of MHHs and FHHs by type of marital status, to account for heterogeneity within household type. The results assist with information on whether poverty reduction policies in Zimbabwe should be sensitive to gender and marital status of the householder. The third objective is to explore the most important contributors to poverty for MHHs and FHHs and inform targeted counter-policies. We achieve the objectives using the Multidimensional Poverty Index and Poverty Income Consumption and Expenditure Survey data for 2011/12 and 2017, produced by Zimstat.

The rest of the study is structured as follows. Section 2 presents the contextual background, Section 3 discusses the methodology and describes the data used for analysis. Results are presented and discussed in Section 4, and the conclusion is in Section 5.

2. Background

2.1 National Picture

Zimbabwe gained political independence from minority white rule in 1980. The Government of Zimbabwe (GoZ) followed a socialist ideology with redistributive policies that required a large public expenditure on the social sector (UNDP 2010). This saw the period 1980-1990 registering some progress towards poverty reduction among the previously marginalised black majority (Sibanda and Makwata, 2017). Living standards also improved due to minimum wages and policies that promoted job security (Zhou and Masunungure, 2006). However, the introduction of the Economic Structural Adjustment Program in 1991 saw a reduction in social sector spending. This reversed most gains the country had made towards poverty reduction. The economy plunged into a crisis during 1997-2008. This partly stemmed from unbudgeted program such as payments to veterans of the nation's liberation war. These triggered unsustainable budget deficits, and high levels of inflation and interest rates (RBZ 2009, Sibanda and Makwata, 2017). The country also embarked on the chaotic Fast Track Land Reform Program (FTLRP) in early 2000s which had devastating effects on the economy and well-being of many households (Stoeffler et al. 2016).

In 2008, the Global Political Agreement (GPA) was signed and it aimed to redress the socio-

economic challenges. A number of pro-poor policy measures were implemented through the 2009 national budget. These include resource allocations in support of restoring public service delivery in health and education and improving social protection for vulnerable groups. Regardless of these gains, the country faced challenges which include serious power shortages and inadequate supply of treated water to industry (Sibanda and Makwata 2017). This increased unemployment due to company closures – at least 4,610 companies closed between 2011 and 2014, forcing 55,443 people into joblessness (GoZ 2014). Capacity utilisation in the formal sector was low at 36.4% which led at least 80% of the employed population into informal employment (Sibanda and Makwata 2017, Confederation of Zimbabwe Industries 2021).

In 2013, following the GPA, the country was still facing economic challenges including poor service delivery by local authorities, water shortages, power shortages, foreign currency shortages, market distortions and rising inflation. These were aggravated by a severe 2018/19 drought which caused food insecurity. A humanitarian crisis also ensued from cyclone Idai and left about 270,000 people in urgent need of assistance (GoZ 2019). This saw the economy registering a negative economic growth rate of -6.5% in 2019.

2.2 Gender perspective of poverty in Zimbabwe

Evidence from other developing countries shows that MHHs and FHHs experience multidimensional poverty differently (Buvnic and Gupta 1997, Klasen et al. 2015, Rogan 2016, Liu et al. 2017). This stems from differences in power dynamics, economic opportunities, and cultural norms. On the one hand, some studies which include African countries find FHHs to be the poorest of the poor (Buvinic and Gupta 1997, Milazzo and van de Walle 2017. Agbodji et al. 2013. Rogan 2016). Others find that FHHs are not poorer than MHHs. For instance, Quisumbing et al. (2001) using survey data for Africa, Asia, and Central America, found that FHHs were poorer than MHHs in only 2 of 10 countries. Due to these empirical irregularities, results from existing literature cannot be generalised.

There are several factors that may place FHHs at high risk of poverty compared to MHHs in Zimbabwe. Informal employment is generally a large source of employment for women, who constitute 54% of the workforce (Zimstat 2019). In 2017, the money-metric poverty rate among households without salaried workers was 89% higher than that for households with a salaried worker. This may expose FHHs to poverty, given that most of them do not have adult male members. However, with the considerable labour market informality in Zimbabwe, many men are also suffering from underemployment and low salaries. The welfare impact could even be worse for MHHs who lost their meaningful source of survival in the formal sector.

Female householders can be classified as de jure or de facto. De facto female headship occurs when a woman is head because her husband is temporarily absent. De jure female heads are identified by marital status such as never married, divorced/separated or

widowed (Zimstat 2019, Horrell and Krishnan 2007). This distinction has implications for the prevalence of poverty. FHHs who receive transfers from a male member are presumably are better-off in terms of consumption or income than others (Horrell and Krishnan 2007). In Africa, some widow-headed households have been identified as significantly impoverished (Appleton 1996, van de Walle 2013). This could be partly due to lack of spousal support and expenditure of resources during illness and death (Kennedy and Haddad 1994). However, in 2017 MHHs were economically poorer than FHHs, but de jure FHHs were poorer than de facto FHHs.

Women in Zimbabwe comprise 54.6% of the workforce in the agriculture, fishery and forestry sector, which is the mainstay of the economy. The contribution of women in the sector is largely unpriced as they disproportionately work as unpaid family workers, and they comprise 70% of household and family labour in rural areas (FAO 2017, Zimstat 2016). Agricultural resource ownership is also skewed towards men. For instance, of the 96% agricultural land acquired under the FTLRP, only 16% was allocated to women (GoZ 2013). This compromises rural FHHs' participation and productivity in agriculture.

In Zimbabwe, 69.2% of all households are situated in rural areas which are disproportionately affected by climate change factors: frequent droughts, floods, erratic rainfall and extreme temperatures. Rural areas also have lower access to basic services than urban areas. This has a disproportionate effect on women's livelihoods by increasing the time-use burden and reducing economic opportunities, with negative effects on FHHs. Against this background, a temporal and gendered analysis of multidimensional poverty in Zimbabwe is pertinent.

3. Methodology and Data

3.1 Methodology

We utilise the Alkire and Foster (AF) (2011a and 2011b) Multidimensional Poverty Index (MPI) based on the 'counting' method to achieve our objectives. The AF method measures poverty at household level and allows aggregation across MHHs and FHHs. It is sufficiently flexible to include several dimensions of welfare, and applies to ordinal data. The MPI is decomposable to show the relative contribution of deprivations in different welfare dimensions to poverty, by sex of the householder. This is fruitful for identifying any differences in poverty dimensions that FHHs and MHHs are deprived.

Implementation of the AF method relies on a dual cut-off identification strategy. In the first step, five welfare dimensions d have been identified as discussed below. Each dimension has been assigned weight W^d given its relative importance. J indicators were chosen to capture each dimension and each has been assigned an equal sub-weight of the dimension (W_j^d) Then the first set of deprivation cut-offs $Z_j^d \in Z$ has been applied to each indicator in a dimension. Each cut-off has been set at discretion and presents the minimum achievement

for a household to be classified as not deprived in that dimension. A household is deprived in the J^{th} indicator if its achievement lies below Z_j^d . For each household, the weights for dimensions that fall below the cut-offs were added Then the second cut-off has been set at one third of the dimensions following Alkire and Santos' (2010) Global Poverty Index (GPI). A household is considered as multidimensional poor if its weighted deprivation count is at least *k* .However, robustness checks are conducted to check sensitivity of the analysis to choice of *k.*

Depending on the relative magnitudes of c_i and k households were then classified as multidimensional poor or non-poor. If for a given household $c_i \geq k$ then it is multidimensional poor. The headcount poverty ratio is calculated as $H = \frac{n}{N}$ where n number of multidimensional poor households and N is the population. In order to account for the depth in severity of multidimensional poverty, intensity (A) is calculated as the average deprivation share across the poor

$$A = \frac{1}{nj}\sum_{i=1}^{N} w_i \, c_i^*$$

where $w_i c_i^*$ is the weighted number of deprivations for poor households. The adjusted head count is given by $Mo = H * A = \mu\left(g^0(k)\right)$. Where $g^0 = \left[g_{ij}^0\right]$ is a matrix whose ij^{th} entry is 1 if household i is deprived in the j^th indicator, and 0 otherwise (Alkire and Foster 2011b,; Rogan 2016). Thus, the adjusted headcount Mo considers both the frequency and intensity of multidimensional poverty. It denotes the total number of weighted deprivations experienced by the poor divided by the total possible number of deprivations that could be experienced by the population.

To analyse whether FHHs and MHHs in Zimbabwe incur different multidimensional poverty experiences, Mo is computed separately by sex of household head, i.e. MPI. Then the ratio of FHHs to MHHs' Mo is calculated to show relative deprivation between these households. If it i's greater than 1, FHHs would be more likely to be poor than MHHs, i.e. a - gender gap (McLanahan et al. 1989 cited in Rogan 2016). To capture changes in the gender gap over time a comparable analysis is carried out for 2011/12 and 2017. These steps are also applied to achieve our second objective.

The third objective is achieved through separately decomposing the MPI for FHHs and MHHs. This helps to show the relative contributions of individual indicators to the overall adjusted headcount (Alkire and Foster 2011a, Alkire and Santos 2010, Rogan 2016). The contribution of each indicator to is derived as: $\frac{W_j^d * CH_J}{M_0}$

where W_j^d and Mo are as previously deÿned and CH is censored headcount: proportion of the population multidimensional poor and simultaneously deprived in the indicator. This is

computed for each indicator as discussed below. Results are analysed in a comparative context, to verify whether MHHs and FHHs suffer from deprivations in similar dimensions, and which dimensions significantly drive their poverty with implications for policy.

Choice of dimensions

Conceptually our study is rationalised by Sen's (1985, 1999) Capability Approach. This captures the diverse, plural, or multidimensional nature of human conditions and development experiences which is not attainable from unidimensional measures. The choice of welfare dimensions for study is based on existing literature on multidimensional poverty (e.g. Alkire and Santos 2010, Stoefler et al. 2016), data and some contextual information about human conditions in Zimbabwe. Five welfare dimensions have been established for the study: Education, Health, Income, Living conditions and Assets. The indicators and weights are shown in Table 1. It is notable that the main analysis of this study has, in line with international literature on multidimensional poverty, applied equal weights to the domains (Alkire and Foster 2011a). Contextualised weights discussed below have been used for sensitivity checks of the results.

Education is an important dimension of well-being which has been considered in many studies of multidimensional poverty (Batana 2013, Alkire and Santos 2010). Educational achievement is important in Zimbabwe, where literacy rates are high by developing country standards. This serves as a crucial underlying condition for households' socioeconomic development. Hence, a household is deprived of education if it has one child between 6 and 12 years who is not enrolled in school. This criterion follows the importance of human capital development in early stages of life. In addition, a household is deprived if none of the adult members surpassed grade 7. Normatively, this dimension is given a weight of 1 out of 5.

The Income dimension has been added to capture the fact that currently economic status and human welfare in Zimbabwe cannot be well explained by educational attainment. The labour market has a large precarious informal sector and a lot of hidden unemployment, e.g. some graduates have been reduced to working as vendors. Therefore, the signalling role of education for economic empowerment has largely been weakened. This also brings into question the suitability of reported unemployment as a measure of economic deprivation. The reality is that some households suffer from unemployment but have a better economic status than their employed counterparts as they are sustained by remittances from relatives in the diaspora. Thus, a better indicator of household economic deprivation would be expenditure status. To this effect, we classify deprived households as those with per capita consumption expenditure below the food poverty line (extreme poverty), and those with an unemployed adult member. Given the intricate link between education and income, this dimension has also been given a weight of 1 out of 5.

Living conditions are another significant determinant of household well-being. These include household access to public utilities such as water supply, sanitation, electricity

Table 1: Suggested dimensions, weights and indicators used to calculate the MPI by household headship; equal weighting

Dimension	Dimension Weight	Indicator	Weight - urban	Weight -rural
Education	0.2	The household has one child between 6 and 12 years not enrolled in School	0.1	0.1
		No adult in the household has surpassed grade 7	0.1	0.1
Health	0.2	One member of the household has been ill but did not get healthcare in the previous 30 days	0.1	0.1
		One member of the household is chronically ill	0.1	0.1
Income	0.2	per capita household consumption expenditure is below the food poverty line (extreme poverty)	0.1	0.1
		One member of the household was unemployed as main occupation in last 12 months	0.1	0.1
Living condi tions	0.2	The house does not have electricity	0.05	0.05
		The house does not have toilets (pit, blair, or flush toilets) in rural areas or flush toilets in urban areas	0.05	0.05
		The source of water in rural areas is an unprotected well or (worse) or is located farther than 1km away in rural areas; the source of water is not piped water on premise in urban areas	0.05	0.05
		The household does not cook with electricity gas or paraffin	0.05	0.05
Assets	0.2	The household does not own at least 2 of: TV, Radio, telephone, landline, fridge, bicycle, motorcycle And does not own a vehicle	0.2	0.066
		The household in a rural area has no agricultural equipment: plough tractor scotchcart, cultivator, wheelbarrow	-	0.066
		The household in a rural area does not own land	-	0.066

Source: adapted from existing literature (c.f. Alkire and Santos 2010; Stoeffler et al. 2016). Assets for rural areas has a weight of 0.2 in a combined analysis with urb

and clean sources of fuel for cooking. However, Stoeffler et al. (2016) note that there has been poor service delivery by local authorities in Zimbabwe for over a decade, which has reduced household access to public utilities or resulted in intermittent access. In the contextualised analysis, this dimension is accorded the highest weight (2 out of 5) given that the deterioration of service delivery has brought health risks and a time-use burden for some household members. For instance, long periods of interrupted water supply imply that individuals need to forgo leisure or other productive activities to fetch water, especially females. Where the secondary water sources are unprotected this fuels health conditions such as cholera and typhoid. The same applies to respiratory conditions linked to unclean energy sources, and open defecation due to lack of sanitation. Indicators for this dimension, shown in Table 1, are closely linked to what has been used in generic GPI studies literature (c.f. Alkire and Santos 2010).

Good health status is also required for households to achieve life satisfaction/happiness. For this study, a household is deprived of health if one member has been ill but did not get healthcare in the previous 30 days. The presence of a household member with a chronic disease would be complementary to this indicator. Both indicators could, however, be compromised by under-reporting as they only capture health status in the past 30 days. Besides, they are a limited portrayal of health status since the datasets in use do not have information on more generic indicators such as child nutrition or child mortality. Food sufficiency across households could have been utilised but the information is only available in 2017. Notably, in analyses that do not invoke equal weights health has been allocated a weight of 0.5 out of 5 given that individuals' health in Zimbabwe is intricately linked to living conditions.

Household assets have also been specified as another dimension. In generic MPI studies, assets fall under the living conditions dimension; in this study they have been singled out as they give an indication of deprivation linked to permanent rather than current consumption. Given that income is most often unstable, assets are useful for smoothing consumption (Brandolini et al. 2010). Asset ownership thus provides a better picture of the capacity of households to manage their vulnerability to poverty, and a lack thereof acts as a proxy for extreme poverty (McKay 2013). For this study, a household is deprived if it does not own a vehicle and at least two of the following: television, radio, cell phone, landline telephone, fridge, bicycle, motorcycle. These assets facilitate human mobility, communication, entertainment, and storage of perishable food, which enhances quality of life. For rural areas, a household is also deprived if it does not own land and agricultural equipment which is closely linked to its means of survival (Stoeffler et al. 2016). In the case of land, this study utilises land ownership rather than land size, since in 2017 information on land size is only available for selected households. This dimension is attached a weight of 0.5 given its intertwining with living conditions.

3.2 Data Source and descriptive statistics

The study utilises the 2011/12 and 2017 Poverty Income Consumption and Expenditure Survey (PICES) conducted by Zimstat. To some extent, these nationally representative household surveys allow for a comparative analysis of household well-being over time. Hence, the two cross-sections are used to assess poverty dynamics among MHHs and FHHs during Zimbabwe's recovery period. Only households that had information on our key variables are included in the study. These were 29,222 households in 2011 and 29,330 households in 2017, 62% of households in each period were male-headed. *De jure* FHHs comprised 63% of all FHHs in 2011 and 2017. Urban households were around 20% of all households in both periods.

Table 2 presents headcount ratios of household deprivation across indicators used for the study by selected characteristics in 2011 and 2017. For all households, there has been a slight temporal improvement in living conditions except for access to clean sources of energy for cooking. In 2011, 67.8% were deprived in this indicator and this increased to 93.2% in 2017. Another deterioration occurred for households that had an unemployed adult as they increased from 5.2 % to 9.6%. Similarly, households whose expenditure per capita was below the food poverty line increased from 16.2% to 22.9%. On a positive note, there has been progress in education and health domains. For instance, households with school eligible children aged between 6 and 12 years who were not enrolled in school decreased from 8.1% to 2.6% from 2011 to 2017. For health, households that had a member who suffered from a chronic illness decreased from 16.4% to 9.2%. These changes suggest that multidimensional poverty could have also been slightly reduced from 2011 to 2017.

Concerning gender differences, in 2011 FHHs were relatively less deprived in access to electricity, children's lack of school enrolment and unemployment. MHHs suffered less deprivation than FHHs in adult education, chronic health conditions and access to health care. This could be linked to household composition and the fact that women suffer more from chronic diseases than men. There were no significant differences in MHHs and FHHs who faced deprivation in the other indicators; see Table 2. In 2017, there were gender differences in deprivation across all indicators barring children's school enrolment. However, MHHs had lower deprivation headcounts than FHHs in most of the indicators, except for access to protected water and consumption expenditure. The latter could be suggesting that high informality in the labour market has made men worse off since they were more likely to be in formal sector jobs, while many women already had experience participating in the informal sector. Taken together these statistics suggest that MHHs were less likely to be multidimensional deprived in 2017 than FHHs.

Further, Table 2 shows that, in 2017, de facto FHHs were less deprived across indicators than de jure FHHs, except for consumption expenditure and access to decent sanitation. This necessitated an analysis of MPI by marital status of the household

Table 2: Raw Headcount Ratios for the indicators used in 2011 and 2017 by selected characteristics

	2011							2017						
	All	FHH	MHH	DFFH	DJFH	Urban	Rural	All	FHH	MHH	DFFH	DJFH	Urban	Rural
Electricity	0.473	0.457	0.482***	0.457	0.457	0.101	0.678***	0.412	0.451	0.390***	0.416	0.472***	0.102	0.573***
Water	0.348	0.341	0.353	0.342	0.340	0.210	0.424***	0.329	0.312	0.338**	0.327	0.303**	0.260	0.364***
Sanitation	0.300	0.288	0.308	0.284	0.290	0.094	0.414***	0.271	0.276	0.268**	0.285	0.271	0.077	0.372***
Fuel for cooking	0.678	0.673	0.681	0.679	0.670	0.163	0.962***	0.932	0.941	0.926***	0.937	0.944**	0.830	0.985***
Child school enrolment	0.081	0.076	0.084***	0.085	0.071***	0.080	0.081	0.026	0.026	0.026	0.025	0.027**	0.019	0.030***
Adult education	0.209	0.243	0.189***	0.234	0.248***	0.201	0.214	0.164	0.217	0.135***	0.192	0.232***	0.048	0.225***
Chronic conditions	0.164	0.190	0.148***	0.120	0.231***	0.174	0.158	0.092	0.112	0.081***	0.075	0.134***	0.080	0.098***
Access to health care	0.160	0.170	0.154***	0.148	0.183***	0.155	0.162*	0.099	0.103	0.097***	0.087	0.112***	0.086	0.106***
Unemployment	0.052	0.044	0.056***	0.031	0.051***	0.049	0.053	0.096	0.101	0.093**	0.089	0.108***	0.245	0.018***
Extreme poverty	0.162	0.162	0.165	0.150	0.158	0.040	0.229***	0.229	0.208	0.242***	0.228	0.195**	0.025	0.335***
Assets	0.417	0.414	0.419	0.413	0.415	0.119	0.582***	0.416	0.529	0.352***	0.453	0.575	0.155	0.552***
Equipment		-	-	-	-	-	0.440	-	-	-	-	-	-	0.530
Land		-	-	-	-	-	0.161	-	-	-	-	-	-	0.321
Observations	29225	10969	18256	4039	6930	5780	23445	29330	11004	18326	4094	6910	5307	24023

Notes: FH= female-headed households, MH= male headed households, DFFH= de facto female-headed households; DJFH= de jure female-headed households
*significantly different at 10%, ** different at 5%, and *** significantly different at 1% from a statistical test of significance.

head. Another notable disparity is that urban households were generally less deprived than their rural counterparts, which requires a spatial analysis of MPI.

4. Discussion of Results

Results for MPI are estimated for the multidimensional poverty cut-off of k=33% of the weighted deprivations which sum to 1. Different cut-off points are used to assess the sensitivity of the results. Households are classified as multidimensional poor if their weighted deprivation count is at least k. The discussion below focusses on the overall picture, rural and urban households, and by marital status of the household head.

4.1 Overall picture and by sex of the household head

MPI results for the country as a whole are presented in Table 3. The national multidimensional adjusted poverty headcount ratio (M_0) was 0.170 in 2011 and 0.153 in 2017. This multidimensional poverty incidence decreased by 0.017 percentage points, i.e. (9.8%) between the two periods, which is statistically significant at 1%. While multidimensional poverty is still evident, this result suggests that the incidence is slowly decreasing within the country's economic recovery period. Notably, our result for 2011 is of the same order as Stoeffler et al. (2016), who reported M_0 of 0.193, although their study had a national rather than a gender perspective.

Concerning gender differentials, results for M_0 show that show that 17.3% of FHHs and 16.8% of MHHs were multidimensional poor in 2011. However, these percentages are statistically similar at the 5% level. This follows, as both poor FHHs and MHHs were deprived in about 45% of the weighted indicators, measured by the intensity (A) of multidimensional poverty. The multidimensional poverty head counts (H) for both household types almost converged at a poverty incidence of 37%. The picture changed in 2017 as FHHs faced higher multidimensional deprivation than MHHs. The M_0 for MHHs was 0.133 while that for FHHs was 0.19 suggesting a gender gap of 43%. The disparity was entirely driven by the gender difference in observed poverty incidence (43%). Further, the M_0 for FHHs increased by 9.9% from 2011 to 2017 while that for MHHs decreased by 21.3%. These results show that although both household types suffered from multidimensional deprivation in 2011, the situation for FHHs deteriorated in 2017 while that for MHHs improved. The inference can be made that gender parity could be achieved by lowering poverty incidence among FHHs.

4.2 Rural/urban households

MPI results for rural and urban households are shown in Table 4. In 2011 the M_0 for FHHs in urban areas was 0.072 compared to 0.085 for MHHs. However, these poverty experiences are statistically similar, which dismisses evidence of a gender gap. The situation was different for rural households, as the gender gap in M_0 showed that FHHs

Table 4: Multidimensional Poverty for Rural and Urban areas, 2011 and 2017

	Urban - Female			Urban - Male			Rural - Female			Rural - Male			Urban gender gap				Rural gender gap			
	Coef.	SE.		Coef.	SE.		Coef.	SE.		Coef.	SE.		Coef.	SE.		Ratio	Coef.	SE.		Ratio
2011																				
H	0.072	(0.008)	***	0.085	(0.008)	***	0.403	(0.006)	***	0.371	(0.005)	***	-0.013	(0.011)		0.8499	0.032	(0.008)	***	1.0872
M0	0.031	(0.004)	***	0.037	(0.003)	***	0.170	(0.003)	***	0.155	(0.002)	***	-0.006	(0.005)		0.8447	0.015	(0.003)	***	1.0935
A	0.435	(0.010)	***	0.437	(0.008)	***	0.422	(0.002)	***	0.419	(0.001)	***	-0.003	(0.013)		0.9937	0.002	(0.002)		1.0057
2017																				
H	0.111	(0.010)	***	0.088	(0.008)	***	0.428	(0.006)	***	0.351	(0.005)	***	0.023	(0.012)	*	1.2592	0.076	(0.008)	***	1.2176
M0	0.046	(0.004)	***	0.036	(0.003)	***	0.181	(0.003)	***	0.147	(0.002)	***	0.010	(0.005)	*	1.2718	0.034	(0.003)	***	1.2289
A	0.417	(0.009)	***	0.413	(0.007)	***	0.423	(0.001)	***	0.420	(0.001)	***	0.004	(0.011)		1.0098	0.004	(0.002)	**	1.0093
Change over time																				
H	0.039	(0.013)	***	0.003	(0.011)		0.025	(0.009)	***	-0.019	(0.007)	***								
	[53.7]			[3.5]			[6.1]			[-5.2]										
M0	0.015	(0.006)	**	-0.001	(0.005)		0.011	(0.004)	***	-0.008	(0.003)	***								
	[48.3]			[-2.7]			[6.6]			[-5.2]										
A	-0.017	(0.013)		-0.024	(0.010)	**	0.002	(0.002)		0.000	(0.002)									
	[-4.0]			[-5.5]			[0.4]			[0.1]										

Notes: All estimates are bootstrapped (500 replications). Significance level: ***=1%, **=5%, *=10%. For changes over time percentage points and standard errors are shown on top while percentage changes are in square brackets.

Table 3: Overall Multidimensional Poverty, 2011 and 2017

	Overall			Female			Male			Female - Male gap			
	Coef.	SE.		Coef.	SE.		Coef.	SE.		Coef.	SE.		Ratio
2011													
H	0.375	(0.004)	***	0.380	(0.006)	***	0.372	(0.005)	***	0.008	(0.008)		1.021
M0	0.170	(0.002)	***	0.173	(0.003)	***	0.168	(0.002)	***	0.005	(0.004)		1.028
A	0.454	(0.001)	***	0.456	(0.002)	***	0.453	(0.001)	***	0.003	(0.002)		1.007
2017													
H	0.344	(0.004)	***	0.425	(0.006)	***	0.297	(0.004)	***	0.128	(0.008)	***	1.431
M0	0.153	(0.002)	***	0.190	(0.003)	***	0.133	(0.002)	***	0.058	(0.003)	***	1.435
A	0.447	(0.001)	***	0.447	(0.001)	***	0.446	(0.001)	***	0.001	(0.002)		1.003
Change over time													
H	-0.031	(0.006)	***	0.046	(0.009)	***	-0.075	(0.006)	***				
	[-8.3]			[12]			[-20.0]						
M0	-0.017	(0.003)	***	0.017	(0.004)	***	-0.036	(0.003)	***				
	[-9.8]			[9.9]			[-21.4]						
A	0.007	(0.001)	***	-0.009	(0.002)	***	-0.007	(0.002)	***				
	[1.6]			[-1.9]			[-1.5]						

N zotes: All estimates are bootstrapped (500 replications). Significance level: ***=1%, **=5%, *=10%. For changes over time percentage points and standard errors are shown on top while percentage changes are in square brackets.

were more deprived by 9%, due to their relatively higher poverty incidence (H) than MHHs (8% gender gap). In 2017, 4.6% percent of FHHs and 3.6% of MHHs in urban areas were multidimensional poor, again due to a high poverty incidence rather than poverty intensity (A). This yielded a statistically significant gender gap of 27%. The result also extended to rural areas as FHHs were 22% multidimensional poorer than MHHs. Thus, FHHs in rural areas were consistently poorer than their male-headed counterparts, and the gender gap increased over time.

A temporal analysis of the multidimensional poverty experiences by sex of the householder reveals that FHHs experienced a poverty increase from 2011 to 2017 regardless of geographic area, while a decrease was registered for MHHs. The highest deterioration in poverty experience was encountered by FHHs in urban areas (48.3% increase in M_0) whist the highest improvement accrued to MHHs in rural areas (5.2% decrease in M_0). When considered alongside the national picture, this outcome links Zimbabwe's decline in multidimensional poverty over the given period more to MHHs than FHHs.

4.3 Marital status

In light of existing literature suggesting that household welfare may vary by the head's marital status, we analyse multidimensional poverty by marital status of the household head. In the preceding discussion, FHHs were shown to have a higher extent of deprivation than MHHs. Hence, we first compare M_0 of MHHs to that for de facto and de jure FHHs and then proceed to examine M_0 by gender of household head and type of marital status. Table 5 shows that in 2011, 17.8% of de jure and 16.5% of de facto FHHs were multidimensional poor compared to 16.8% of MHHs. These figures were, however, statistically similar which dispels the existence of a gender gap.

In contrast, there were gender gaps in adjusted poverty headcount in 2017. De jure FHHs had an M_0 of 0.206, while this was 0.164 for de facto FHHs and 0.133 for MHHs. This shows that de jure FHHs' deprivation score was 25.6% higher than de facto FHHs'. Based on these figures, statistically significant gender differences in multidimensional deprivation emerged. De jure FHHs were 55% more deprived than MHHs, while this relative deprivation was 23% for de facto FHHs. Thus, de jure FHHs were relatively worse off than de facto FHHs when compared to MHHs. Results for changes in poverty over time show that de jure FHHs incurred a 16.3% increase in multidimensional poverty from 2011 and 2017, while de facto FHHs incurred a negligible decrease of 0.3%.

Table 6 presents outcomes of never married (single), married and widowed/ divorced FHHs and their MHHs counterparts.

Never married (single) heads: In 2011, the adjusted poverty headcount was marginally higher among single FHHs (M_0 of 0.161) than single MHHs (M_0 of 0.156). The opposite was observed in 2017 as FHHs' M_0 was 0.098 compared to 0.109 for MHHs. Both single FHHs and MHHs experienced a decrease in multidimensional poverty from 2011 and 2017, with

Table 5: Multidimensional poverty for De jure and De facto FHHs and MHHs

	Male		De jure Female		De facto Female		De jure Female - Male Gap			De facto Female - Male Gap		
	Coef.	SE.	Coef.	SE.	Coef.	SE.	Coef.	SE.	Ratio	Coef.	SE.	Ratio
2011												
H	0.372***	(0.005)	0.384***	(0.008)	0.371***	(0.011)	0.012	(0.024)	1.032	-0.001	(0.023)	0.997
M0	0.168***	(0.002)	0.178***	(0.004)	0.165***	(0.005)	0.009	(0.012)	1.059	-0.004	(0.011)	0.982
A	0.453***	(0.001)	0.463***	(0.002)	0.444***	(0.002)	0.010	(0.023)	1.022	-0.009	(0.022)	0.980
2017												
H	0.297***	(0.004)	0.461***	(0.008)	0.367***	(0.010)	0.164***	(0.029)	1.552	0.070***	(0.024)	1.236
M0	0.133***	(0.002)	0.206***	(0.004)	0.164***	(0.005)	0.074***	(0.014)	1.549	0.032***	(0.012)	1.233
A	0.446***	(0.001)	0.477***	(0.002)	0.447***	(0.003)	0.001	(0.023)	1.069	0.001	(0.023)	1.002
Change over time												
H	-0.075***	(0.006)	0.077***	(0.012)	-0.004***	(0.014)						
	[-20]		[20]		[-1.1]							
M0	-0.036***	(0.003)	0.029***	(0.006)	-0.0005*	(0.0003)						
	[-21.4]		[16.3]		[-0.30]							
A	-0.007	(0.002)	-0.015***	(0.003)	0.003***	(0.0002)						
	[-1.5]		[-1.8]		[0.68]							

Notes: All estimates are bootstrapped (500 replications). Significance level: ***=1%, **=5%, *=10%. For changes over time percentage points and standard errors are shown on top while percentage changes are in square brackets

Table 6: Multidimensional poverty by marital status and gender of household head (2011 – 2017)

	Single			Married			Widow/divorced		
	Female	**Male**	**Diff.**	**Female**	**Male**	**Diff.**	**Female**	**Male**	**Diff.**
2011									
H	0.365	0.360	0.005***	0.371	0.372	-0.001**	0.386	0.372	0.014***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
A	0.442	0.434	0.009***	0.444	0.453	-0.009***	0.464	0.465	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
M0	0.161	0.156	0.005***	0.165	0.169	-0.004***	0.179	0.173	0.006***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2017									
H	0.231	0.267	-0.036***	0.367	0.292	0.075***	0.480	0.424	0.055***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
A	0.426	0.410	0.017***	0.447	0.449	-0.002***	0.448	0.430	0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
M0	0.098	0.109	-0.011***	0.164	0.131	0.033***	0.215	0.182	0.033***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Changes over time									
H	-0.134***	-0.093***		-0.004***	-0.080***		0.093***	0.052***	
	(0.002)	(0.001)		(0.001)	(0.000)		(0.001)	(0.001)	
	[-36.7]	[-25.8]		[-1.08]	[-21.5]		[24.1]	[14]	
A	-0.016***	-0.024***		0.003***	-0.004***		-0.016***	-0.035***	
	(0.000)	(0.000)		(0.0002)	(0.000)		(0.000)	(0.000)	
	[-3.61]	[-5.53]		[0.68]	[-0.88]		[-3.45]	[-7.53]	
M0	-0.063***	-0.047***		-0.0005*	-0.037***		0.036***	0.009***	
	(0.016)	(0.001)		(0.0003)	(0.0002)		(0.000)	(0.001)	
	[-39.1]	[-30.1]		[-0.30]	[-21.9]		[20.1]	[5.20]	

Notes: All estimates are bootstrapped (500 replications). Significance level: ***=1%, **=5%, *=10%. For changes over time percentage points and standard errors are shown on top while percentage changes are in square brackets

higher decreases registered among the single FHHs (39.1% compared to 30.1%).

Married heads: In 2011, the incidence of multidimensional poverty was marginally lower among married FHHs than married MHHs (16.5% against 16.9%). This position was reversed in 2017 as 16.4% of married FHHs were multidimensional poor compared to 13.1% of their male-headed counterparts. From 2011-2017, MHHs experienced a considerable decrease in multidimensional poverty (21.9%) while a trivial decrease was observed (0.30%) among FHHs. Thus, married FHHs were worse off over time compared to married MHHs.

Widow/divorced heads: In both periods, multidimensional poverty was higher among households with widow/divorced female heads compared to their counterpart MHHs. For instance, 21.5% of the FHHs were multidimensional poor in 2017 compared to 18.2% for the MHHs. Generally, both widowed/divorced MHHs and FHHs experienced an increase in multidimensional poverty from 2011 to 2017. The poverty increase was much higher among FHHs (20.1%) than MHHs (5.20%). When considered across marital status groups, multidimensional poverty was higher among households headed by the widowed/divorced, in both 2011 and 2017. Worse still, these households experienced a temporal increase in poverty while other groups had a decrease. Accordingly, poverty eradication among FHHs in Zimbabwe should be sensitive to the householder's marital status; widows and divorcees are worse off compared to their married and single counterparts.

4.4 Decomposing multidimensional poverty

The multidimensional poverty index M_0 can be decomposed to assess the contribution of each dimension to poverty, which is important for policy purposes. Figure 1 shows results for MHHs and FHHs in 2011 and 2017. In both periods, a low asset base, lack of access to electricity and clean sources of fuel for cooking, and extreme poverty, were the greatest contributors to multidimensional deprivation. These dimensions indiscriminately affected all households regardless of the heads' sex and time period. However, in 2011 poor adult education also had a significant influence on FHHs' deprivation, while it affected both household types in 2017. Notably, low household asset base and unclean sources of fuel for cooking contributed 51% to overall poverty in 2011 and 2017.

Table 7 presents results for rural and urban households. For urban areas, in 2011, a low asset base explained almost 35% of deprivation faced by both household types; chronic diseases, no access to health care, poor adult education, unclean sources of fuel for cooking and low access to electricity were also notable contributors. Extreme poverty also contributed to deprivation in MHHs while poor adult education had a slightly larger contribution to poverty for FHHs than MHHs. In 2017, health and education were low contributors, whereas unemployment and unclean sources of cooking fuel became greater sources of deprivation for both household types, although less than assets.

Similar to urban households, a low asset base and unclean sources of fuel for cooking were also significant sources of deprivation in rural households in 2011, regardless

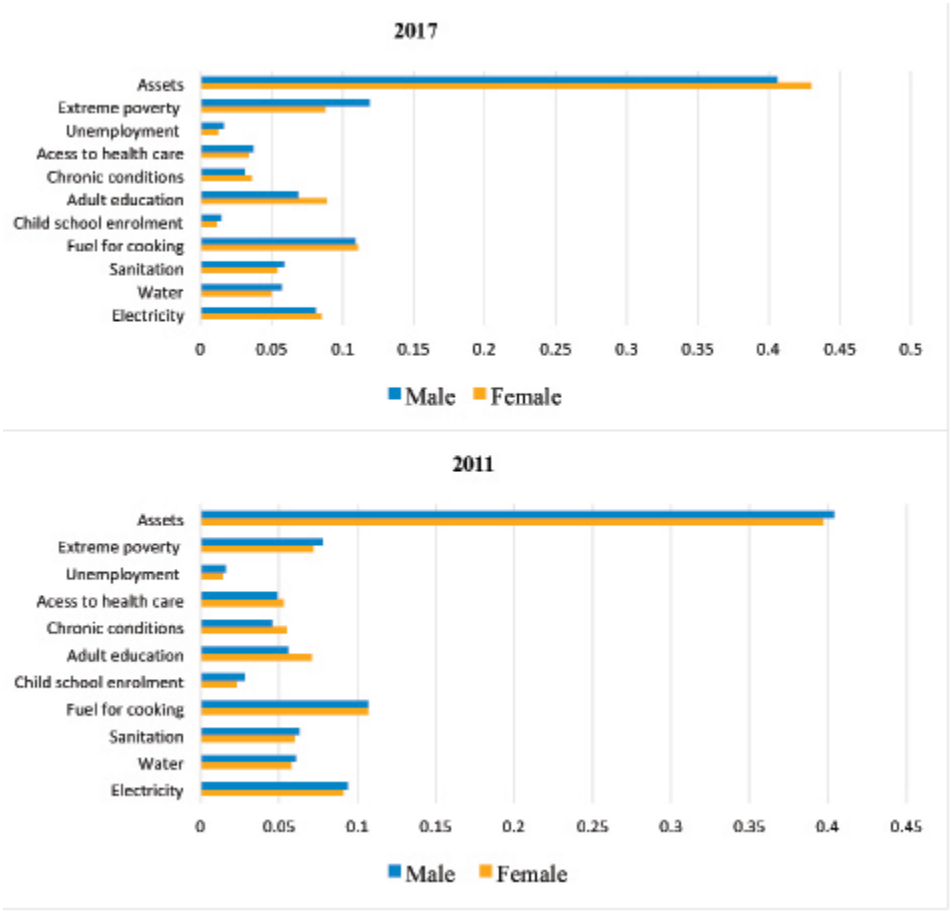
Table 7: Percentage Contribution of Each Dimension to Multidimensional Poverty in Rural and Urban areas for k=33%, 2011 - 2017

		2011				2017			
		Urban		Rural		Urban		Rural	
		Male	Female	Male	Female	Male	Female	Male	Female
	M_0	0.037	0.031	0.155	0.17	0.036	0.046	0.147	0.181
% Contribution of subgroup to M_0 (%)									
Domain 1	Electricity	0.072	0.061	0.103	0.1	0.048	0.049	0.091	0.098
	Water	0.077	0.072	0.067	0.065	0.069	0.047	0.06	0.056
	Sanitation	0.058	0.058	0.07	0.067	0.035	0.023	0.067	0.062
	Fuel for cooking	0.073	0.076	0.118	0.117	0.093	0.108	0.119	0.118
Domain 2	Child school enrolment	0.052	0.040	0.038	0.03	0.030	0.021	0.017	0.014
	Adult education	0.072	0.100	0.076	0.093	0.046	0.057	0.089	0.112
Domain 3	Chronic conditions	0.073	0.102	0.065	0.074	0.037	0.054	0.04	0.046
	Access to health care	0.086	0.093	0.068	0.073	0.056	0.062	0.048	0.045

Domain 4	Unemployment	0.017	0.015	0.022	0.018	0.113	0.122	0.009	0.005
	Extreme poverty	0.071	0.051	0.105	0.096	0.05	0.034	0.153	0.117
Domain 5	Assets	0.349	0.333	0.129	0.129	0.423	0.423	0.121	0.142
	Agriculture Equipment			0.105	0.106			0.118	0.127
	Land			0.034	0.032			0.07	0.058

household type. Other sizeable contributors were agriculture equipment deprivation, low access to electricity, extreme poverty and poor adult education. While these indicators were also significant in 2017, extreme poverty overtook assets to become the largest contributor to deprivation in MHHs (15% versus 12%). Notably, extreme poverty had a relatively larger contribution to deprivation in MHHs (15.3%) than FHHs (11.7%). The relative contribution of agriculture equipment deprivation, poor adult schooling and extreme poverty to multidimensional poverty in FHHs also increased from 2011 to 2017. More importantly, a meticulous analysis of the results shows that, overall, asset deprivation and having no adult who surpassed grade 7 in the household were the key contributors to the increase in the gender gap from 2011 to 2017. This discussion largely shows that MHHs and

Figure 1: Percentage Contribution of Each Dimension to Multidimensional Poverty for k=33%



FHHs in Zimbabwe were deprived in similar dimensions. Also rural households faced more contributors to their poverty than urban households.

4.5 Sensitivity checks

To assess robustness of our results we carry out two types of sensitivity checks that are linked to indicator weights and cut-off points given normative choices surrounding their specification in the AF method. Poverty domains in the main analysis were equally weighted. In this section, context specific weights were applied to the variables as discussed earlier. The five domains were weighted as follows: Education (20%), Health (10%), Income (20%), Living conditions (40%) and Assets (10%).

Results in Table 8 in the appendix confirm that nation-wide poverty decreased (by 12.1% from 2011-2017). Also in 2011, there was no statistically significant gender bias in the occurrence of multidimensional poverty. In 2017 FHHs were generally more deprived than MHHs, a gender gap of 24.9% (M_0 of 20.6 compared to 16.5). The results also confirm that multidimensional poverty decreased among MHHs by 19.5% while it increased among FHHs by 1%, although the latter is statistically insignificant.

To assess sensitivity of the results to different cut-offs, multidimensional poverty was estimated using equal weights and cut-off points of 10%, 20%, 30%, 40% and 50%. The results are presented in Figure 2 in the appendix. These are qualitatively in congruence with those obtained at cut-off of 33%, which shows less sensitivity to choice of cut-off point. Taken together, these robustness checks show that our main results can be relied on.

5. Conclusion and Policy Recommendations

Multidimensional poverty incidence in Zimbabwe did not discriminate households by sex of the householder in 2011. This could be due to a lagged effect of the economic crisis that generally eroded household welfare. However, in 2017 FHHs faced higher deprivation than MHHs. This suggests that the relative position of FHHs became worse while that for MHHs improved during the economic recovery period. Our outcome for MHHs builds onto the declining trend uncovered by Stoeffler et al. (2016) at national level, during 2001-2011.

We also found heterogeneous poverty experiences by marital status of the household head. De jure FHHs were poorer than de facto FHHs and MHHs. Also, FHHs and MHHs with widow/divorced heads experienced higher poverty than those with single or married heads. The former experienced a temporal increase in poverty while the others had a decline. Further, an analysis of the gendered household poverty gap by geographic location showed that only rural areas were affected since they faced more contributors to their deprivation than urban households.

Other results show that FHHs and MHHs had similar sources of deprivation regardless of time period. The key contributors were deprivations in the asset, living conditions and income dimensions. Therefore, sources of deprivation in MHHs and FHHs affected both households alike. We also noted that asset deprivation and having no adult who surpassed grade 7 in the household were the key contributors to the increase in the gender gap from

2011 to 2017.

Our results suggest a need for policies that relax constraints on asset ownership and strengthen poor households' welfare and economic empowerment. Low household income/expenditure can be improved by promoting the creation of decent jobs and bolstering small-to-medium enterprises. Concerted efforts to improve living conditions and particularly household access to electricity and clean sources of fuel for cooking are also essential. Lastly, donor programmes and the GoZ's targeting of social safety nets should be sensitive to de jure FHHs being more deprived than de facto FHHs. The same applies to strategies to reduce the gender gap as it is more of a rural than urban problem.

This study is not without limitations. First, due to data constraints, our analysis excludes other important indicators of poverty such as food security and nutrition. Second, the analysis is focused on FHHs and MHHs and does not explicitly consider the position of women within these households. Hence, some of our policy recommendations may not directly apply to women who live in MHHs as they may face different constraints. This can be addressed by future studies which focus on the situation of female- and male-dominated households.

top while percentage changes are in square brackets

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Appendix

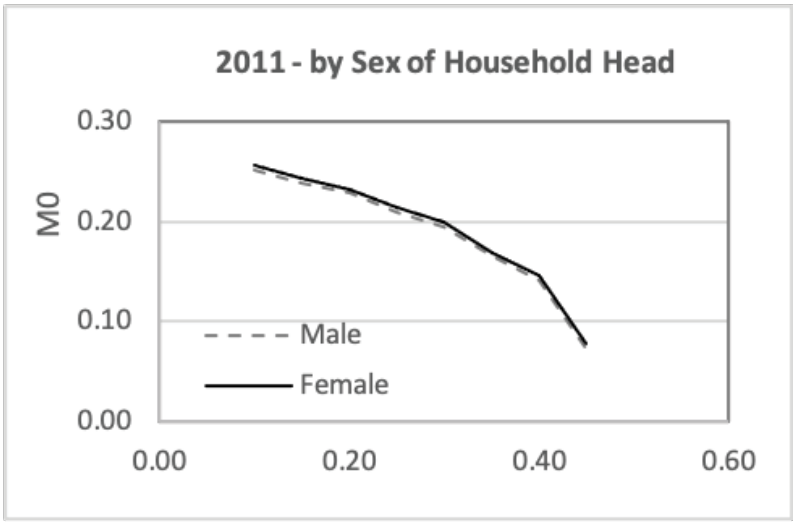
Results for sensitivity checks:

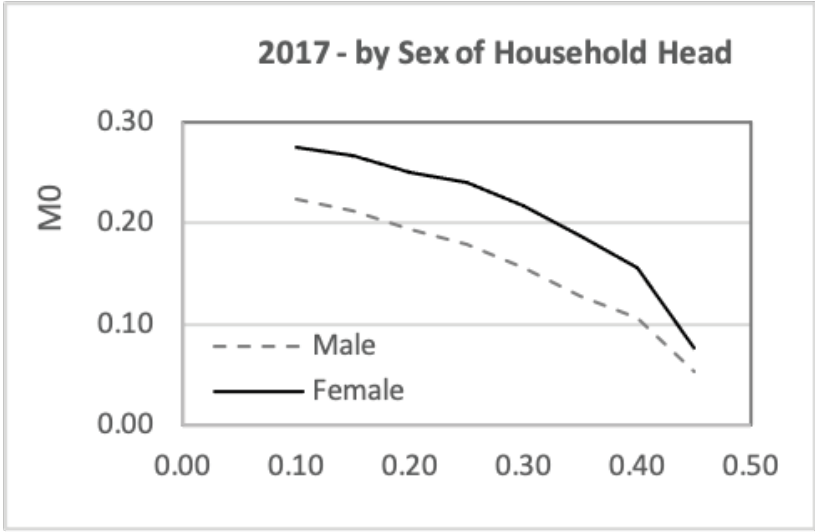
Table 8: Robustness check to context specific weights, Overall results and by sex of the household head, k=33%

	Overall			**Female**			**Male**			**Female - Male gap**			
	Coef.	SE.		Coef.	SE.		Coef.	SE.		Coef.	SE		**Ratio**
2011													
H	0.425	(0.004)	***	0.424	(0.007)	***	0.425	(0.005)	***	-0.001	(0.008)		0.9976
M0	0.204	(0.002)	***	0.204	(0.003)	***	0.204	(0.003)	***	-0.001	(0.004)		1.0000
A	0.481	(0.001)	***	0.481	(0.002)	***	0.481	(0.001)	***	0.000	(0.002)		1.0000
2017													
H	0.377	(0.004)	***	0.431	(0.006)	***	0.347	(0.005)	***	0.084	(0.008)	***	1.2421
M0	0.179	(0.002)	***	0.206	(0.003)	***	0.165	(0.002)	***	0.041	(0.004)	***	1.2485
A	0.476	(0.001)	***	0.478	(0.002)	***	0.474	(0.001)	***	0.004	(0.002)	*	1.0084
Change over time													
H	-0.048	(0.006)	***	0.006	(0.009)		-0.078	(0.007)	***				
	[-12.7]			[1.5]			[-18.4]						
M0	-0.025	(0.003)	***	0.002	(0.004)		-0.040	(0.004)	***				
	[-12.1]			[1.0]			[-19.6]						
A	-0.005	(0.002)	***	-0.002	(0.002)		-0.007	(0.002)	***				
	[-1.0]			[-0.4]			[-1.4]						

Notes: All estimates are bootstrapped (500 replications). Significance level: ***=1%, **=5%, *=10%. For changes over time percentage points and standard errors are shown on top while percentage changes are in square brackets.

Figure 2: Results based on different cut off points by Sex of the Household Head, k=33%





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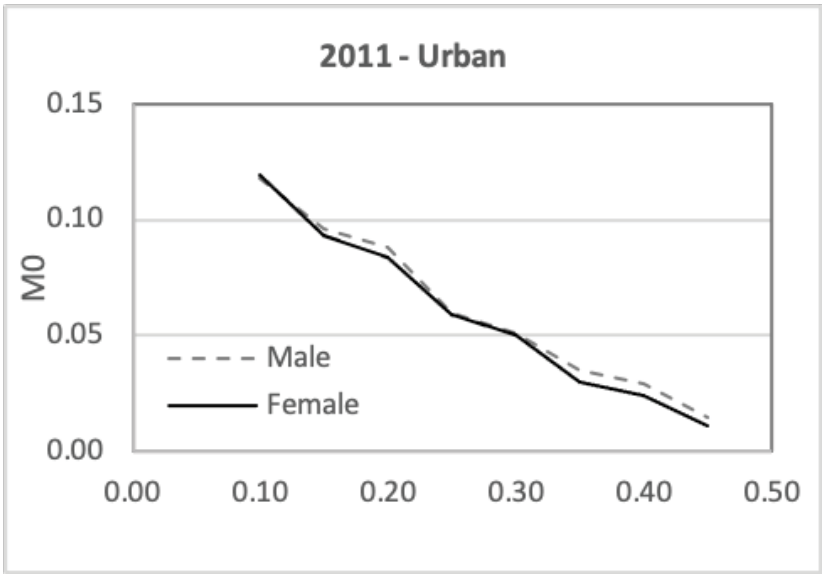

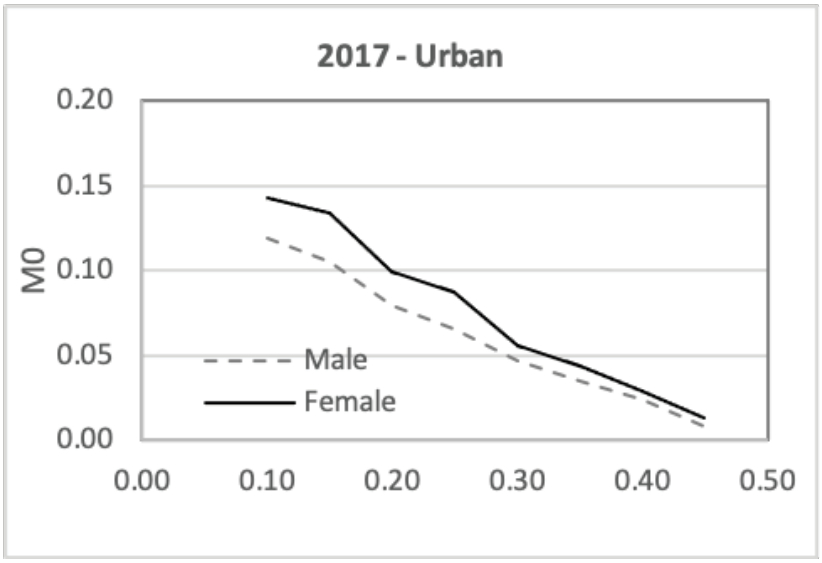

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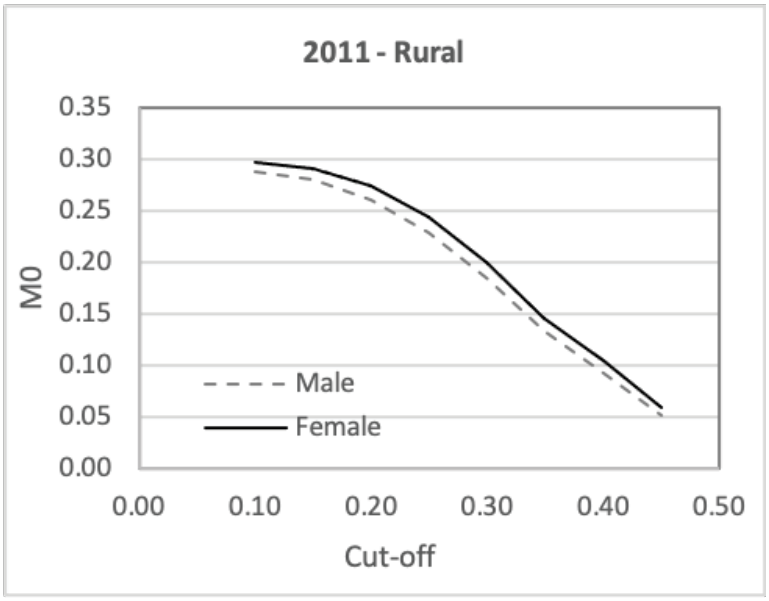
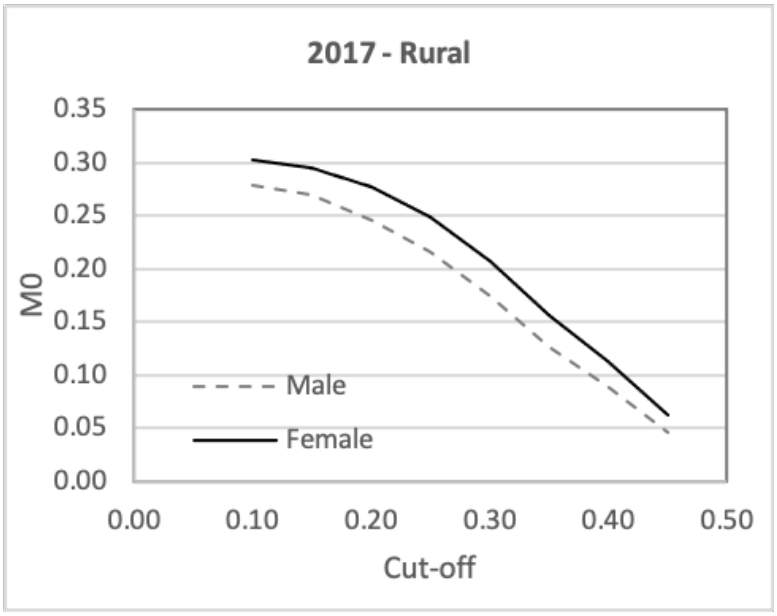




Agricultural Free Input Support Schemes, Input Usage, Food Insecurity and Poverty In Rural Zimbabwe

Carren Pindiriri, Fortune Mazvita Nyajena,
Grown Chirongwe, Grace Nicholas Nkomo

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, and 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 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

Jel classifications : I32, I38, Q18

1. Introduction

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 (GoZ 2019, World Bank 2019, Baltzer and Hansen 2011, IMF 2019). 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%) 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 (GoZ 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 (ibid.) but the country still experienced a food production gap of over 50% of the required national consumption (GoZ 2019). Input subsidy schemes are centred on the assumption that by reducing the costs of agricultural inputs, their usage will go up, thereby increasing production and food security (Druilhe and Barreiro-Hurle 2012).

Governments face a dilemma of whether to increase expenditure on subsidising vulnerable households or manage budget deficits through cutting down subsidies. Cutting down subsidies for vulnerable households may however have future budgetary implications as the demand for food aid may rise in the future. Thus, governments may be tempted to subsidise the vulnerable households to avoid future spikes in 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 mobilising sustainable and affordable funding for farmers with large farms in order to boost agricultural productivity in staple crops and livestock to ensure food security; the Presidential Input scheme 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 paper 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.

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 and Rashid 2013, Holden and Lunduka 2014, Baltzer and Hansen 2011, Crawford et al. 2006). On the other hand, there also exists strong evidence that agricultural input subsidies may lead to inefficiencies, agricultural market distortions and policy distortions which may drain the government's budget (Baltzer and Hansen 2011, Banful 2010, 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 and 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. The debate on the continued application of input subsidies and their design has 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 (see Lopez et al. 2017). Recently, Gwatidzo and Muyengwa (2020) evaluated the impact of command agriculture on maize yield 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.

Two major issues arise from free input support schemes once implemented. The first concerns 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 taxpayers' 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, 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.

The second issue 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 reducing poverty amongst vulnerable households through enhancing agricultural productivity. Therefore, the question is whether these input support schemes 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.

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 the planning and restructuring of some subsidy schemes, where the government is contemplating to liberalise the economy. However, impact evaluations in agriculture are limited in Zimbabwe and other developing countries (see Lopez et al. 2017, Chirwa and Dorward 2013, Jayne and Rashid 2013). The main goal of this article is, therefore, to cover this gap by providing a rigorous impact evaluation of government policies and programmes 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:

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

The rest of the article is organised as follows: Section 2 covers methodology while Section 3 presents the findings. Conclusions and policy implications are presented in Section 4.

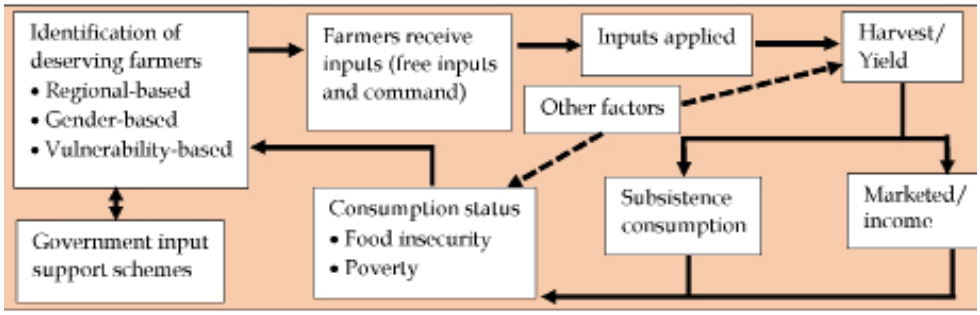
2. Methodology

2.1 Theoretical framework

The benefits and costs of an input subsidy are extensively discussed in economic theory. Conventional microeconomic theory suggests that subsidising private goods such as agricultural inputs in a competitive market with no market failure distorts resource allocation (Mas-Colell et al. 1995). An input subsidy acts as a negative tax to farmers which reduces the input price paid by the farmer and consequently raises 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 the 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, Siamwalla and 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 constraints (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. 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 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 many rural households rely on subsistence agriculture, any intervention that influences yield will therefore have a direct effect on their well-being or poverty. Figure 1.1 illustrates how government input support schemes are linked to household poverty. Input subsidy influences the affordability and availability of inputs which in turn influences output. Output is either consumed or sold to generate the revenue/income required by farmers to spend on purchased food and non-food items.

Figure 1.1: Input support and poverty linkages



Source: Authors' illustration

Figure 1.1 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 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 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. The framework in Figure 1.1 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 but are also influenced by other factors such as post-harvest storage and losses, climate variability and shocks, soils, and farmer knowledge.

One of the main advantages of using the 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. 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 paper 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 their income falls below a given poverty line, say less than US$1.25 per day. In Zimbabwe, the poverty line is established by the Zimbabwe National Statistics Agency (Zimstat). Food security on the other hand is a multidimensional concept which broadly characterises food availability (physical access to food), food accessibility (economic access to food), food utilisation (absorption of nutrients into the body), and vulnerability (Mahadevan and Hoang 2015). For the purposes of this study, an index for measuring food security generated by Zimstat from the 2017 PICES 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).

2.2 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 was applied in this article. We used two modules, namely, the poverty module and the Agriculture Productivity Module (APM). While the poverty module provides data aggregated at the household level, the APM collects plot level data. So, within a household, there can be several plots. As a result, we merged one household to many plots. Like the poverty module, the APM is a nationally representative survey on agricultural productivity. 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.

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.

With a total of 2,338 APM household responses, less than 4% 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. However, the assessment of command programmes may provide useful information regarding the recipients of command inputs as done by Gwatidzo and Muyengwa (2020). The 2017 APM has some questions that are useful in evaluating the impact of input support schemes on food security and poverty. For example, question 8 asks whether a household used any FREE SEED for [CROP] on the

[PLOT] during the agricultural season 2016/2017. The data indicate that about 18.3% of the 13,385 plots used free seed while 81.7% used purchased seed. The number of responses is 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 2.1 illustrates the number of plots which used free seed under various government and other programmes during the APM 2017. Other sources include non-government actors and well-wishers.

Table 2.1: Responses to input support

Programme ↓	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)

Despite the increase in government spending on input support schemes, extreme poverty rose to 29% in 2017 from 21% in 2011/12 with rural poverty reaching 40.9% 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 increased slightly from 76% in 2011 to 76.9% in 2017, while urban poverty declined from 38.2% to 30.4% in the same period (Zimstat 2019). The same source shows that individual poverty rose from 84.3% in rural areas in 2012 to 86% 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 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. 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 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 gender, helps policy makers 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. Generally, the first set of results helps policy makers to design agricultural input support schemes that 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 . 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:

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

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

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

where Q_i is the outcome variable (food insecurity or poverty) of household i, ˜ is an intercept term, S_i is agricultural free input support for household i, $Prov_j$ is province j, $\boldsymbol{Z}$ is an $n \times k$ vector of household characteristics, λ_1 , λ_2 and $\boldsymbol{\theta}$ are the estimated parameters and e_i is an error term which was assumed to be logistically distributed. $\boldsymbol{X}$ is an $n \times k$ vector of factors that influence the probability of receiving free seed support and $\boldsymbol{\beta}$ is a vector of estimated parameters. The term $Prov_j S_i$ is an interaction term of province and free input support. Hence, the parameter λ_{2j} measures the regional or spatial impact of free input support schemes on the outcome variables relative to the base province. A robust λ_{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 v_i is correlated with 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, $Corr(S,V) \neq 0$ 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 $\boldsymbol{X}$, generates a good instrument for S. We therefore combine PSM and the Heckman in this study. Triangulation of these techniques helps in reducing the biases inherent in one technique. The findings help policy makers to identify regions in which input support schemes are more effective, therefore providing the basis for the argument for or against regional differential subsidies.

Furthermore, with regard to empirical strategy, there has been increased realisation of the importance of impact evaluations as an important tool of analysing 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 (ibid., Pamuk et al. 2015, Carter et al. 2014, Duflo et al. 2008, Chibwana et al. 2010, 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 applied empirical strategies.

The provision of some of the input subsidies in Zimbabwe has not been conditional upon certain defined households' characteristics. Hence, RDD is not appropriate since it requires some form of assessment 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 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 its implementation (endline 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.

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 subsidised. 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 and Skuras 2003). Following Pindiriri (2018), let i be an index representing the i^{th} household and S_i 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 Q_{i0} and Q_{i1} to be the potential outcome that would occur when a household does not receive an input support ($S_i = 0$) and when a household receives an input subsidy ($S_i = 1$), 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:

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

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:

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

The observed outcome (input usage, income, food insecurity and poverty) of the household is there expressed as:

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

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

Equation (5) can equally be written as:

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

where $b_i = Q_{i0}$ 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 β_i) is not observable, the treatment effect, β_i, is unidentified. However, Rubin (1977) demonstrates that with a randomised 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 ($E(Q_{i1}|S_i = 1)$) is the same as the expected outcome of the untreated if the untreated had received subsidies ($E(Q_{i1}|S_i = 0)$). 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 e˜ ect (ATE) and the average treatment e˜ ect on the treated (ATET):

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

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

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 and 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:

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

$e(X_i)$ can equally be regarded as a balancing score which is a function of the covariates (X_i) given as $\varphi(X)$ such that the conditional distribution of X given $\varphi(X)$ 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, $\{Q_{i1}, Q_{i0} \perp S_i\} | X_i$. Second, we assume that the probabilities of being treated and of not being treated are positive (the overlap assumption). With these assumptions, referred to as 'strong ignorability' by Rosenbaum and Rubin (1983), the average treatment effect on the treated (ATET) presented in (8) can be expressed as:

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

Since the study is non-experimental where propensity scores are known, propensity scores were estimated using the logit. In addition to demographic characteristics such as education and gender, the scores were generated using district dummies to account for regional characteristics such as climate variability and shocks and soil types. The estimated 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 subsidise 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.

In poverty measurement, a household is 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$31.30 per person was rebased to US$29.80 per person; the upper was rebased from US$ 70.40 to US$66.10 while the rebased lower poverty line is US$45.60. Nevertheless, the analysis on poverty impact of free input schemes focused on the lower poverty line. 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. It is important to note that findings from a lower line may differ from those based on extreme poverty line. 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.

3. Empirical findings of the study

3.1 Descriptive statistics, distribution and targeting of government input support

The mean plot size from 13,785 plots is about 0.73 hectares (ha) with a minimum of 0 and a maximum of 1,295 hectares. Only 0.6% 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 paper'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 paper. Hence, only 13,710 plots were investigated with a mean size of 0.4 hectares. A total of 18.4% of the plots applied free seed received from government, NGOs, relatives and seed dealers. Out of the 975 plot responses on free seed, 62.4% applied seed input from the presidential input support scheme, 32.6% from input support for the vulnerable, and 5% from NGOs and other providers (see Table 2.1 in the preceding section). About 10.6% of the 11,194 plot

responses applied for the command agriculture programme. The findings show that 7.8% 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 3.1 and 3.2.

Table 3.1: 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

Table 3.2: 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 the Presidential input support	Percent of plots under free seed from input support for vulnerable	Percent of plots under free seed from NGOs and other prog-rammes
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

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

The findings presented in Tables 3.1 and 3.2 show that there are variations across provinces,

regarding the government's free input support schemes. Free input support programmes are more pronounced in Matebeleland South, Matebeleland North and Masvingo. For instance, Table 3.1 shows that 32.7% of the total plots in Matebeleland South received free inputs in the 2016/17 farming season compared to only 12.2% 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. Out of the 609 plots which applied the presidential seed input, 22.7% were from Manicaland, 19.7% from Matebeleland South and 12.3% from Mashonaland Central. Similarly, the largest share of plots which received free seed for the vulnerable is from Mashonaland Central (25.6% of the 317 plots) and Manicaland (19.2% of the 317 plots). However, the mean quantity of seed from input support programmes is smaller in the southern regions of the country (Masvingo, Matebeleland South and Manicaland) compared to Mashonaland provinces and Midlands. In the Mashonaland region, fewer 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%) 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%), Mashonaland West (23%), Mashonaland East (14%) and Midlands and Mashonaland Central both at 8.4%. 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%, Matebeleland South 3.9% and Masvingo 5.1%. The results reveal that the command input support scheme is skewed, and it largely benefited farmers located in Manicaland and Mashonaland provinces. The beneficiaries are mainly located in natural regions I to III (about 82.6% of the beneficiaries are 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 are 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

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 beneÿted from the program. Since the APM did not cover large scale A2 farming areas where the bulk of command agriculture beneÿciaries are, the ÿndings on anythingrelating to command agriculture should be treated with caution. The ÿndings in this paper are therefore mainly centred on the presidential and input support for the vulnerable households

predominant in regions IV and V. The largest share of plots receiving free seed is in regions IV and V with 22.7% and 29.7%, respectively. About 53.4% 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, the presidential input support and input support for the vulnerable support farmers with maize seed in over 50% 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.

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. Figure 3.1 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 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.

These districts with the highest poverty prevalence are located in drier ecological regions IV and V which have the largest number of plots (over 50%) 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 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%) 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% plots under free input support. In general, the poorest districts are the largest beneficiaries of free seed support schemes. Districts with the largest share of plots under free seed support are illustrated in Table 3.3. Superimposing these districts on the poverty maps, show that they are all in high poverty areas.

Table 3.3: Poor districts with the largest share of plots under free input support

District	Percentage of plots under free seed	Percent of poor households
Mangwe	57.3	50
Hwange Rural	45	60
Gwanda Rural	39.7	41

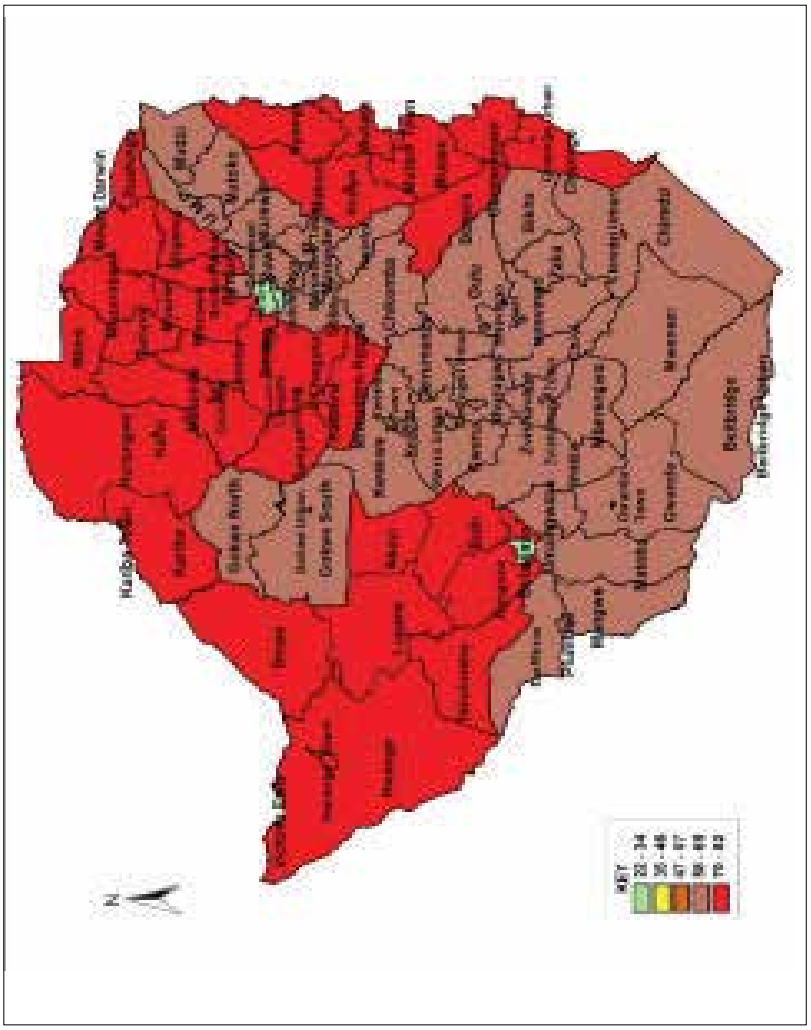


Figure 3.1: Household poverty prevalence map by District

Source: Zimstat (2019)

Table 3.3: Poor districts with the largest share of plots under free input support		
District	**Percentage of plots under free seed**	**Percent of poor households**
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, particularly 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 3.2, which demonstrates 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 schemes, 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).

Although 52% of the population in Zimbabwe are female as in the 2012 Census, 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 show that about 43.6% of the recipients of government's free inputs were plots under the ownership of female-headed households while 56.4% 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% of the recipients of free inputs in Mashonaland Central were for plots in female-headed households while 73% were under male-headed households. Similarly, in Mashonaland West only 28.6% of the plots under free input were under female-headed households and in Midlands, 29.9% 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, the presidential input support and input support for the vulnerable households, need to be redesigned 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.

Figure 3.2: Scatter plot of free seed recipient plots against district poverty

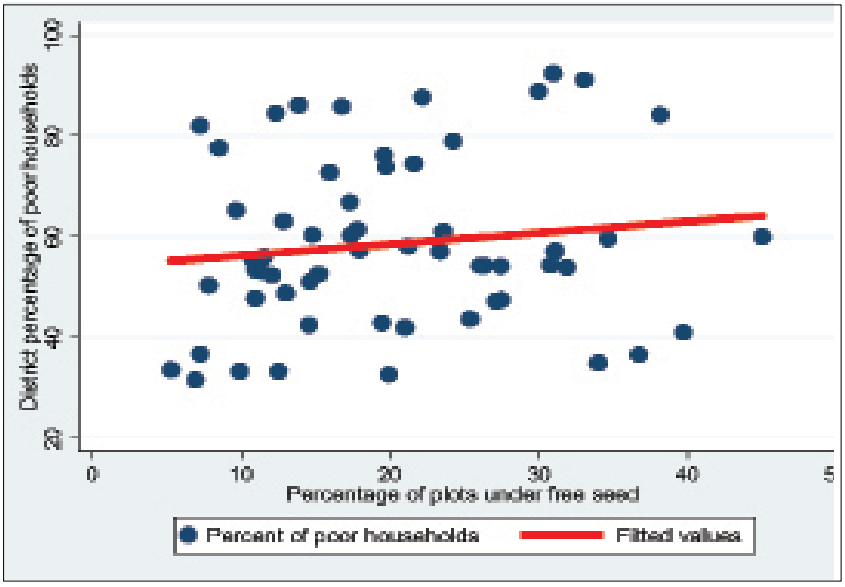


Table 3.4(a) presents provincial yield variability in kilograms per hectare and percentage of the poor, Table 3.4(b) presents yield variability in kilograms per hectare and percentage of the poor by land use, and Table 3.4(c) presents poverty and yield by resettlement type. The main advantage of the descriptive statistics presented in Tables 3.4(b) and 3.4(c) is that the APM survey is nationally representative. Table 3.4(a) shows that yield per hectare and the percentage of poor households vary significantly across provinces. Mashonaland East and Masvingo have the largest coefficients of variation in yield, 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. Using the lower poverty line of US$45.60, Mashonaland provinces are the poorest, followed by Matebeleland North. Poverty levels are very high in the communal and resettlements areas.

Table 3.4(a): Provincial poverty status and yield coefficient of variation (CV)

Province	Obs	Percent of plots under estremely 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
Mash Central	1350	43.9	70.4	11.3	1.4
Mash East	2905	34.2	63.8	31.9	12.2
Mash West	1446	33.7	62.2	7.6	1.64
Mat North	692	28.2	59.5	9.1	1.19
Mat 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 and Mash and Mat stands for Mashonaland and Matebeleland, respectively.
Source: Authors' computations from APM

Table 3.4(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. **Source**: Authors' computations from APM

Table 3.4(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

Of the 58% of plots under poor households, 29.4% are in communal areas and 27.7% in resettlement areas. About 0.5% of the plots in small scale commercial areas belong to poor households compared with 0.6% of the plots in large scale commercial areas. The Pearson statistic for the measure of association rejects the hypothesis that poverty and land use are independent. Furthermore, the findings in Table 3.4(b) demonstrate that the main recipient plots of free seed are in communal and resettlement areas. Less than 1% of the plots, in both small and large commercial areas, benefited from free seed input support. The Pearson measure 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 provides additional evidence of a positive association between poverty and free seed input support. Similarly, the findings in Table 3.4(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 findings from Tables 3.4(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 underutilisation 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 regard 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 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. The Gini coefficient is over 50% 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.

The descriptive findings demonstrate that the design of the command agriculture scheme promotes self-selection of applicants. Most of the participants are in natural 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 strengths 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 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.

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

The findings from the Heckman probit regressions are presented in Table 3.5. Free seed support was instrumentalised 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 λ_{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 a 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 3.5, 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 3.5: Heckman 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*****
		(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)

	(1)	(2)	(3)	(4)
VARIABLES	**Food insecurity**	**Food insecurity**	**Poverty**	**Poverty**
Mat north*free seed	-0.364*** (0.101)	-0.204* (0.106)	base	0.025 (0.080)
Mat south*free seed	-0.272*** (0.082)	-0.112 (0.093)	-0.288*** (0.082)	-0.263*** (0.058)
Midlands*free seed	-0.197** (0.091)	-0.037 (0.097)	0.327*** (0.093)	0.352*** (0.072)
Masvingo*free seed	-0.206** (0.083)	-0.047 (0.090)	-0.025 (0.080)	base
Constant	1.730*** (0.177)	1.309*** (0.103)	0.458*** (0.086)	0.432*** (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 than in 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 being ineffective in drier regions such as Masvingo and Matebeleland. The descriptive statistics results in sub-section 3.1 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 3.5 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 increased 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.

3.3 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 3.6. The coefficients are all positive in the two outcome models (input use and income) but statistically insignificant. However, the 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 in those 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 3.6 are only regressed on the treatment variable instrumented using district dummies, the 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 there being 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 coefficients in Table 3.6 reveal insignificant impact of free seed input support on seed application, income, and poverty while the 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 suggest 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% 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 in 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 is combined with training in farming, planning, marketing, and capitalisation. Giving vulnerable households inadequate inputs is not sufficient to drive them out of poverty and food insecurity. However, we treat the impact findings in this study with caution for 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 3.6: Impact of free seed on input use, poverty, food insecurity and income

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**Input use (seed intensity)**	**Income**	**Food insecurity**	**Poverty**	**Per capita consumption**
(1 vs 0)	87.3	14.95	0.090***	0.027 *	-2.002***
	(200.6)	(26.0)	(0.015)	(0.014)	(0.746)
(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%, 5% and 1%, respectively. The treated are recipients of free seed labelled 1 and the non-treated are labelled 0.

For robustness, 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 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 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.

4. Conclusion, policy implications and recommendations

4.1 Conclusion

We began this research, firstly, by assessing the nature of free seed input and command input distribution. These descriptive statistics also supported why studying the poverty implications of free input support is worth more than studying command poverty implications. The descriptive statistics show that free inputs and command inputs are not equally distributed across provinces or 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 more than 50% in most of the districts. In terms of quantities of free seed, the mean quantity varies across provinces and districts. Although free seed support targets 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 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, regionalisation/devolution, soil quality, seed type and quantity and agricultural ecological conditions may be crucial to changing the situation of vulnerable households. The presidential input progremmes, which mainly supports farmers with maize seed, requires regional diversification, for example by supporting farmers with small grains seed in drier regions such as the southern part of the country.

Secondly, we asked whether the free inputs are properly targeted by the government. The answer to this question is that the majority of plots under free seed input are found in the poorest districts. 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 if the impact of free seed on food insecurity and well-being of smallholder farmers is province specific. The Heckman 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 than

others. 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 considered 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 it does. In fact, there is an indication that the free input support schemes are failing to move poor households out of poverty and food insecurity.

4.2 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, 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 large enough to promote food security, the available 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 must forgo the political dividend arising from distributing the meagre resources over a larger population.

In conclusion, the paper recommends that free input support schemes should be redesigned. Free inputs must be provided as a composite package consisting of other services such as extension services, training in crop and livestock production, farming planning, income generation, marketing, and capital acquisition. Input quantities 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 to be 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. All the activities under the proposed new scheme must be continuously monitored through rapid feedback loops from beneficiaries, 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.

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 an 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.

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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	-.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

Energy and Poverty: the Efficacy of Electricity Subsidy in Alleviating Poverty in Zimbabwe

Alex Bara, Wellington J. Matsika
Tobias Mudzingwa. Arnold Mabasa Damba

ABSTRACT

The study set out to investigate the effectiveness of electricity subsidies in poverty alleviation in Zimbabwe through addressing the questions around the quantum and distribution of the subsidies between the poor and non-poor. The study also addresses the questions around the influence of the subsidy design and access features on the targeting performance of the subsidy. In order to understand the targeting performance of electricity subsidies in Zimbabwe, the Poverty, Income, Expenditure and Consumption Survey (PICES) household data was used in undertaking a benefit incidence analysis of the electricity subsidies. Benefit incidence analysis assesses the extent to which subsidies benefit the poor vis-à-vis the non-poor, hence showing the extent to which the subsidy is effective in reducing poverty. It also shows the key drivers of targeting performance in terms of access factors and design factors of the subsidy, hence providing information about potential areas of policy intervention. Empirical evidence carried here-in shows limited connectivity and usage of electricity by the poor and high level of exclusion of the poor in subsidy benefit, not helping in poverty reduction. The article established that current electricity consumption subsidy scheme in Zimbabwe has low target performance, implying that it is not pro-poor. The high level of exclusion due to low access, uptake and connection rates for poor households against the non-poor contribute to the lack of pro-poorness in the subsidy scheme. Policy simulations of possible subsidy options reveals that electricity connection subsides have a potential for a high impact in alleviating poverty in Zimbabwe and that consumption subsidies alone are not effective in trying to improve the lives of the poor.

KEYWORDS： Electricity, PICES, Poverty, Power-tariff, Subsidies, ZESA, Zimbabwe

1. Introduction and Context

Electricity in Zimbabwe is heavily subsidized. In 2017 the Zimbabwe Electricity Distribution and Transmission Company sold electricity to households at an average of US 9.96 cents per kWh, which was lower than the estimated efficient cost of supply of US12.4 cents per kWh[1]. This implied a subsidy of 24.5% per kWh consumed by households. The high proportion of subsidies in Zimbabwe could be indicative of a subsidy design that may be too generous, with low target performance and heavy burden on the fiscus.

Electricity is subsidised in many forms, including R&D, investment, generation, decommissioning and consumption **(**Kitson et al., 2011). In Zimbabwe consumption-linked subsidies include reduced rate of import duty for solar components, quantity-based increasing block tariff (IBT) schedule subsidy and VAT exemption. However, this study focuses on household electricity consumption subsidies and grid electricity which is generally considered of high quality and potential for enhancing productive activity. Until June 2020, Zimbabwe has been applying an IBT structure with three consumption blocks heavily subsidized. Such a structure is less self-sufficient, less redistributive, and lacks direct supply-side linkage[2]. This results in government subsidizing electricity utility companies through capital injection to cover losses from subsidies, despite government fiscal constraints. It also results in underinvestment in electricity generation and grid expansion by utility companies, which further limits opportunities for electricity access and connection among the poor and marginalised.

Improving the targeting performance of the subsidies is imperative as it focuses subsidy benefit on the poor who genuinely need the subsidy. It also reduces the cost of providing subsidies and creates fiscal space for government by limiting subsidies to the non-poor.

1.1 Electricity Access, Uptake and Consumption in Zimba we – Insights from PICES Data

The 2017 PICES data, indicate that 74% (2.4 million) of households have access to the national grid, of which, actual household connections are low, at 32% (1.1 million) – see Figure 1. Among the poor, the uptake rate of connections given access is 8%, while it is

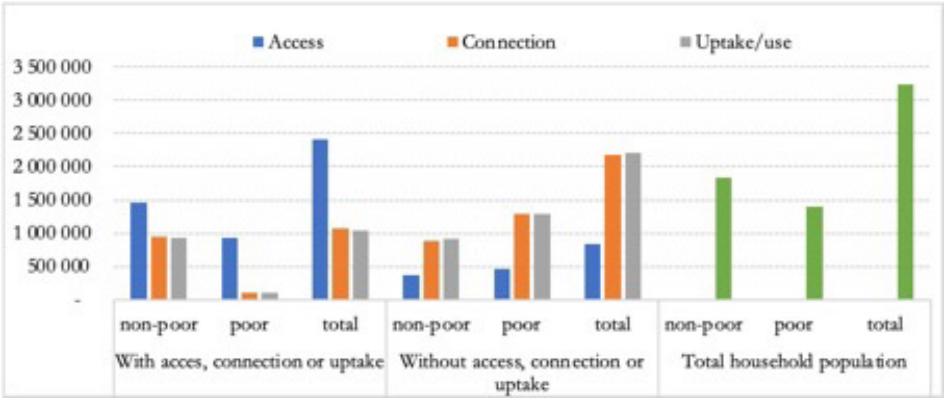
1 Based on data from the World Bank (2020).

2 In June 2020, Government announced a new tariff schedule with four blocks, with a new block of 201-300kWh that has a relatively lower tariff rate compared to the then existing tariff for consumption to that level, whilst maintaining tariff levels for the next band as before. The third block of the new tariff schedule, however, has a subsidy redistributive effect, allowing ZESA to charge above efficient cost reflective tariff. Notwithstanding the negative subsidy benefit on the fourth block, which is a result of the fixed exchange rate, the subsidy benefit on new tariff schedule remains similar to the old schedule, which is biased toward increased consumption, and does not discourage inefficient consumption.

relatively higher for the non-poor at 52%. Uptake or use of electricity among those with connections is relatively high (97% for the poor and 98% for the non-poor), suggesting that once a household is connected it has a higher propensity to consume electricity.

In rural areas, most households do not have any form of electric energy. About 56% of the poor are without electricity versus only 38% of the non-poor. Grid electricity usage is largely for the non-poor in rural areas (14%) than for the poor (3%). Solar home systems are the predominant source of electric energy in rural areas for both the non-poor and the poor, followed by solar lanterns. The main reasons for not having a connection to the grid differ across location and poverty status, but they mainly include initial costs, distance to national grid (mostly in rural areas) and non-ownership of land and property. Average monthly total expenditure on electricity of US$12.09 for the poor, remains low compared to US$22.73 for the non-poor. Low connection, usage of electricity and limited quantity consumed combine to suppress total value of the subsidy received by the poor households per month, leading to uneven subsidy distribution between the poor (9%) and non-poor (91%).

Figure 1: Electricity access, connection and uptake, 2017 (Number of households)



Source: Authors' construction from Zimstat 2017 PICES data

2. Literature Review: Electricity Subsidies and Poverty: The Broader Context

There are several reasons why subsidies are important in the context of poverty reduction. Subsidies redistributes resources and make utility services affordable to the poor, thereby facilitating access to and use of electricity and improving their social welfare (Komives et al., 2005; Sovacool and Hess, 2017). They reduce the burden of electricity costs on the poorest 40% of households in Central America, thus contributing to poverty reduction

(Urdinola and Wodon 2012).

The efficiency and effectiveness with which subsidies reduce poverty and redistribute income to the poor is, however, predicated on the assumption that subsidies are pro-poor, reach and disproportionately benefits the poor more than the non-poor. However, subsidies may be ineffective in reaching and distributing resources to the poor (Vega et al., 2019). In Central America, subsidies reduced poverty with high levels of inefficiency because a large proportion of subsidies (more than 60c per dollar) benefited high-income households (60% of the households). Arze del Granado et al. (2012) found that electricity subsidies were regressive in 20 developing countries because the poor were consuming disproportionately less electricity than the rich. In Argentina, even though subsidies were found to protect the poor, they were not effective because they benefited the rich and non-residential consumers more than the poor households (Lakner et al. 2016).

Kitson et al. (2011) pointed three common approaches to measuring subsidies. The price gap approach, which measures the difference in observed price for electricity versus a free market reference price. This study applies this approach. However, this approach captures producer subsidies only to the extent that they are reflected in the consumers price. The transfer measurement approach, quantifies subsidy associated with a given programme, regardless of whether or not there is effect on end price. The integrated approach, combines direct financial transfers (including those benefiting producers through government assumption of risk) as well as transfers generated between producers and consumers and vice versa as a result of government policies. The main example of which is the Producer Support Estimate and Consumer Support Estimate (PSE-CSE) framework applied in particular by the OECD.

The design of a subsidy matters in determining the efficiency of a subsidy in reducing poverty and redistributing income. The threshold to determine household eligibility to a subsidy and the depth of a subsidy (i.e. the subsidy amount per unit of electricity consumed) are the main drivers of the efficiency of a subsidy scheme in Central America. The targeting strategy that relies on the amount of electricity consumed as an indicator of rich/poor households results in higher errors of inclusion and exclusion because the relationship between electricity consumption and income is not perfect.

Most studies on benefit incidence explain targeting performance of subsidies but do not explain factors behind performance of subsidies. Angel-Urdinola and Wodon (2007) found that electricity consumption subsidies in Cape Verde, Rwanda, and Sao Tome and Principe were regressive mainly due to access factors that prevent the poor from using electricity. The study established that shifting from IBT structure to VDT structure and from consumption to connection subsidies, though may not make the subsidy pro-poor, improves targeting performance of electricity subsidies. They also noted that the increase in targeting performance was mainly due to higher quantities consumed by poor and well-designed connection subsidies which were relatively more pro-poor than consumption

subsidies as they raised benefit incidence above one (Angel-Urdinola and Wodon, 2007).

Reforming subsidies has potential to generate substantial fiscal savings. In Central America it is estimated that reducing subsidy leakages to high-income households reduces fiscal costs by 30% to 50% without increasing poverty. However, it is noted that even though subsidy reform may increase subsidy pro-poorness, some households, especially middle-income households, would be negatively impacted and therefore government should address such costs. Progressive taxation and targeted fiscal transfers are found to be more efficient than residential electricity subsidies in achieving poverty reduction, distributional equity and macroeconomic stability. Araar and Verme (2012) showed that restructuring of utilities' tariffs has great potential of improving equity and efficiency of government spending. Komives et al. (2005) revealed that targeting mechanisms (e.g. IBT, VDT, geographic) do not address the utility services access gap between the poor and the non-poor, hence implying that subsidy reforms that seek to improve targeting mechanisms can only reduce poverty up to a limited extent and that connection subsidies are very important in reducing poverty when the access gap between poor and non-poor is very high.

Subsidy reform can be gradual or big bang. The latter gives rise to sharp increase in prices of electricity if subsidies are generally significant, thus resulting in higher welfare losses which the poor can fail to absorb. Some have suggested reforming electricity subsidies by integrating them into social assistance programmes[3] which have better mechanisms for identifying beneficiaries and distributing the subsidies with greater accuracy, addressing errors of exclusion (i.e. excluding the poor from subsidy benefits) or inclusion (i.e. including the rich in subsidy benefits).

Countries have looked at different ways of reforming their subsidy schemes. In El Salvador, the government eliminated electricity subsidy targeted at middle- and high-income groups of the population that consumed 100kWh to 300kWh of electricity in order to reduce subsidy fiscal costs. Honduras introduced geographic targeting whereby high-income neighbourhoods were excluded from the more generous subsidy scheme in order to improve the targeting performance of the electricity subsidy.

Lessons from international experience suggest that it is important to consider the following when reforming subsidies: (a) Identifying the population groups that will be negatively affected by the electricity subsidy reforms and consulting them in advance and providing compensatory policy measures to reduce adverse impact on their welfare and secure their buy-in; (b) Making public the benefits of electricity subsidy reform and ensuring that the reform efforts are credible; (c) Recognising and addressing political economy challenges to increase chances of success in reforming the subsidies; (d)

3 The integration of electricity subsidies into social assistance programmemes, however, works wellwhen the country has a high quality social assistance roster which identifies low-income households at national scale.

Ensuring that the reform agenda enjoys sufficient support from the government; and (e) Replacing subsidies with more accurately targeted forms of social assistance can often advance the same policy objectives at a lower fiscal cost (UNEP, 2003).

2.2 The downside of electricity subsidies

Good as they are intended and perceived, subsides have their own downside:

- Subsidies for electricity may aggravate the level and intensity of poverty if the tax system used to finance the electricity subsidies is regressive, while subsidy benefits to the poor are small (UNEP, 2008).
- In the midst of low revenue-to-GDP ratio and high fiscal constraints, subsidies constitute high opportunity cost in the form of public investment and social services such as health and education (Sovacool and Hess, 2017).
- Subsidies under-price products and artificially increase demand, hence creating shortages and funding pressure to provide the necessary infrastructure to meet higher demand. In Myanmar, subsidised domestic electricity created domestic shortages as suppliers preferred exporting electricity to China and Thailand at relatively higher prices (Sovacool, 2012; UNEP, 2008).
- The subsidization of fossil fuels significantly contribute to high carbon footprint (about 36% of carbon emission between 1980 and 2010, Stefanski, 2014), leading to global warming and climate change which disproportionately affect the poor who lack the means to adapt their livelihoods.

2.3 The distributional aspects of subsidies

The efficacy of a subsidy in helping to alleviate poverty and reduce inequality can be assessed through investigating its targeting performance. If a subsidy is properly targeted it benefits the poor and the vulnerable who most need the subsidy than the non-poor who can afford without any assistance. In that way, the resource envelop required by the government to assist the poor is reduced, creating fiscal space to finance other poverty reducing programmes. In addition, proper targeting subsidy discourages inefficient use/ consumption by the non-poor which could arise if they are included in the subsidy.

The targeting performance of an electricity subsidy is evaluated by considering three dimensions of performance suggested by Komives et al. (2005). These dimensions are: (i) benefit incidence, (ii) beneficiary incidence and (iii) subsidy material value (or subsidy depth). The benefit incidence shows how well a subsidy instrument targets the poor vis-à-vis the other households (i.e. pro-poorness of the subsidy). It is the average share of subsidy benefits received by the poor divided by the average share of subsidy benefits

accruing to the entire population of households. Alternatively, it is the share of subsidy benefit to the poor divided by the share of the poor in the total population. A value of 1 means the subsidy is neutral because it delivers a subsidy benefit to the poor that is equal to the share of the poor in the population. A value greater than 1 means the subsidy is progressive (benefits the poor more than the non-poor); and a value of zero means none of the poor benefits from the subsidy.

The beneficiary incidence shows the extent of subsidy miss-targeting, measured by the error of exclusion (i.e. the proportion of the poor who do not receive a subsidy) or error of inclusion (i.e. the proportion of non-poor household who benefit from the subsidies. The material value of the subsidy shows the significance of the value of the subsidy received by the poor, thus informing about the generosity and impact of the subsidy on the poor. It is measured by the average subsidy value received by poor households as a percentage of their average income.

3. Methodology

3.1 Incidence analysis of electricity subsidies

The process of subsidy analysis typically begins with static incidence analysis (Araar and Verme, 2012). This will be used to examine the current distributional status of subsidies across households without considering any reform to the subsidy. It will give insights on whether subsidies are pro-poor or pro-rich and whether subsidies affect the level of poverty and inequality or not. Through static incidence analysis the study will give insights on the total cost of the subsidy to the government, who benefits from the existing subsidies and to what extent they benefit. The analysis will also give insights on the targeting performance of the subsidy, hence its effectiveness in income redistribution and poverty reduction . Static incidence analysis provides the baseline upon which to evaluate simulated subsidy reforms. The approach developed by Komives et al. (2005), Angel-Urdinola and Wodon (2005) will be used in conducting incidence analysis.

3.2 Identifying households getting the subsidy and how much they get

In order to identify the households who receive a subsidy and those that do not receive it, as well as to measure the level of subsidy received, the following steps are followed:

a. Ancillary charges and fees such as the 6% rural electrification levy are deducted from electricity expenditure to get actual electricity consumed and avoid over-estimation of electricity consumption. A simplifying assumption is made that all households did not have debts that they were paying for in their current bills so as to avoid over-estimation of current consumption.[4]

4 This assumption is reasonable because most of the electricity in Zimbabwe is prepaid and there has been about 7 years since pre-paid meters were installed. During these 7 years we expect that all

b. To calculate the quantity of electricity consumed by each household, the tariff schedule that existed during the time of the reported expenditure by the household is applied to the expenditure obtained from step (a). Residential electricity pricing in Zimbabwe is based on the IBT scheme, therefore when household total expenditure on electricity falls within the first block, the quantity consumed is estimated easily by dividing its electricity expenditure which falls within the first block by the tariff applicable to the first block as follows:

c. $$kWh_{h,1} = \frac{e_{h,1}}{p_1} \qquad (1)$$

However, if household total electricity expenditure falls in any other consumption block outside the first consumption block, then the quantity consumed will be obtained by deducting the maximum possible expenditure in the previous consumption block from the households total electricity expenditure and dividing the outcome by the tariff which is applicable to the consumption block that the household belongs. Then add all the maximum quantities of the consumption blocks , , which precede the consumption block where the household's total consumption belongs. The formula is as follows:

d. $$kWh_{h,b} = \frac{e_{h,b} - \bar{e}_{b-1}}{p_b} + \sum_{j=1}^{b-1} Q_j \qquad (2)$$

The same reasoning behind the formula is applied in any other tariff schedule such as VDT. As an example, consider an IBT schedule with three blocks and a household who spends US$40 on electricity per month as depicted in Table 1 below.

Table 1: Example tariff structure

Block number	**Consumptio block (min-max) kWh**	**Max. consumptio per block**	**Applicable Tari (US$/kWh)**	**Max. possible exp. per block ()**
1	0-50	50	0.10	5
2	51-200	200	0.16	24
3	201 and more	>200	0.20	>24

e. Clearly, the household's expenditure is greater than US$24 and therefore

households should have cleared their arrears.

its consumption block should be where it consumes more than 200kWh. Therefore the household's total quantity consumed for the month given an expenditure of US$40 will be calculated as follows:

f. [(US$40-US$24)/US$0.20] kWh + 200kWh + 50kWh = 330kWh
The unit average price of electricity faced by each household is obtained by dividing electricity expenditure obtained in step (a) by the quantity of electricity consumed obtained in step (c).
g. The average cost of generating, transmitting and distributing electricity to residential consumers, assuming efficient operations, was obtained from the cost of supply study commissioned by Zimbabwe Electricity Regulatory Authority (ZERA).
h. The financial value of the subsidy for each household is calculated by subtracting from the average cost of generating, transmitting and distributing electricity obtained from step (d) the unit price of electricity paid by the household obtained in step (c) and multiplying that by the total quantity of electricity consumed obtained from step (a). This approach of calculating the financial value of a subsidy received by the households is called the price-gap approach. The financial value of the subsidy is important in understanding how subsidies affect the use of public funds and the financial health of the utilities provider and is an appropriate measure of the cost to the government or the utility of providing the subsidy (Komives et al., 2005).
i. If the subsidy obtained from step (e) is positive, then that particular household received a subsidy and if on the other hand it is negative then that particular household did not receive a subsidy but rather cross-subsidized other households.

3.3 Calculating subsidy targeting performance indicators

After getting the financial value of the subsidy for each household, the lower poverty line obtained from 2017 PICES data was used to distinguish the poor from non-poor using a binary indicator. Three dimensions of subsidy targeting performance (i.e. benefit incidence, beneficiary incidence and subsidy material value) were then measured.

3.4 Decomposing subsidy targeting performance

In order to inform policy reforms, there is need to go beyond merely indicating how the subsidy performed in targeting the poor, to analysing the drivers of performance of the subsidy. The three dimensions of subsidy targeting performance described above do not show the drivers of the performance of the subsidy. Therefore, the study followed the

approach by Angel-Urdinola and Wodon (2005) to decompose the benefit incidence into access and subsidy design factors that influence the overall performance of the subsidy. This will inform the policy makers about the potential areas of reform in the short- and long-term to enhance subsidy impact on poverty reduction. The approach decomposes benefit incidence into five factors: (i) access to the grid (i.e. the grid is in the neighbourhood of the household), (ii) uptake or rate of connections to the grid by households that have access to the grid, (iii) targeting, (iv) rate of subsidization, and (v) quantity consumed. Factors (i) and (ii) are access factor while factors (iii) to (v) are subsidy design factors. Mathematically, the benefit incidence is decomposed as follows:

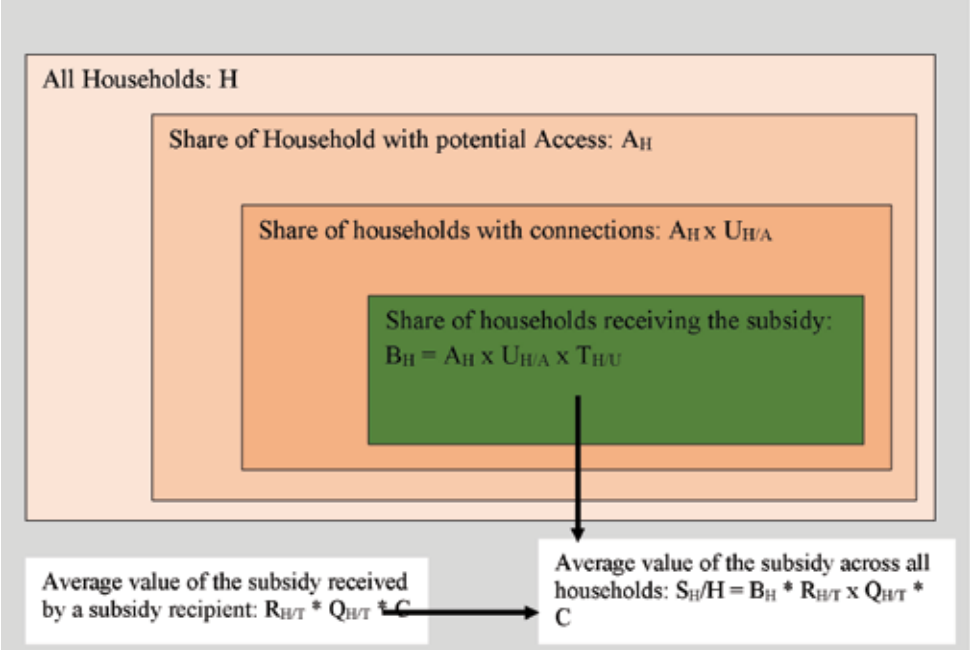
$$Benefit\ incidence = \frac{A_P}{A_H} * \frac{U_{P/A}}{U_{H/A}} * \frac{T_{P/U}}{T_{H/U}} * \frac{R_{P/T}}{R_{H/T}} * \frac{Q_{P/T}}{Q_{H/T}} \qquad (3)$$

where $\frac{A_P}{A_H}$ is the ratio of the share of poor households that have potential access to electricity to the share of all households with potential access to electricity; $\frac{U_{P/A}}{U_{H/A}}$ is the ratio of the uptake rate among the poor to the uptake rate among all the household (i.e. the ratio of the shares of poor to all households that actually use electricity because the decide to connect to the grid); $\frac{A_P}{A_H} * \frac{U_{P/A}}{U_{H/A}}$ is the ratio of the actual connection rate among the poor to the actual connection rate among all households (i.e. the ratio of the share of poor households that are connected and use electricity to the share of all households that are connected and use electricity); $\frac{T_{P/U}}{T_{H/U}}$ is the ratio of the share of poor households with access and connection who are targeted and actually receive a subsidy to the share of all households with access and connection who are targeted and actually receive a subsidy; $\frac{R_{P/T}}{R_{H/T}}$ is the ratio of the average rate of subsidization for the poor to the average rate of subsidization of all households; and $\frac{Q_{P/T}}{Q_{H/T}}$ is the ratio of average quantity of electricity consumed by the poor subsidy recipients to the average quantity of electricity consumed by all households who are subsidy recipients. The framework for decomposition of the subsidy performance is shown in Figure 2.

Table 2: Scenarios for modifying the subsidy design

	BASELINE		**SCENARIO 1**		**SCENARIO 2**		**SCENARIO 3**		**SCENARIO 4**	
BLOCKS	kWh	price	price	kWh	kWh	price	kWh	price	kWh	price
1	1-50	0.02	1-50	0.02	1-50	0.02	0-190	0.062	1-50	0.0199
2	51-300	0.11	51-190	0.11	51-190	0.11	>191	0.124	51-100	0.0399
3	>300	0.15	>191	0.124	191-300	0.124			101-200	0.0699
4					>300	0.13			201-300	0.0998
5									301-400	0.1025
6									>400	0.1197

Figure 2: Framework for decomposing subsidy performance.



Source: Komives et al. (2005)

3.5 Subsidy reform simulation

The simulation of electricity subsidy reforms in the study is based on the standard economic consumer's choice model suggested by Araar and Verme (2012). They show that electricity subsidy reform simulations can be done using less information such as a household budget survey showing household total expenditure/income, expenditure on electricity, a poverty line, own-price elasticity of electricity, and tariff schedules for electricity. The following scenarios were considered in the simulations :

The study simulate modification of IBT schedule and assessing the impact of these modifications on the targeting performance of the resulting modified IBT. The study does not, however, focus on simulating the impact of changing access because as noted by Komives et al. (2005), access is difficult for policy makers to influence in the short-run and that it changes over time due to investments made in the grid expansion. In addition, the simulation of expanding the grid would require detailed information from a supply-side survey which would enable the modelling of the investment behaviour of electricity supply firms. Therefore, the focus of the simulations is on the subsidy design features which are within easy reach of the policy makers to influence and on the connection subsidies as an alternative to consumption subsidies. Four scenarios that modify the subsidy design are considered (Table 2).

a. Scenario 1: the IBT schedule for 2017 is modified in two ways. The size of

the second block is reduced from 51-300kWh to 51-190kWh. The 190kWh threshold is a conservative consumption level guided by the average monthly electricity consumption by the poor using lower bound poverty level, which the study set to accommodate all poverty levels.[5] This will likely help to reduce errors of inclusion, although there are also chances of households revising their consumption due to price effects, which may even worsen errors of inclusion. The second modification involves changing the price for the last block to reflect the efficient cost recovery price, currently at US$0.124 per kWh, for consumption above the new threshold of 190kWh.

b. Scenario 2: the modified IBT schedule in Scenario 1 is further modified by introducing a limit of 300kWh on the third block and adding a forth block with consumption of 301kWh and more. Furthermore, a volume differentiated tariff (VDT), pegged at US$0.1600 per kWh is introduced for consumption above 300 kWh. The intuition for this simulation is that the current IBT scheme subsidizes all levels of consumption, thus lacking a threshold beyond which a punitive tariff is effected to discourage potentially inefficient household consumption of electricity. Therefore, for consumption above 300 kWh a household has to pay a tariff of US$0.1600/kWh for all units consumed. Thus, this will discourage potentially in efficient consumption of electricity. Since the price of US$0.1600 for the final block is greater than the efficient cost recovery price of US$0.124, this scenario is expected to generate some cross subsidies to the extent that households consume way more than the 300 kWh threshold.
c. The third scenario considers a shift from IBT schedule to VDT schedule which gives a subsidy on consumption up to 190 kWh at a price of US$0.062/kWh. For consumption which is above 190 kWh, that is, beyond the conservative upper bound average household electricity consumption by poor households, an efficient cost recovery price of US$0.124 per kWh is effected.
d. Scenario 4 represents the reconfiguration of the IBT schedule in November 2020 wherein ZEDTC introduced a six-consumption-block tariff schedule and changed the marginal prices of the consumption blocks as shown in Table 9. It is expected that increasing the number of blocks reduces consumer surplus and hence increases the revenue accruing to the electricity utility companies. However, one of the setbacks on the tariff schedule modification is that all the consumption remains subsidized regardless of the income

5 The 190kWh is an average based on poor households' electricity consumption calculated using the ZIMSTAT PICES dataset. The average is not basic consumption as defined by ZETDC's basic or subsistence consumption.

level of consumers. Thus, the tariff schedule potentially poses significant subsidy burden on the government and encourages inefficient consumption. Ideally, the threshold beyond which potentially inefficient consumption is penalised by charging at least a cost reflective tariff, should be introduced.

4. Discussion of Research Findings

4.1 Overall subsidy structure implicit in households' tariff schedule

In Zimbabwe, the IBT schedule is used in the pricing of household electricity and delivering of the subsidy to households. Alternative subsidy targeting methods such as means-testing, or geographic targeting have never been used. Table 3 shows evolution of IBT schedules for 2011-2020. The tariffs for Zimbabwe were almost stagnant from 2013 until revisions made in March 2020 to account for inflation through inflation indexing [6].

Table 3: 2013-2020 (Mar) IBT Tariff Schedule

Metering	Tariff Block	Charge per kWh in US dollars (2011-2017) and ZWL (2019-2020)			
		2011	2014-18	2019 (Oct)	2020 (Mar)
Conventional Meter	1-50kWh	0.02	0.02	0.41	0.49
	51-200kWh	0.02	0.02	0.91	1.08
	51-300kWh	0.11	0.11	3.87	4.61
	Balance	0.15	0.15	3.87	4.61
Prepaid Meter	1-50kWh	0.01	0.02	0.41	0.49
	51-200kWh			0.91	
	51-300kWh	0.06	0.11	-	1.08
	Balance	0.15	0.15	3.87	4.61

Source: ZETDC

The first 50 kWh units consumed by households are considered to be the lifeline, charged a tariff of US$0.02/kWh to ensure that the vulnerable and poor households can afford to purchase electricity. The second block of consumption has 51-300 kWh, but this block was revised to 51-200 kWh in October 2019 in an effort to reduce subsidies as

6 Electricity charges for domestic customers or households are zero rated for VAT in terms of Statutory Instrument 168 of 2012, whilst fi ed charges on commercial and domestic electricity are Zero rated for VAT in terms Statutory Instrument 245 of 2005. Implicitly, from 2009 to 2019 electricity sales, Government has forgone a total of about US$430,158,414.79 ($430 million) in value added tax (VAT) exemptions.

envisaged in the tariff determination code. This block was charged a tariff of US$0.11/kWh until 2019 when revisions were made to reflect inflation and exchange rate dynamics. The final block, which has consumption beyond 300kWh is charged a tariff of US$0.15/kWh.

In June 2020, Government announced a new tariff schedule with four blocks (Table 4). The new tariff schedule introduced a new block of 201-300kWh with a relatively lower tariff rate compared to the then existing tariff for consumption to that level, whilst maintaining tariff levels for the next band as before.

Table 4: The Current IBT Tariff Schedule-June 2020

Metering	Tariff Bloc	Charge per kWh in ZWL (US dollars*)	Quantity eighted Subsidy depth
Conventional/Prepaid Meter	<50kWh	0.49 (0.0196)	15%
	51-200kWh	1.08 (0.0432)	36%
	201-300kWh	2.94 (0.1176)	8%
	301+	4.61 (0.1844)**	-17%

*the conversion was at the official rate of 1USD to 25$ZWL

**at the time of completion of the study, the exchange rate had moved to 1USD to 57.3$ZWL, giving a subsidy depth of 49% for the block.

The new IBT schedule has some important implications for poverty. Holding other things constant and assuming a cost of supply of US$0.124/kWh, this tariff schedule implies a quantity weighted cumulative subsidy depth for the four consumption blocks of 42%[7] below the cost of supply which compares with 44% of the three consumption blocks applied in 2017. The fourth block of the new tariff schedule, however, has a subsidy redistributive effect, allowing ZESA to charge above efficient cost reflective tariff[8].

Notwithstanding the negative subsidy benefit on the fourth block, which is a result of the fixed exchange rate at the point of this analysis, the subsidy benefit on new tariff schedule remains similar to the old schedule, which is biased toward increased consumption. This significantly increases affordability and access to electricity by the higher consumers of electricity, often the non-poor. It also implies that the subsidy

7 This figu e jumped to 131% immediately upon movement of exchange rate from 1USD to 25ZWL to 57.3ZWL

8 This negative subsidy depth is only available for a given/fi ed exchange rate between USD and ZWL. If the exchange rate moves, the implied subsidy also changes and the net effect is dependent on whether tariffs responds to movement in the exchange rate.

is significantly reducing the burden of electricity expenditure among the non-poor, as compared to the poor. In addition, the new tariff schedule lacks an effective threshold beyond subsidized consumption level. Thus, even if households increases consumption, say to beyond 1000kWh, they will still receive a subsidy for the subsided portion, with no tariff penalties for over consumption regardless of whether or not such consumption is inefficient for a household. As a result, the current IBT subsidy model does not discourages inefficient consumption. Ideally, there should be a threshold beyond which the price overshoots the cost of supply of electricity. That thresholds should exempt most of the poor and ensure that the non-poor who can afford are subsidising the poor.

4.2 The Distributional Effects of Current Electricity Subsidies

Benefit Incidence: The targeting performance of the subsidy scheme embedded in the 2017 IBT schedule depicted by a benefit incidence indicator of 23%, implying that the electricity subsidy in Zimbabwe is regressive (Figure 3). This means that the poor households are getting only 23% of what they would have received under a universal targeting programme that distributes subsidies equally across all households. Implicitly, the poor households are receiving a share of the subsidy that is lower than the share of the poor households in the population. Thus, the findings suggest that a universal targeting approach that distributes electricity subsidies equally across all households would have been better than the self-targeting mechanism that is used by the IBT scheme.

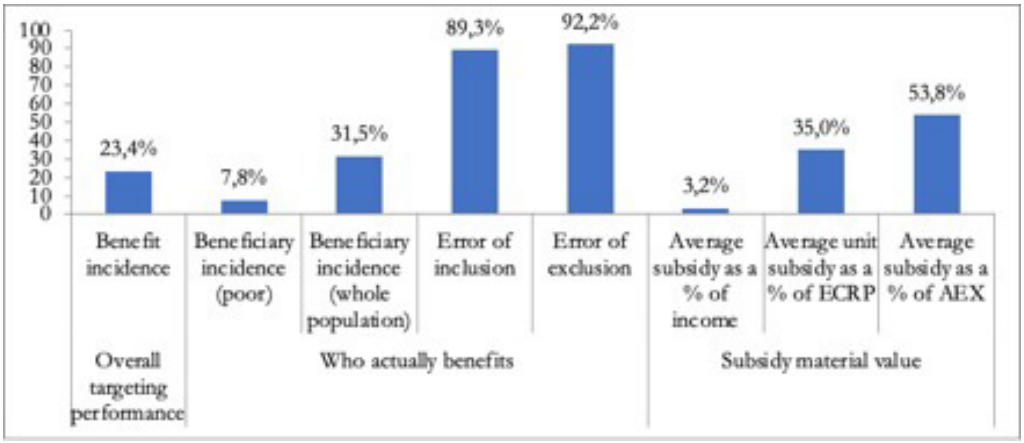
The challenge with the IBT schedule is that its targeting performance is predicated on the assumption that electricity consumption is a good indicator of household level of income. Therefore, it assumes that poor households consume less electricity and get deeper discounts through the lifeline block and other subsidized lower consumption blocks. On the other hand, the non-poor are assumed to consume more and therefore pay at least the cost recovery price for a greater part of their consumption. However, in Zimbabwe electricity consumption and income have a relatively lower correlation coefficient of 0.44.[9]

Also, the targeting in the IBT scheme is not purposive in the sense that everyone who consumes electricity receives a subsidy for part of their consumption (i.e. lifeline block consumption). By subsidizing up to 300 kWh, the IBT subsidy scheme is too generous and perpetuates high errors of inclusion, whereby rich people benefit from the subsidy, and limits cross subsidization among the households, thus potentially reducing the

9 The Pearson's correlation coefficient was used to determine the correlation between household weighted income and expenditure on electricity. Household total expenditure was used as a proxy for household income. There are several reasons why the correlation value is low in Zimbabwe and these include the following. The data used relates to the period when load shedding was high, hence consumption was constrained by supply and therefore it did not matter how much income one has. The use of alternative sources of energy such as gas and solar especially given the unreliable electricity supply also potentially weaken the correlation between electricity consumption and income.

pro-poorness of the subsidy. In addition, subsidizing a large part of consumption limits the scope for self-sufficiency of the subsidy model which ensures that the non-poor households cross subsidize the poor household without needing the government to make subsidies. In Costa Rica and Nicaragua the IBT systems are almost self-sufficient.

Figure 3: Indicators of subsidy performance for the 2017 IBT schedule



Source: Authors' own calculations from 2017 PICES data set

Notes: ECRP=efficient cost recovery price of electricity per kWh. AEX=average expenditure on electricity

The IBT scheme does not explicitly differentiate between the poor and non-poor, and with most of the consumption subsidized (78% of the kWh consumed pay less than cost recovery price), the cumulative benefits of subsides increase with consumption, disproportionately benefiting the non-poor whose consumption is high.[10] The share of subsidised kWh for the poor was only 8% of the total number of subsidised kWh. This was by far less than the 92% share of subsidised kWh for the non-poor. Furthermore, the target performance based on consumption level assumed in the IBT schedule does not factor low usage by the non-poor due to limited supply/availability of electricity and use of alternative sources of energy by the non-poor. Given supply side constraints in Zimbabwe, consumption of electricity could also be limited by supply of electricity. The non-poor are able to afford alternative sources of energy while consuming within subsidized range when tariffs go up. The poor would exhaust their income on alternative sources in the absence of electricity and are, therefore, crowded out by the non-poor who have resources to afford electricity and alternative sources.

Beneficiary incidence: The beneficiary incidence captures the probability that a household would benefit from the electricity subsidy. It is estimated at 8% for the poor

10 The new tariff schedule, with four blocks attempted to address the perpetual subsidy for all consumption levels by having a tariff that was above cost of supply tariff at the time (assuming the then exchange rate of USD1:ZWL$25). The tariff immediately went below cost of supply (to the moment the RBZ introduced a auction system on foreign exchange with rates

and 32% for the whole population. It means the chance or probability that the poor will benefit from the consumption subsidy delivered through the 2017 IBT scheme is 8%. The low beneficiary incidence is explained by the high number of poor households who are not consuming electricity because they either do not have access or they have access but not connected or they have access, are connected but did not consume electricity for other reasons.

Error of exclusion and inclusion: The error of exclusion in the subsidy scheme is very high at 92%. Thus, the subsidy is to a greater extent not helping much to reduce poverty since the bulk of the poor are not included by the current subsidy scheme. This is mainly attributed to household access-to-electricity factors explained in the decomposition of subsidy targeting performance into access and design features of the subsidy (see the next section).

The error of inclusion is estimated at 89%, suggesting that almost nine in ten non-poor households benefit from the subsidy. If subsidies are given to the non-poor who could actually afford non-subsidized electricity, it means that the subsidy could actually encourage inefficient consumption of electricity among the subsidized non-poor, resulting in the crowding out of the poor. A high error of inclusion implies that the subsidy is increasing inequality among households instead of reducing it. In this case, the 8% of the poor are included in the subsidy against 89% of the non-poor, hence explaining the low targeting performance and regressive nature of the subsidy scheme.

The error of inclusion is exacerbated by lower rates of electrification in Zimbabwe which is skewed against rural areas (National Renewable Energy Policy, 2020), and therefore majority of the population, mostly rural poor populace, is without access to electricity and thus automatically excluded from subsidy benefit.

Access to electricity subsidies enhances quality of life and enables generation of income through other subsistence productive activities. High errors of inclusion suggest that the government has scope to create fiscal space by reducing the subsidies for the non-poor and redeploy the resulting savings into poverty reducing expenditures. Given the monthly subsidy of US$6,312,411 to the non-poor, the government would save up to US$67,838,367 by reducing the errors of inclusion.

This amount was equivalent to 18% of the 2017 national budget allocation to the Ministry of Health and Child Care, 8% of the allocation to the Ministry of Primary and Secondary Education, 25% of the allocation to the Ministry of Higher and Tertiary Education, and 9% of the total sales revenue for ZETDC. For ZETDC the savings from reducing errors of inclusion could be used to expand the grid to increase accessibility to the poor, or enhance efficiency of the electricity utilities, and reduce the cost recovery price and hence burden of subsidies whilst increasing affordability.

Subsidy material value: The materiality of the subsidy was estimated at 3% of the

average poor household's total income.[11] However, with this measure of materiality of the subsidy it is difficult to assess, without additional information, the significance the subsidy. This is the price gap between the efficient cost recovery price of electricity per kWh and the average price of electricity per kWh paid by the poor who benefited from the subsidy. The greater the price gap, the greater the depth of the subsidy and the extent to which the subsidy enhances affordability for the poor. It also shows the extent to which the subsidy creates savings on electricity expenditure for the poor, which savings can be used to increase expenditure on other items.

The unit subsidy can be expressed as a percentage of the efficient cost recovery price of electricity (ECRP). The study estimated the unit subsidy for the poor at US$0.0434 per unit of electricity consumed or 35% of the efficient cost recovery price. Thus, the subsidy was generous as the poor households saved more than a third of their expenditure per unit of electricity they consumed.

The depth of the subsidy can also be captured by the average subsidy for the poor expressed as a percentage of the poor households' average electricity expenditure (AEX). This shows how much of the poor households' expenditure on electricity is reduced as a result of the subsidy. This indicator is estimated at 54%, showing that the subsidy is very generous as the average expenditure on electricity for the poor is reduced by more than half of what they would have paid without a subsidy.

These indicators show that for the poor who are using electricity, the current subsidy is significant and enhances affordability while creating savings that can be used on other expenditures. However, the challenge is that low access and high errors of exclusion by the poor, reduces the total subsidy benefits they enjoy, resulting in more benefits accruing to the non-poor. Thus, the low benefit incidence of the subsidy, coupled with its generosity, creates scope for significantly reducing subsidies without significantly affecting the poor.

4.3 Decomposition of electricity subsidy performance

Using the values in Table 5 the determinants of subsidy targeting performance were computed with comparative analysis between the poor and total households (Table 6). The poor have a lower share in most determinants of subsidy performance, indicative of poor performance of subsidies towards poverty alleviation among the poor. For example

11 The material value of the subsidy as a percentage of income is calculated using the formula $[R_{P/T}*Q_{P/T}*C]/Y_{P/T}$ where the variables are as defined in Table 7.

, Table 5: Description and values of the components of the benefit incidence indicator

Symbol	Descriptio	Value
Ω	Benefit incidence	0.234
SH/H	Average subsidy benefit in the entire population	2.164
SP/P	Average subsidy benefit among the poor (US$)	0.507
C	Average cost-recovery price of electricity (US$)	0.12
B_H	Probability of receiving a subsidy in the whole population (i.e. beneficiary incidence)	0.31
B_P	Probability of receiving a subsidy among the poor (i.e. beneficiary incidence)	0.08
A_H	Share of households with access in total household population	0.74
A_P	Share of the poor households with access in total poor households	0.66
$U_{H/A}$	Share of households using/up-taking electricity among those with access	0.43
$U_{P/A}$	Share of poor households using electricity among the poor with access	0.12
$T_{H/U}$	Share of households subsidized among those with access, connection and targeted	0.98
$T_{P/U}$	Share of poor subsidized among the poor with access, connection and targeted	1.00
$R_{P/T}$	Rate of subsidization for the subsidized poor	0.35
$R_{H/T}$	Rate of subsidization for the subsidized population	0.26
$Q_{P/T}$	Average quantity of electricity consumed by the poor	149.87
$Q_{H/T}$	Average quantity of electricity consumed by the households using electricity	214.03
$E_{H/T}$	Average expenditure on electricity in the population using electricity	19.66
$E_{P/T}$	Average expenditure on electricity among the poor	12.09
$A_H * U_{H/A}$	Actual connection rate to the electricity grid for all households	0.32
$A_p * U_{P/A}$	Actual connection rate to the electricity grid for the poor	0.08

Source: Authors' computations from the PICES household survey data sets, 2017

the poor have a lower expenditure rate, quantity consumed, share of access, connections and receipt of subsidy compared to the entire population. The rate of subsidisation, among the poor with access, however, remains higher than the average for the country. This is partly because the poor consume relatively less electricity and therefore enjoy the deeper discounts at lower levels of consumption. As consumption increases, the subsidy

depth reduces, resulting in lower rate of subsidisation associated with the non-poor who consume relatively more.

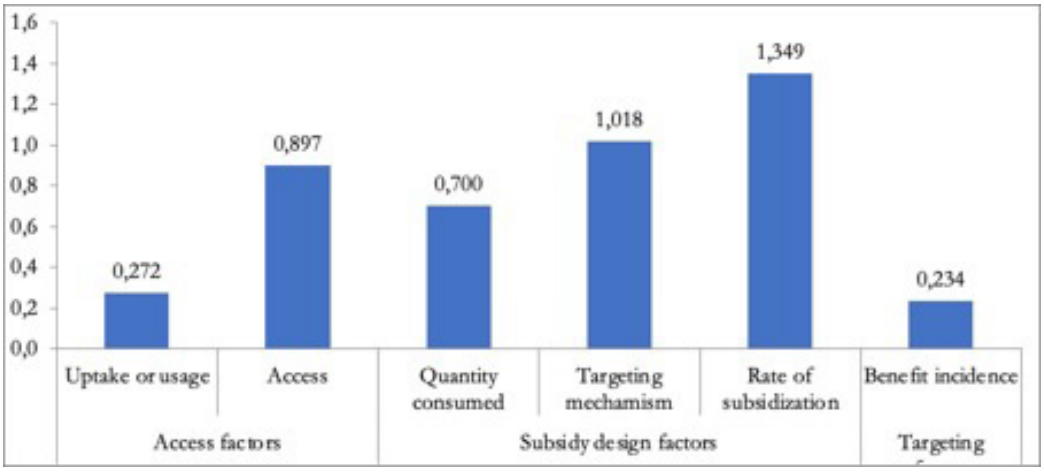
Table 6: Decomposition of Determinants of Subsidy Performance

	share of households with access (A)	share of households with uptake or usage (U)	share of households subsidized (T)	rate of subsidization (R)	average quantity consumed kWh/month (Q)
poor households	0.66	0.12	1.00	0.35	149.87
all households	0.74	0.43	0.98	0.26	214.03
ratio (poor to all)	0.90	0.27	1.02	1.35	0.70

Source: Authors' calculations from PICES 2017 data sets based on framework by Angel-Urdinola and Wodon 2005a.

The relative comparative ratios between the share of the poor and all households then gives decomposition of drivers of subsidy targeting performance (Figure 4). The key driver for poor targeting performance revealed by the benefit incidence indicator of 23%, computed from the given data, is low uptake or usage of electricity.

Figure 4: Determinants/drivers of subsidy targeting performance



Source: Authors' calculations from PICES 2017 data sets

While access for the poor households is almost at par with that of all households, their uptake rate of electricity is relatively lower compared to that of the non-poor. This suggests that the gap between access and usage of electricity is mainly underpinned by

low actual connections to the grid among the poor.[12] As noted in Table 5, the access rate for the poor (66%) is relatively closer to that of all the households (74%). However, the usage rate is very low for the poor at 12% compared to 43% for all the households[13]for those with access. Thus, the actual connection rate to the grid for the poor is very low at 8% (i.e. A*U=66%*12%) compared to 24% for all the households with access. As a result, the targeting performance of the subsidy is very low (about 23%) mainly because of lower usage of electricity which is mainly driven by lower rate of connections among the poor. This implies that in order to improve the subsidy targeting performance to the advantage of the poor, priority has to be given in addressing connections to the grid by the poor. A significant share of the poor has access but not connected (58%) hence it is automatically excluded from the electricity consumption subsidy, making the subsidy very regressive. By simply helping the poor households to connect, the targeting performance of the consumption subsidy will improve. Thus, intervention measures by government should be towards facilitating connections to the grid by the poor households while reviewing the consumption subsidy to optimize the benefits to the poor.

The second factor that is mainly driving the poor targeting performance of the subsidy is quantity of electricity consumed. Consumption subsidies benefit those who consume the subsidized product. Without consumption there will be no benefit. Thus, all the households without access or connection or usage of electricity are excluded from the subsidy benefit. The proportion among poor households without either access, or connection, or usage is very high at 92% which means a significant proportion of the poor households are automatically excluded from the subsidy benefit. Thus, in such cases of higher exclusion of the poor due to lack of access, connection and usage, a consumption subsidy is not a good policy instrument of trying to help the poor.

With consumption subsidies, the higher the level of consumption the more the subsidy amount accrues to the benefit of the consumer (i.e. if there are no thresholds for the amount subsidized and no over-pricing of the product for additional units consumed). In the case of the 2017 IBT schedule most of the electricity consumed (up to 300 kWh) was subsidized and therefore more total cumulative subsidy benefits accrue for higher consumption up to the 300 kWh threshold. On average the non-poor consume relatively more than the poor and this could partially be explained by relatively lower burden of electricity expenditure among the non-poor compared to the poor.

Although the rate of subsidization is progressive, there is more room for improvement. The analyses of the IBT schedule across different tariff blocks support this finding in that the schedule subsidizes the non-poor at the same rate as poor households at lower levels of consumption. As consumption increases to the mid-tier block, consumption is

12 It might also be indicative of the broadness of the definition of access used in the survey, which seem to be highly inclusive, accommodating households who are in the vicinity of the national grid as mentioned in Part II.

13 These ratios might have been affected by the broader definition of ccess.

still subsidized despite possibility that a relatively lower share of the poor might not be consuming in the block. However, additional consumption above 300 kWh is priced more than the cost recovery price. This discourages potentially excessive inefficient consumption of electricity, promotes self-financing in the subsidy scheme, reduces the burden of subsidy on the government and promotes income redistribution between the poor and non-poor. The PICES Data shows that some households consume in excess of 3700 kWh, a level which is beyond expected household consumption. Thus, charging a tariff which is at least cost reflective discourages such potentially inefficient consumption (for example commercial use of electric power meant for domestic). Geographical targeting of subsidies should also be considered.

Access to the grid, at a rate of 66%, among the poor against 74% of the entire population leading to an access ratio of 0.9, on paper fairly contributes in improvement of targeting performance of the subsidy. However, with access alone and without connection the poor neither uptake nor use the electricity from the grid and, therefore, the errors of exclusion from the consumption subsidy are magnified. Thus, with limited connection despite high access to the grid by the poor, the consumption subsidies will tend to be regressive. Attention has to be paid to supply-side interventions that increase connection to the grid among the poor.

The results of the decomposition of the benefit incidence indicator generally show that the main factor undermining the performance of the subsidy targeting is low rate of electricity usage among the poor households relative to the total population, leading to higher rates of exclusion. A relatively large share of the poor with access need to be assisted in connecting to the grid in order to enhance targeting performance of the consumption subsidy. Thus, improving the rate of connections among the poor may increase the pro-poorness of the subsidy. This implies that the government may need to explore connection subsidies instead of consumption subsidies or even exploring a combination of both subsidies. Currently, the government is not subsidizing connections to the grid.

The results also show that subsidizing consumption is not a good priority when connection and usage rates of electricity by the poor are relatively lower, as this makes the subsidy regressive and less beneficial to the poor. However, since quantity consumed is the second main factor influencing the targeting performance, consumption among the poor needs to be encouraged through improving the subsidy design scheme. For instance, higher and potentially inefficient consumption may be penalized by paying above cost recovery price. The rate of subsidization and targeting mechanism have room for improvement, but they are relatively not the main drivers of poor subsidy targeting performance. The targeting mechanism embedded in the IBT scheme does not discriminate between the poor and non-poor and therefore tends to be neutral on its influence on the targeting performance. Purposive targeting needs to be considered

to improve the pro-poorness of the subsidy. The subsidy needs to be given to the poor households only or to ensure that the non-poor are subsidized to a very lesser extent.

4.4 Weakness/gaps in the existing electricity subsidy model

The above discussion of research findings reveal that the current subsidy scheme is not pro-poor, implying it has high level of exclusion of the poor and low target performance, mainly due to low uptake, connection rates and quantity consumed by poor households against the entire population. There are several other observable gaps in the existing model that explains this outcome, which could be the points of focus on the suggested subsidy reform programmeme:

- The country is using a passive targeting mechanism, which e targets subsidies through quantity consumed (e.g. as in IBT). Instead, active targeting is more accurate and reduces errors of inclusion, hence leading to higher targeting performance of subsidies. However, it may be considerably difficult to identify and deliver subsidies to people who qualify for it. Active targeting of subsidies requires administrative selection of the beneficiaries (Komives et al., 2005). However, such a targeting system for subsidies may be very costly to design and take many years to build and many more to refine, and once in operation their administrative costs may be very high (Scott and Pickard, 2018). Personal attributes (e.g. student, pensioners, veterans, refugees, etc.), geographic indicators (e.g. poor neighbourhoods, rural areas, high density areas, etc.) and proxy means test variables (e.g. electricity consumption below a threshold, quality of electricity connection, income threshold, electricity expenditure above a burden limit expressed as a percentage of total expenditure, etc.) may be used to administratively identify potential beneficiaries of the subsidy (ibid.).
- Despite the difficulties in active targeting of subsidies, the increase in digital solutions has increased the number of means tested (or administrative) targeting mechanisms in use recently (Scott and Pickard, 2018). Active targeting would be relatively cheaper to implement if the social assistance programme is very strong, with wide coverage. Then, active targeting would ride on the social assistance database of beneficiaries to identify and deliver the subsidy. In Zimbabwe, already the water utility – Zimbabwe National Water Authority (ZINWA) and municipal authorities – uses active targeting for its subsidies. Specifically, geographic targeting is being used by ZINWA in determining water tariffs, whereby subsidized tariffs are disbursed to neighbourhoods where the poor reside. The framework for geography-based electricity subsides may ride on the existing experience

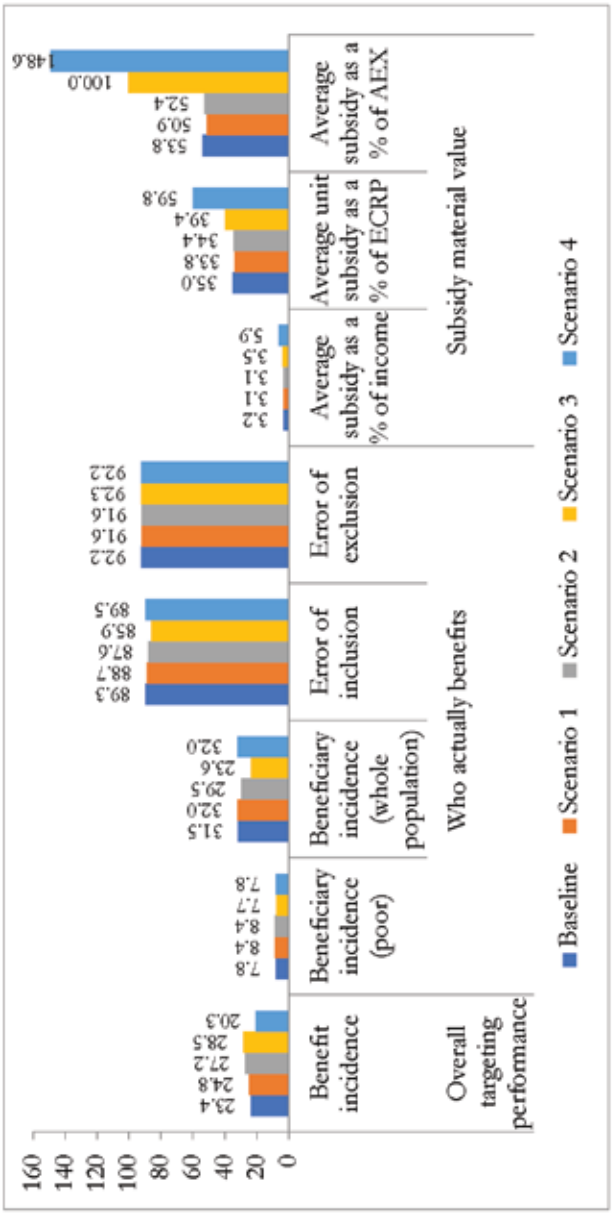


Figure 5: Targeting performance of simulated scenarios

Source: Authors' computation using 2017 PICES household survey data

and infrastructure to embark on active targeting of electricity subsidies.

- Related to that, the current subsidy model does not have connection subsidies and does not cover for compensation of electricity infrastructure development by consumers, particularly the poor. The existing arrangement is such that consumers can do connections and install electricity infrastructure at their own costs to expedite connection to electricity[14].
- The overall consumption subsidy model is not linked to the supply side, rather it is focused on the demand side and assumes supply as constant. The model does not factor the loss by the ZESA through cost of generation, lost margins, power theft and absence of penalties on non-payment of electricity (for households that are not on prepaid metering). Besides, the existing model has a negative trickle-down effect on to electricity generation and supply. For example, the power company simply reduces the tariff rate as recommended by the Government in lieu of tax relief. The electricity company does not receive the equivalent amount as a grant from government in compensation for the cost in generation of the subsidised electricity. ZESA is then forced to absorb the costs of the subsidy, which then threatens its operational and power generation substantiality.
- In addition, the current model does not promote distribution of electricity by IPPs. Whereas most IPPs can generate electricity to augment current generation by ZESA, they face the challenge of distribution as they rely on ZESA infrastructure. Also, the current model does not deliberately support development of green energy.

4.5 Simulated and Non-Simulated Electricity Subsidy Reforms

Simulation of possible subsidy options reveals that increasing connectivity to electricity by the poor is critical in ensuring high incidence of benefit on the poor. Possible simulated and non-simulated subsidy reforms for Zimbabwe include reconfiguration of the IBT tariff schedule, introducing connection subsidies, enhancing non-tariff-based subsidy reforms and integrating supply side subsides.

Reform Option 1: Reconfigure the tariff schedule

The current IBT subsidy scheme was deemed to have a low targeted performance with subsidy benefits accruing more to non-poor than the poor. The current electricity

14 For example, people can engage a private contractor to install an electricity line and do in-house installations. ZETDC will then inspect, authorize and energize the connections. ZESA does not pay for the infrastructure as they take it as a donation from customers through an agreement. The ownership and rights of control of the infrastructure will be transferred to ZESA as soon as the connection is done. During the first five years, households who intend to connect from the established infrastructure have to pay compensation to the other households who are the primary financiers of the infrastructure

subsidy is applicable to every consumption block, potentially resulting in lack of cross-subsidization, income redistribution and self-financing. It was also noted that the targeting performance of the subsidy was mainly driven by lack of usage among the poor.

The results of the simulations of the subsidy design under the four scenarios are shown in Figure 5. The results show that the VDT scheme (Scenario 3) outperforms the other schemes with a targeting performance indicator of 29%, a relatively generous subsidy to the poor and relatively lower errors of inclusion. However, this comes at the expense of a relatively slightly lower beneficiary incidence to the poor of 8% and high errors of exclusion of 92% (Figure 5).

A VDT combined with an IBT (Scenario 2) is the second highest performer in terms of targeting performance (27%), beneficiary incidence and errors of inclusion and exclusion followed by Scenario 1 at 25% and Scenario 4 (20%). Overall, the simulated subsidy scheme scenarios indicate that while changing the subsidy design may improve the targeting performance, this does not cause the consumption subsidy schemes to be pro-poor. All the subsidy designs simulated are regressive, thus emphasizing the importance of addressing the access factors, attempting other forms of subsidies which are not consumption subsidies and other targeting mechanisms which are not self-targeting.

Reform Option 2: Introduce connection subsidies

Connection subsidies rather than consumption subsidies may generate progressive distribution of subsidies since the main problem is limited usage among the poor due to poor connectivity to the national electricity grid. The average connection fee in Zimbabwe is US$100 whereas the average cost of a connection is US$250. The connection fee between the poor and non-poor is the same. However, the study simulates a scenario where a larger subsidy is given to the poor such that the connection fee for the poor is US$50. The results for the simulation of connection subsidies indicates that connection subsidies are better targeted than consumption subsidies with a benefit incidence ranging between 0.33 to 1.9 (Table 7).

Table 7: Benefit incidence Simulations for connection subsidies

	Benefit Incidence indi ator
Scenario A	0.325
Scenario B	1.859
Scenario C)	1.808

Source: Authors' calculations from 2017 PICES data and ZERA data

Thus the connection subsidies are potentially pro-poor and therefore may be more effective in ensuring that the poor benefit form subsidies. This is mainly attributed to the fact that the main problem why the poor are excluded in consumption subsidies is limited

usage of electricity due to lower rates of connections among the poor. Therefore, improving connections by subsidizing the connection fees is a very effective way of ensuring that subsidies are pro-poor. However, literature notes that the uptake of connections may be low even if the cost of connections is subsidized (Lee, Miguel, and Wolfram, 2020). This suggests that more needs to be done apart from giving subsidies and that there are other barriers to establishing connections apart from costs of connection.

Reform Option 3: Non-tariff based subsidy reforms (non-simulated)

Simulated models based on tariff based subsides consumer have shown a weakness of not being optimal. The observed intuitive rationale for such an outcome is that there is need to compliment these reforms with other non-tariff based reforms for tariff based subsidy reforms to be effective. Non-tariff subsidy reforms are critical in addressing the targeted performance incidence of tariff subsidies. In Zimbabwe there are many incidences of power theft[15] and access to subsidies power by deemed strategic sector and big players with no accruing benefits. Also, the structure of transfer pricing on part of public institutions and entities accessing power is not clear. There is need for reforms on classification of large and strategic consumers of power as well as recasting of the existing subsidy model. For example, government could move entirely or in part from input based power subsidy to out based power subsidy for large consumers such as industry and agriculture. The government could then implement a targeted subsidy system on these critical sectors.

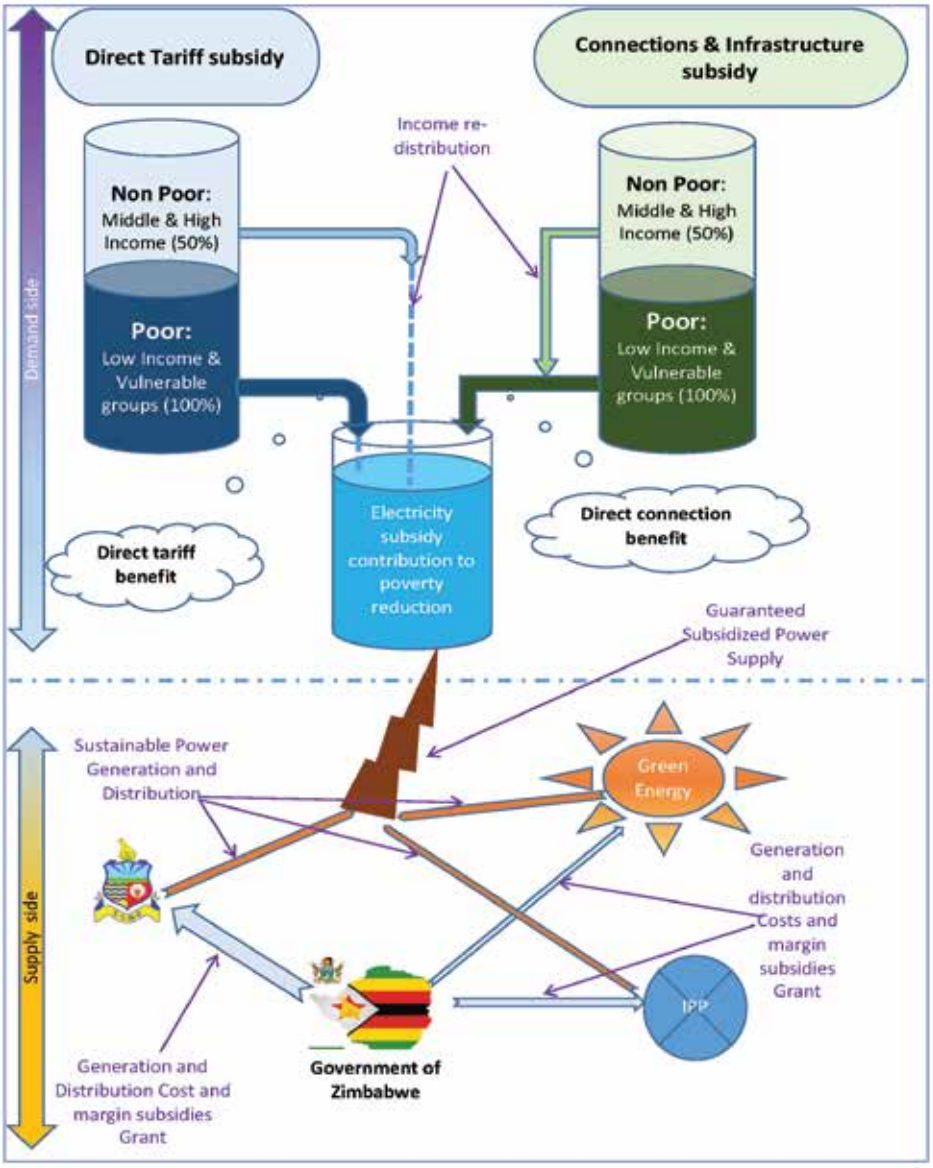
Reform Option 4: Integrating supply side subsides (Non-simulated)

Whilst the study focused on consumption subsidies, the optimality of the reform policy agenda is not complete without supply side reforms. Consumptions subsidies viewed in isolation are not the sole conduit for power subsidies for poverty alleviation. The burden of subsides to the part government cut across supply and consumption subsidies. These subsidies impair the financial health of the energy suppliers, deter investments in the energy sector, and impose large fiscal costs where they are provided by governments (Kitson et al., 2011). Subsidies can be reformed by reducing costs as well as increasing revenues and stakeholder analysis and distributional analysis are important for designing suitable reform programmes (ibid).

The power generating and distributing company is carrying the burden of consumption subsidies and this has affected their operational viability. The operational challenges faced by public power companies (ZPC and ZETDC) reflect elements of the companies carrying the burden on state power-subsides. ZESA is faced with serious revenue collection challenges as the majority of customers are failing to settle their bills on time. Attempts have been made in the past years review tariff structures to have pricing of

15 Although heft penalties were introduced to curb vandalism and theft of electricity infrastructure there is still room to consider other effective measures as well.

Figure 6: Household Income-Differentiated and Supply Enhanced Power subsidy model



Source: Authors' formulation

power that is towards full cost recovery, while at the same time preserving price subsidies for low income households. ZESA, has also instituted demand side management (DSM) programmes[16] with a view to reducing energy consumption and improving its operational performance. The effectiveness of these measures is, however, weighed down by the inefficient subsidy scheme the country is implementing.

With a quantity target approach used in current subsidy model, if supply is restricted or tariff increases, it would imply that majority of people will consume in the first block which is highly subsidized. The poor would then be excluded by crowding out given that they exhaust their resources on alternative sources of power and would not be able to afford electricity. Such a structure would the affect the power company, ZESA, in that most of its power ends up being consumed at below cost, not because consumers are not willing but supply is limiting consumption.

The inclusion of supply side subsides is on the notion that supply of power is a major determinant of the effectiveness and target performance of consumption subsidy matrix. ZESA's regular request for tariff review should be a trigger to also consider supply side subsidy reforms. Zimbabwe is currently facing power deficit and this impact on availability of power to household, and often ZESA resort to shedding power for extended periods. The effective generation and technical subsides that accrue to ZPC/ZETDC might not be adequate to cover the loss incurred through loss incurred through subsidies power generation costs and margin losses. Many Sub-Saharan African countries are characterized by weak institutions, poor quality of electricity service delivery typified by frequent outages, and weak social protection systems that pose serious challenges to the design and implementation of subsidy reform (Kojima, *et al,* 2014).

5. Conclusion and Policy Eecommendations

Deductions from the study are that, with proper reforms and structuring, electricity connection subsides have a potential for a high impact in alleviating poverty in Zimbabwe. Consumption subsidies alone are not effective in improving the lives of the poor and these need to be complemented by connection and supply side subsidies that support increased uptake of electricity by the poor. In other words, the low uptake and usage of electricity excludes the poor from benefits of electricity subsides, implying that with consumption subsidies, it is the poor who are technically subsidising the non-poor by exclusion due to limited connectivity and uptake of electricity. The policy decision, therefore, should not be about whether or not subsidies should continue to be used as tool of alleviating poverty, rather it should be on how to reform the subsidies in order to optimize their effectiveness in alleviating poverty.

The study recommends policy reforms premised on a reviewed electricity subsidy

16 ZESA managed to implement the pre-paid meter programme, upgrade of the existing billing system, and enforcement of the disconnection policy for seriously delinquent accounts.

model that combines reconfigured consumption (IBT tariff schedule) and connection subsidies, based on household income, differentiated using geography and supported by supply-side subsidies (Figure 6). The model depicted in Figure 4 says the central government should bear the cost of consumer subsidies such that investments into electricity generation, transmission and distribution as well as in maintenance of infrastructure are not compromised due to unfunded subsidies. This ensures that more electricity is generated with access and connectivity to electricity extended to the poor so that they benefit from the consumption subsidy.

The connection subsidy enables the poor to afford the cost of connecting to the electricity grid so that their uptake of electricity is increased, potentially enhancing their benefit from the consumption subsidies. The geographic zoning of households according to their locations which proxy their income status would be used as targeting mechanism for subsidy beneficiaries. The zoning could be based on local authority classification. Those in low income (high density) areas would be regarded as the poor targeted for a relatively higher level of subsidy, while those in medium income (medium density) areas would be targeted as medium income earners who benefit from a lesser subsidy level and those in high income (low density) areas would be regarded as non-poor and therefore may be considered as non-eligible for the subsidy.

The upside of the proposed model is that it optimises on electricity subsidies by incorporating a number of different types of electricity subsidies, for the benefits of the poor consumer, the electricity producer(s) and the government. To the poor household, there is income redistribution through higher charges for high income households and heavy users, whilst the power companies' income is enhanced through transfer of burden of subsidy to central government, as well as through charging efficient pricing without disadvantaging the poor. The model also assists the electricity supplier in containing excessive use of subsidised electricity, electricity theft and reduction of error of inclusion. To government, the model ensures efficient distribution of benefits of subsidy, without burdening the power producer.

Specific policy reforms that could be implemented include:

a. The reconfiguration of the IBT tariff schedule to include an efficient cost of supply tariff for consumption beyond an average consumption for the poor. An additional block, for consumption beyond a threshold, say 1000kWh, meant to enforce efficient consumption by penalizing consumption mostly for commercial use under household connections.
b. Introduction of connection and electricity infrastructure development subsidies in order enhance access, connection, and uptake of electricity. This can be achieved through introducing electricity credits for a portion of the value of the connection or infrastructure based on income levels.
c. Restructuring of supply-side subsidies and non-tariff subsidy reforms (including

power theft and reconfiguration of electricity subsidies to large and strategic consumers) and incorporate them in the consumption subsidy model.

Areas for Further Study

The above findings, simulations, conclusions, and recommendations are based on a partial equilibrium analysis which considers individual consumption behaviors contained in PICES data. The analysis is, therefore, restricted to assessing direct financial subsides that accrue upon consumption of electricity, excluding the indirect subsidies and costs that the poor realistically incurs. For example, costs borne by ZESA are funded by the fiscus which in turn is financed in part through taxation. The subsidy burden might indirectly be transferred to the poor through high level of taxation. The study, therefore, recommends further research that focuses on a general equilibrium analysis of the effect electricity subsidies, which incorporates indirect costs such as taxation paid by the poor, as well as supply-side subsides.

In addition, the article assesses the efficacy of the existing subsidies in alleviating poverty. However, analysis should also consider the economic efficiency of subsidies in addition to making them pro-poor. Implicitly, the major objective for policy makers should be to have an electricity pricing policy that ensure economic efficiency of resource use and ensuring financial viability of the power producers. Consistent with this, further studies should, therefore, include subsidies to non-households, mostly on commercial. The data on cost of service for Zimbabwe by the World Bank shows that agricultural subsidies are extremely important and significant and that any sustainable programme of subsidy management needs to consider these. A comprehensive study on total subsidies for both household and non-household sectors in Zimbabwe could inform an economically efficient subsidy regime in the energy sector.

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Remittances, consumption patterns and household investment: The case of Zimbabwe

Tendai Gwatidzo and Tafadzwa Mupingashato

Abstract

Using nationally representative household survey data on Zimbabwe we utilize propensity score matching and multinomial treatment regression approaches to investigate the impact of domestic and international remittances on household expenditure. The results from the propensity score matching approach suggest that remittances, in general, tend to stimulate all categories of household expenditure (food, durables, education and health), indicating that remittances tend to reduce liquidity constraints faced by households in Zimbabwe. We find that domestic remittances increased expenditure on food and healthcare emergencies but had no impact on durables and education. International remittances, on the other hand, stimulated the expenditure on all expenditure categories (including on durables and education). Furthermore, households that received international remittances witnessed larger increases in all categories of expenditure, compared to domestic recipients. This suggests that international remittances are important in not only reducing household liquidity constraints but in stimulating expenditure on important household investment in durables and education. We also found corroborating evidence when using the robustness checks from the multinomial treatment regression approach. That domestic remittances largely stimulate expenditure on food and healthcare emergencies while international remittances stimulate expenditure on all household categories indicates that household treat domestic and international remittances differently. This suggests that households perhaps consider domestic remittances to be compensatory and international remittances to be transitory income.

1. Introduction

When it comes to international financial flows to developing countries, researchers have tended to give greater attention to foreign direct investment (FDI), portfolio investment

and official development assistance (ODA). Since the late 1990s, development economists have however started paying more attention to remittances sent home by international migrants (Yang, 2011). This is because international remittances to developing countries have significantly increased, sometimes exceeding ODA and sometimes even approaching the magnitudes of FDI.[1] Given the large magnitudes of remittances and also the fact that they are a more stable financial resource (compared to FDI, for example) researchers have expended more research effort (by conducting both macro and micro level studies) to better understand the drivers and impact of international remittances.[2]

Important questions have been raised in the literature regarding the household usage of remittances (Adams and Cuecuecha, 2010, 2013). For example, how are remittances used by households in the migrant source countries and what is the impact of such remittances on poverty? There is no consensus on the impact of international remittances: findings on the usage and impact of remittances tend to be either optimistic or pessimistic. For example, Chami et al. (2003)3 argue that a significant proportion of remittances are used to finance status-oriented consumption goods and, when invested, the remittances are invested inefficiently.4 This view is however challenged by Adams and Cuecuecha (2010, 2013), Yang (2008), Randazzo and Piracha (2019) and Osili (2004), who argue that households that receive remittances tend to use a significant proportion of them on household investment goods such as health and housing.5 In fact, Adams and Cuecuecha (2010) found that households receiving international remittances tend to spend less on food consumption and more on education and housing.

In the extant literature it is argued that the household is the main decision unit that determines how remittances are used (Randazzo and Piracha, 2019). The impact of remittances on household expenditure, or even their developmental role, depends on how remittances are perceived by the households: as transitory income, compensatory income or as any other income type. When they view remittances as transitory income, households tend to invest a significant amount more productively, investing in education, health and physical capital. However, when they view it as compensatory income, households tend

1 According to the Word Bank's World Development Indicators database, in 2018 international remittances to developing countries amounted to more than USD500 billion and Zimbabwe received almost USD2 billion from international remittances.

2 Examples of macro studies include Gupta et al. (2009). Examples of micro studies include: Adams and Cuecuecha (2010, 2013) and Acosta (2011).

3 Also see for Entzinger (1985) and Lewis (1986) for similar sentiments.

4 Indeed there is some anecdotal evidence at the household level on the misuse of international emittances in Zimbabwe. For example, a migrant's remittances sent home to build a house being used for consumption purposes.

5 Adams and Cuecuecha (2010) investigated the impact of remittances on household expenditure and investment in Guatemala. Adams and Cuecuecha (2013) investigated the impact of remittances on household investment and poverty in Ghana. Yang (2008) investigated the impact of remittances on household investment in Philippines. Osili (2004) investigated the impact of remittances on housing investment in Nigeria.

to use remittances to finance recurrent expenditure rather than productive investments (Adams and Cuecuecha, 2013). When they perceive it like any other income type there is no expectation that households will use remittances differently.

The main objective of this study is to investigate the usage and impact of remittances in Zimbabwe. The country is an interesting case study for a number of reasons. First, the country's economic and political instability (since the early 2000s) drove a large number of Zimbabweans out of the country, with most of them migrating to South Africa, the United Kingdom and the US.6 Given that a large number of Zimbabweans in South Africa may have entered the country illegally and may thus be unrecorded it is difficult to know the exact number that have left the country since 2000. However, data (which can only be used as indicative) from the Global Migration online database shows that the number of Zimbabweans residing outside the country increased by about 2% per year (in 1990-2000) to 5% per year (in 2000-2017). Most of these individuals maintain social and economic ties with their families back home. They therefore send money back home. Whilst some remittances may be sent for consumption purposes, or are discretionary, others may be for a specific purpose7 (for example, to build a house, to send a child to school, for the medical care of a relative, etc). The World Bank online database has information on remittances covering the period 1980-1994 and 2009-2019. The information on remittances for the period 1980-1994 shows that remittances to Zimbabwe averaged about USD10 million per year. Figure 1 shows the amount of remittances to Zimbabwe for the period 2009-2019.8 It shows that, compared to the 1980s and early 1990s, remittances in 2009 (and beyond) had increased to billions (USD1.2 billion in 2009). In 2012 the country received over USD2 billion in remittances (13.17% of the country's GDP). The annual average amount of remittances during the 2009-2019 period was USD1.78 billion.

Second, most studies on remittances have focused on large remittance recipients like India, China, Mexico and the Philippines. Although African countries such as Nigeria, Senegal and Ghana have received some attention, smaller countries like Zimbabwe have received little. This may be due to data unavailability.9 Given that the structure of the Zimbabwean economy is quite different from, say, Mexico or the Philippines, it is important

6 Given that a large number of Zimbabweans in South Africa may have entered the country illegally and may thus be unrecorded it is difficult to know the exact number of Zimbabwean that left the country since 2000. However, data (which can only be used as indicative) from the Global Migration online database shows that the number of Zimbabweans residing outside the country increased by about 2% per year (during the period 1990to 2000) and 5% per year (during the period 2000-2017).

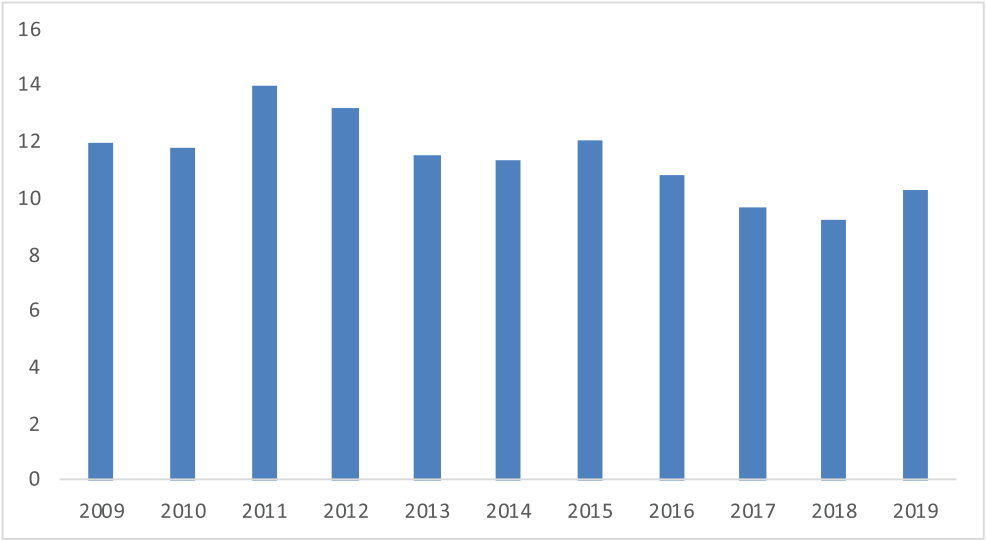
7 According to Yang (2011) another important question is whether migrants have or desire greater control over how family members back home use the remittances they receive.

8 See also Table 1 in the appendix.

9 The study uses survey data from the Poverty Income, Consumption and Expenditure Surveys PICES), which were conducted in 2011 and 2017. The PICES is one of the few data sources with a module on remittances.

to investigate how Zimbabwean households perceive and spend remittances. Also, given that data distinguish between internal and international remittances, it is important to assess if the two are spent differently and if they have different impacts.

Figure 1: Remittances in Zimbabwe (2009 – 2019)



Source: WDI Online Database

For policy makers, understanding how remittances are spent is important. If it is true that they are used inefficiently or are for conspicuous consumption, it may be necessary to come up with incentives to encourage better usage. Given the many Zimbabweans who left the country since the early 2000s, it is important to have a clearer understanding of not only the amount of resources being remitted but the impact of such remittances on the welfare of those left behind. For examples, are the remittances being considered as transitory income and thus being used for capital investments into education, health or housing? Or are they being perceived as compensatory income and thus being used to finance recurrent consumption rather than investment goods? Or do households simply view remittances like any other income and therefore do not give them any special treatment? Understanding all these issues will help the government craft the right policies to ensure efficient remittance usage, enhancing the impact of remittances on the welfare of its citizens and harnessing them for development.

It also is important to note that the Zimbabwean government has since independence in 1980 invested significantly into education. A large number of those who left the country may have benefitted from that investment. Although the brain drain may be considered harmful to the country, the inflows of remittances from those in the diaspora can help the

government revitalise the education and health sectors, whose infrastructure has been deteriorating for quite some time.

Given the above, the main objective of the study is to assess the impact of remittances on household consumption patterns and household investment. More specifically, it seeks to investigate: (a) if the consumption patterns of households receiving remittances are different to those not receiving remittances; (b) if household investment (into health, education and housing) of those receiving remittances are different from those not receiving remittances; (c) if the impact of internal remittances differs from that of international remittances, and (d) to suggest policy implications emanating from the study. The study utilises household level survey data from the 2011 and 2017 Poverty Income Consumption and Expenditure Survey (PICES) conducted by Zimbabwe National Statistics Agency (ZimStat).

The remainder of the paper is organised as follows. Section 2 presents the relevant extant literature. In section 3 the data used for the study and the methodology are discussed. Section 4 presents the empirical results, followed by a number of diagnostics tests. In section 5 robust checks are conducted. Section 6, concludes the study, and section 7 presents policy recommendations.

2. Literature Review

There is a dearth of literature on micro-based studies that investigate the impact of remittances in Zimbabwe. Unlike the current study, which uses nationally representative survey data, most studies focus on particular regions; those that cover the entire country are mostly descriptive in nature and therefore do not adequately assess the impact of remittances on poverty or household expenditure. Examples include Nzima et al. (2017), Ncube and Gomez (2011) and Tevera and Chikanda (2008). Nzima et al. (2017) used survey data covering people from Zimbabwe's Tsholotsho district as well as Zimbabweans based in South Africa to investigate the usage of remittances in Tsholotsho. They found that the majority have been used to cushion family members from poverty, while a little has been used for investments and savings. Assessments of the remitting patterns of emigrant Zimbabwean medical doctors found that they were sending remittances to their families to cushion them against the harsh economic climate in the country. Ncube and Gomez (2011) also use survey data covering Tsholotsho District in Zimbabwe to explore the link between remittances and local development. They found that households used some of their remittances to acquire farming equipment and tended to invest mostly in traditional agricultural activities. Mugumisi (2014) used survey data to investigate the reasons why Zimbabweans based in South Africa and Botswana send remittances back home. He found the following as the major motives: altruism, self-interest, implicit family agreements, and portfolio investment. Using 2005 household-level survey data covering 723 households

in Zimbabwe, Tevera and Chikanda (2008) explore the impact of remittances on poverty. They argue that remittances reduced vulnerability to hunger, ill-health and poverty in both rural and urban households. The study shows that remittances are mostly used for the consumption of food, school fees, medical expenses, and building. A small number of households have been able to use their remittances to increase income through the purchase and sale of goods or in investment in transportation or farming.

From the above analysis, we note that the studies largely look at the motivation to remit and not on the relationship between remittances and household consumption. This study seeks to fill this gap in the literature. This study especially follows the approaches used by Adams and Cuecuecha, (2010, 2013), Acosta (2011), Randazzo and Piracha (2019), and Cox-Edwards and Rodriguez-Oreggia (2009). Randazzo and Piracha (2019) use nationally representative survey data from Senegal, as well as a combination of the propensity score matching and multinomial treatment regression approaches, to investigate the impact of remittances on household expenditure. They found that remittances stimulate household expenditure but domestic and international remittances were not treated differently by the households. Adams and Cuecuecha (2013) use the two-stage multinomial selection model to investigate the impact of remittances in Ghana, finding that remittances tend to reduce poverty. More importantly, they found that remittances stimulate expenditure on health, education and housing. These results from Ghana corroborate findings by Adams and Cuecuecha (2010) on Guatemala. Cox-Edwards and Rodriguez-Oreggia (2009) however found that remittances did not really affect labour force participation rates in Mexico. Acosta (2011) used survey data from El-Salvador and found that remittances had no effect on schooling, even though it tended to reduce the extent of child labour. These mixed results indicate that the debate on the impact of remittances remains unsettled, and that more country-level studies that adequately capture country specific factors need to be conducted.

3. Methodology and Data

3.1 Methodology

The objective of this study is to investigate the impact of remittances on household expenditure. There are two main problems that may affect the study results: selection bias and simultaneity (Adams and Cuecuecha, 2013). First, migration and sending remittances are selective processes (Randazzo and Piracha, 2019). The households receiving remittances and those not receiving remittances may be systematically different. For example, households receiving remittances may be more motivated and less risk averse. Second, choices made by households that lead them to being poor may be correlated to their choice of whether or not to receive remittances (Adams and Cuecuecha, 2013). An ordinary least squares regression approach may therefore fail to establish the causal

relationship being investigated.

To mitigate the above identification challenges we use two main identification strategies, i.e. propensity score matching and multinomial treatment regression (MTR) approaches to investigate the usage and impact of remittances. These approaches have been used by a number of authors in the literature. See for example, Adams and Cuecuecha (2013) on Ghana, Adams and Cuecuecha (2010) on Guatemala, McKenzie (2006) on Mexico, Randazzo and Piracha (2019) on Senegal, and Acosta (2011) on El Salvador.

The Propensity Score Matching Approach

This study uses the propensity score matching (PSM) approach to investigate the impact of remittances on household expenditure. Whilst there are a variety of other quasi-experimental approaches,[10] the PSM approach seems to be appropriate given the data at our disposal. For example, it works quite well even when used with cross-sectional data.[11] Like any other quasi-experimental approach the PSM estimator seeks to solve a missing data problem. In this particular case the missing data problem arises from the fact that we only observe households that receive remittances but we do not know what their expenditure would have been if they did not receive remittances (counterfactual). That is, we cannot at the same time observe the same households with and without the remittances. Properly matching households receiving remittances and those not receiving remittances will help create the counterfactual. In order to match the remittance recipients to non-recipients we start by running a probit regression. The equation for the probit regression is stated as follows:

$$P_s = f(\text{household characteristics, regional characteristics}) \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where P_s is a dummy variable taking a value of 1 if a household received a certain type of remittances and 0 if not. Where *s* stands for the type of remittance received; we classify households into three mutually exclusive states: not receiving any remittances, receiving internal remittances only, and receiving international remittances only. Another possible state is the combined one where a household receives both internal and international remittances. We will therefore conduct the matching based on these different states. Specifically, we match households that receive internal remittances only to households that do not receive remittances to estimate the impact of domestic remittances. Similarly, we estimate the impact of international remittances by matching households that receive international remittances to non-recipient households. Lastly, we will combine the internal and international remittance recipients to estimate the impact of remittances in general. Working with these different categories of remittances will help us investigate if these two types of remittances have different effects on household expenditure.

If we consider a remittance recipient to be a treated unit and therefore a programme

10 Examples include the regression discontinuity, the difference-in-difference and the instrumental variable approaches.

11 The PICES data used for the analysis is cross-sectional.

participant – as in impact evaluation literature – we can then state that being selected into the programme may be a function of a number of characteristics. These include household and regional characteristics, and include household wealth level, household size, age, gender, ethnicity, educational level of household head, household farm/plot size, rural/urban dummy, and provincial regional dummies. The following equation shows the probit/logit regression used to estimate the propensity score:

Prob(Y=receive remittances) = f(education level of HH, age of HH, gender of HH, ethnicity of HH, household size, size of land owned by household, whether household has children below age 5, number of adults in the household, urban/rural dummy, provincial dummy)……..(2)

When selecting the covariates to be included in the above model we especially need those variables that are likely to affect the probability of receiving the remittances. That is, we select characteristics that are not affected by the outcome but do affect participation (receiving remittances). For example, in our case we do not expect variables like age, gender, ethnicity, rural/urban dummy, provincial dummy, etc., to be affected by the status of being a remittance recipient. After selecting the right characteristics, we run the above regression and estimate the propensity score. The estimated propensity scores give us the probability of receiving remittances. The propensity scores capture the combined effects of the likelihood of receiving remittances thereby avoiding the curse of dimensionality.

The next step is to use the scores to match households receiving remittances with those not receiving remittances. Households receiving remittances that have propensity scores closer to those that are not receiving, are matched. The expectation is that, if matching was done correctly, the expenditure patterns observed for non-remittance recipients is what we would have observed for the recipients had they not received remittances. That is, the matched households not receiving the remittances are the counterfactual for the households receiving remittances. In the literature, several matching algorithms are used to conduct the matching. They include: the nearest neighbour, radius or caliper estimator, stratified or interval estimator and kernel method.

With the *nearest neighbour* matching estimator, for each remittance recipient we find a non-recipient household with the closest propensity score and match the two. The difference in outcomes for each matched pair is calculated, with the ATT being the average of the estimated differences (Randazzo and Piracha, 2019). One weakness of the nearest neighbour estimator is that it can easily yield bad matches, particularly if the difference between the propensity scores for a treated household and its closest untreated counterpart is high. To avoid this problem one can use the *caliper matching* estimator, which imposes a maximum distance between two neighbours being matched: a neighbour lying outside the threshold is excluded and only those falling within the caliper are used (Dehejia and Wahba, 2002). We will use the commonly used thresholds:

0.01, and 0.05. The choice of the threshold must take into account the fact that a very low threshold, while giving us the best matches, may come with very few such matches while a very high threshold, while giving us a high number of matches, comes with a large number of bad matches. The *interval matching* estimator divides the common support region into intervals and calculates the programme impact within each interval. The weighted average of these impacts is then the programme impact (Shahidur et al., 2010). The *kernel matching* estimator is a non-parametric estimator which matches a treated unit with a weighted average of all untreated units, with the closest units receiving more weight (ibid).

Each of the above matching estimators has its advantages and drawbacks. None of them can be considered superior to the other. One weakness of the propensity score matching approach is that there is no guidance in the literature on the choice of matching estimators. The superiority of a given matching estimator may therefore depend on the context and data being used (Randazzo and Piracha, 2019). We therefore conducted the matching using the following matching estimators for robustness: the nearest neighbour, caliper and kernel estimators. Depending on the results emanating from the matching it is also possible to test and ultimately select the best estimator among those used, à la the Hausmann test, when choosing between random effects and fixed effects model. The procedure entails using only those households that did not receive any remittances. We will start by estimating their propensity score, randomly assign some into a treatment group and some into a control group, conduct some matching using all the above matching estimators and then estimate an impact. Given that we are only using the control group (that is, those who are not receiving remittances) the expectation is that there should not be a significant difference in the household expenditure for those assigned into the 'control' and 'treatment' groups (i.e. no impact). The best matching estimator therefore should be the estimator that tells us that there is no difference in the outcome (household expenditure in this case) between these two groups that are essentially the same.

For credibility, the PSM approach requires two important assumptions to hold. These are the overlap condition and the conditional independence assumption (CIA). The common support or overlap condition ensures that there is sufficient overlap in characteristics of the treated and untreated units to find adequate matches. Those that fall outside the common support region are dropped and only those households (in the treatment and control groups – i.e. those receiving and not receiving remittances) falling in the common support region will be used for the analysis. The CIA states that the potential outcomes must, after controlling for the observable characteristics, be independent of treatment status. This means after controlling for the household and regional characteristics, the treatment assignment (i.e. whether one is receiving remittances or not) would be as good as random. This reduces selection bias and thus helps in creating a more credible control group or counterfactual. It must be noted that whilst one can check for the existence of

common support, the CIA cannot be tested for. A clear understanding of the context being studied is important for one to be sure that indeed the CIA is less likely to be violated.

Weaknesses of the Propensity Score Matching Approach

Like any other estimator the propensity score matching approach has a number of weaknesses. Firstly, the CIA condition may fail to hold. This may then affect the randomness of treatment assignment. Secondly, the PSM approach assumes that participants and non-participants are matched based on observable characteristics. It is however possible that unobservable characteristics such as the household head's innate ability, level of risk aversion, or the household's commitment level, may affect participation,[12] creating or worsening the selection bias problem as the treatment and control group may be systematically different due to the unobservable characteristics.[13] Thirdly, the PSM estimator, which is also highly data-hungry, may be affected by the absence of common support. Some of the above weaknesses can be corrected by, for example, combining the PSM and difference-in-difference approaches. We however do not have adequate data to use this particular approach.

The Multinomial Treatment Regression (MTR) Approach

Even though the PSM approach described above helps create a counterfactual and a resultant impact, it still has the disadvantage of failing to control for unobservable characteristics. Households receiving remittances may therefore still be systematically different from those not receiving. This may affect both the migration-remit decision as well as the outcome. To reduce the selection bias we use the multinomial treatment regression approach (with and without instrumental variables).14 But it must be noted that according to McKenzie and Sasin (2007), in the absence of a good IV the PSM, compared to other quasi-experimental approaches, performs quite well and may even be better than a poor instrument (Randazzo and Piracha, 2019).

The MTR approach was proposed by Deb and Tirivedi (2006) and Deb (2009) and has been used by a number of authors including Randazzo and Piracha (2019) and Adams and Cuecuecha (2010, 2013). The approach is made up of two main components, an outcome equation and a selection equation, which are linked by observed and unobserved characteristics (Randazzo and Piracha, 2019). For our purposes, the outcome variable in the model is household expenditure or budget share and the treatment variable is remittance receiving status. The remittance receiving status has three categories: no remittances received, domestic remittances received, and international remittances

12 And also outcomes that are being evaluated. For example, the choice of expenditures level.

13 Unfortunately, the presence or absence of selection bias cannot be tested.

14 Our approach is therefore to use the PSM approach, the MTR approach without IVs (as done in-Randazzo and Piracha, 2019) and the MTR approach with IVs (as done in Adams and Cuecuecha, 2010, 2013).

received. The selection equation estimates the probability of a given household receiving a certain category of remittance. Following Randazzo and Piracha (2019) and Adams and Cuecuecha (2013), the probability that a given household receives a certain remittance type is given by:

$$Pr\left(REM_{dj}\middle|z_j l_j\right) = \frac{exp\ (z_i'\alpha_j + \delta_d l_{jd})}{1 + \sum_{k=1}^{D} exp\ (z_j'\alpha_k + \delta_d l_{jk})} \quad \text{.....(3)}$$

Where REM_{dj} is a dummy variable capturing each of the remittance statuses. The probability depends on household characteristics captured by the variable Z_i and a latent factor l_{jd} (Randazzo and Piracha, 2019). The latent variable l_{jd} captures the unobserved household characteristics affecting the probability of receiving remittances. More specifically the model to be estimated in first stage is:

Prob(Y=receive remittances) = f(education level of HH, age of HH, gender of HH, ethnicity of HH, household size, size of land owned by household, whether household has children below age 5, number of adults in the household, ***instrumental variables****, urban/rural dummy, provincial dummy)*

.....(4)

Where *HH* stands for household head.

Because we are trying to estimate the expenditure share we use the following Working-Leser model:

$$Y_{ij} = \alpha_i + \beta_i logEXP_j + \gamma_i X_j + \theta_i REM_{dj} + \lambda_d l_{jd} + \varepsilon_{ij} \quad \text{.....(5)}$$

Where Yij stands for household j's budget share in good i. The budget shares to be used are budget shares of: durables, food, health and education. To estimate the impact of remittances on food budget share we run equation (5) using the food budget share as the dependent variable. To estimate the impact of remittances on the education budget share, we run equation (5) using the education budget share as the dependent variable.15 The variable Xj stands for household characteristics, REMdj is a dummy variable capturing each of the remittance statuses. For example, if for household j, the impact being assessed is the impact of domestic remittances, REMdj would take a value of 1 if household received remittances and 0 if not. This is then repeated for the other mutually exclusive remittance status categories. EXP stands for total household expenditure, θi is the parameter of interest. It shows the effect of the different categories of remittances on household expenditure or budget share. The variable ljd represents the selection correction variable, and shows us the extent of the correlation between unobservable remittances determinants and the household expenditure or budget share.

Depending on what the household spends its money on, household expenditure will be categorised into the following categories: food, health, education, durables and

15 A similar procedure is followed for the rest of the budget shares.

other. The MTR model is estimated using STATA 16's 'mtreatreg' command.16 We start by estimating the above framework in the absence of instrumental variables and then, for robustness, add instrumental variables. Randazoo and Piracha (2019) estimate their model without the instrumental variable and simply rely on the nonlinear functional form of the remittance status equation.

We use two instrumental variables or exclusion restrictions to address the problem of endogeneity. The instrumental variables are distance to the post office and distance to growth points. In Zimbabwe post offices have traditionally been used as points to receive registered mail and money, particularly by those in the rural areas.[17] For example, money sent to a rural household may be sent to a relative residing in urban areas, who then forwards it, through the post office located in the rural areas, to its final recipient. The growth points are also another channel used to send money to those in rural areas: money from the diaspora is received in towns and then get forwarded to the rural recipients for collection at a growth point. The shorter the distance to the growth point or post office the cheaper or easier it is to send remittances. So the distance to the post office or growth point is related to the probability of receiving remittances. Distance to the post office is unlikely to influence household expenditure,[18] but it is possible that those closer to growth points may spend more than those staying far away. We therefore think that distance to the post office may be a better instrument that distance to growth points. We however use both and interpret our results with that weakness in mind.

3.2 Data used for the study

This study uses the data from the Poverty Income Consumption and Expenditure Survey (PICES) for 2011 and 2017. The 2017 survey contains more than 30,000 households and the 2011/12 PICES contains 29,765 households. The nationally representative surveys contain information on aspects of living conditions in Zimbabwe, including consumption expenditure, household income, informal sector contribution, poverty and inequality issues and social welfare interventions by the government. More important for this study, the surveys also contain information on income transfers within and outside the country. They include an international migration module which probes for information on migration, including the characteristics of people that emigrated from Zimbabwe, as well as information on households that received domestic and international remittances. The study uses information on general household characteristics as well as that on remittances to investigate the impact of remittances. The households were asked if they received any remittances in the last twelve months or in the last month. Their response was used to

16 See Deb (2009) for more details on the procedure.

17 Data from the World Bank's World Development Indicators online database indicates that in 2019 the rural population in Zimbabwe accounted for about 68% of the country's total population.

18 The first stage results shown in Table 13 and 15 for the MTR approach show that households located close to a post office or growth point are more likely to receive remittances.

categorise them into four groups: those that did not receive any remittances, those that received domestic remittances only, those that received international remittances only, and those that received both remittance categories. Our estimate of remittances are on a monthly basis, where annual figures are reported by the households the corresponding monthly remittances were derived by dividing the annual values by twelve.

The total household expenditure is the outcome of interest. For an in-depth analysis, we further categorise household expenditure into food, health, education and durables budget shares. Tables 2 and 3 show the consumption expenditure distribution as well as the variable summary statistics for both surveys years. Table 4 shows the expenditure patterns for remittance recipients and non-recipients. Tables 2, 3 and 4 all show that, for the years 2011 and 2017,19 households that receive remittances tend to spend more on all expenditure categories (food, education, health and durables) than those that do not receive remittances. Regarding other household characteristics we find that 68% of the non-remittance recipient households were male-headed, while 43% of the remittance recipients were male-headed (See Table 2). This may indicate that a large number of male household heads were migrating and sending remittances, hence the low proportion of male-headed households in the remittance receiving category. In terms of the population distribution by age group, we find that household heads aged 30-39 years dominated the other age groups (22% of them in remittance receiving households, 29% of them in the non-remittance receiving households). Migration seems to be a function of education and unemployment. For example, 50% of the remittance receiving households had household heads with secondary education, compared to 48% for non-remittance receiving households. Ten percent of the remittance receiving households had a family member with tertiary education, compared to 7% for the non-remittance receiving households. Families with larger shares of unemployed adults were likely to receive remittances. The share of unemployed adults was 21% for the remittance receiving households but only 4% for non-remittance receiving households. Regarding the provincial distribution of households receiving remittances we find four provinces to be dominant (accounting for 60% of remittance receiving households): Harare (19%), Midlands (16%), Manicaland (14%) and Bulawayo (11%).

4. Empirical Results of the Study

This section presents results from the PSM and MTR approaches. The PSM approach has two main steps. The first entails estimating the propensity scores which are then used to conduct the matching (matching the remittance recipients to non-remittance recipients) and to estimate the average treatment effect on the treated (ATT) in the second step. Table 5 and 6 present the first step results for the years 2011 and 2017, respectively. Table 7

19 We observe a more or less similar pattern when looking at the descriptive statistics for the survey years 2011 and 2017. In this section we therefore focus on the more recent 2017 data.

shows the ATT results for both 2011 and 2017. We use the following matching estimators to estimate the ATT: nearest neighbour, caliper and kernel estimators. The remittance recipients were categorised into three main groups: domestic remittance recipients only, international remittance recipients only and those that received both international and domestic remittances. When it comes to the category of remittance recipients that received either domestic or international or both domestic and international remittances, the results suggest that remittances (for both years) had a positive and significant effect on all categories of household expenditure. For example, in 2011 (2017) households that received any kind of remittances spent an additional USD10[20] (USD6.56) per month on food than they would have spent if they did not receive remittances. Similar patterns are also observed for other expenditure categories. For this treatment category, the ATT estimates for both years and across all the categories of household expenditure were positive and significant, regardless of the matching estimator used. This suggest that remittances help in relaxing the budget constraints for households, enabling them to increase household expenditure. It is however important to separate remittance recipients (domestic versus international remittance recipients) as this enables us to further investigate if households perceive domestic and international remittances differently.

When it comes to domestic remittances we find that they have a positive and significant effect on the food and healthcare categories of expenditure.[21] For example, in 2011 (2017) domestic remittance recipients spent an additional USD6.32 (USD4.77) per month on food than they would have if they did not receive remittances. The ATT estimates for the food category are positive and significant (for the 2011 data the ATT is significant at the 1% level regardless of the matching estimator used and for the 2017 data it is significant at the 10% level when using the nearest neighbour and at the 1% level when using the caliper and the kernel matching estimators). The ATT estimates (when using the 2011 data) for the health expenditure category are positive and significant (at the 10% level when using the nearest neighbour and caliper matching estimators, and at the 5% level when using the kernel matching estimator).

Regarding the impact of international remittances on household expenditure, we find that in 2011 (2017) those that received international remittances spent an additional USD20 (USD17.65) per month on food than they would have spent if they did not receive remittances.[22] A similar pattern is observed for the other expenditure categories and matching estimators. Across both years the ATT estimates are significant across all categories of household expenditure, regardless of the matching estimator used. For example, the ATT estimates for food (in 2011), durables (in 2017) and education (in

20 Using the Kernel matching estimator.

21 In this category the treated are those that received domestic remittance only and the untreated are those that did not receive any remittance.

22 Using the Kernel matching estimator.

2017) were positive and significant at the 1% or 5% level of significance, regardless of the matching estimator used. For 2017 the food ATT was significant at the 1% level when using the caliper and kernel matching estimators, and at the 5% level when using the nearest neighbour matching estimator. The 2011 results also show that the ATT for durables was significant at the 10% level when using the caliper and nearest neighbour matching estimators. When using the 2011 data, the ATT for education expenditure was significant at the 1% level (when using the nearest neighbour and kernel matching estimators) and at the 5% level when using the caliper matching estimator. When using the 2017 data, the ATT estimate was significant at the 1% level when using the caliper and kernel matching estimators, and at the 5% level when using the nearest neighbour matching estimator. The ATT estimate, when using the 2011 data, for the health expenditure category was significant at the 5% level of significance (when using the nearest neighbour and caliper matching estimators) and at the 1% level (when using the kernel matching estimator). When using the 2017 data the ATT estimates on the impact of international remittances on health expenditure were significant at the 10% level, regardless of the matching estimator used.

As stated in the introduction, households can perceive remittances as transitory income (in which case they would spend them on durables and education), or compensatory income (in which case they would mostly spend them on food or healthcare emergencies), or just as any other income. The evidence from the study suggests that households spend their remittances on both durables and food, so it is difficult to conclude whether they perceive remittances as transitory or compensatory income. What is clear, however, is that households perceive domestic and international remittances differently. The fact that domestic remittances seems to be used for emergencies like food and healthcare while international remittances are used for durables and education (in addition to food and healthcare) suggests that, to a certain extent, households may be considering international remittances to be transitory income (hence the expenditure in education and durables) rather than compensatory income, while they may be likely to consider domestic remittances as compensatory income (hence its use on food and healthcare emergencies).

The impact of all forms of remittances (i.e. domestic or international or both) on food and healthcare expenditure weakened somewhat from 2011 to 2017. The impact of all forms of remittances on durables expenditure in 2017 was larger than the 2011 impact, and the impact on education expenditure in 2017 was smaller than the impact in 2011 (when using the caliper and kernel matching estimators). The impact of domestic remittances on food and healthcare expenditure also declined from 2011 to 2017, as did the impact of international remittances on food, education and healthcare expenditure. The impact of international remittances on durables, however, increased during the period.

Given the importance of common support when using the propensity score matching approach, we conducted some diagnostic tests to check the quality of matching. Table 8 and Figure 2 present the post-estimation results testing for the quality of matching. Figure 2 shows that there is overlap in the pscores across the three categories of treatment. Table 8 shows that matching reduced the bias by more than 99% for each treatment category. For each treatment category, the matched pscores for the treatment group were statistically identical, indicating the overall similarity between the treatment and control group, post-matching.

5. Robustness check using the Multinomial Treatment Regression (MTR) Approach

One weakness of the PSM approach is that it matches on observable characteristics and does not correct for the selection bias emanating from unobservable characteristics. In this section we use the MTR approach to assess the impact of remittances. For this approach we establish three important categories of households: households that receive no remittances (the base category), households that receive domestic remittances only and households that receive international remittances only.[23] This helps us better understand whether households treat internal and external remittances differently. We therefore have three household statuses in this section: whether a household received no remittances, whether it received domestic remittances only or whether the household received international remittances only. As stated in the methodology section the impact of remittances is estimated using two equations (4 and 5). The results shown in Table 9 (using 2011 data) and Table 10 (using 2017 data) were estimated using equation 4 (from now on called first stage results). The results shown in Tables 11 and 12 (from now on called second stage results) were estimated using equation 5 and were based on the data from the years 2011 and 2017, respectively. The results based on the 2011 data show that receiving domestic remittances stimulates expenditure on durables (2.5%), healthcare (about 1%) and education (about 2%) (see Table 11). The results however indicate that receiving domestic remittances reduces expenditure on food (3.7%). The estimated parameters for durables, healthcare and education are all significant at the 1% level. The results from the 2017 data also show a positive relationship between receiving domestic remittances, on the one hand, and the expenditures on durables and education, on the other (see Table 12). When it comes to international remittances we find a positive relationship between receiving international remittances and food expenditure (using 2011 data) and between receiving international remittances, on the one hand, and expenditures on durables and education, on the other (using 2017 data). Results from the 2017 survey also show a negative relationship between receiving

23 Households that receive both domestic and international were not used in this section of the study.

remittances (international or domestic) and expenditure on food. This result suggests that households receiving emittances may be considering remittances to be transitory and therefore spending it on education and healthcare rather than on food. These results support findings by Adams and Cuecuecha (2010) on Guatemala, Randazzo and Piracha (2019) on Senegal and Adams and Cuecuecha (2013) on Ghana.

To further check the robustness of the above results in this section we introduce two exclusion restrictions or instruments. These restrictions must predict the probability of receiving remittances but must be uncorrelated to household expenditure. Also, although the relevance of the exclusion restrictions in terms of their explanatory power in the selection equation can be easily tested there is no formal over-identification test developed in this framework. It must however be noted that our mixed multinomial choice which models receiving remittances and their impact on household expenditure can in principle be identified even without the exclusion restrictions (that is, when one uses the same variables in both the selection and outcome equations as done above). See for example Randazzo and Piracha (2019). Based on data availability we selected the distance to the nearest post office and the distance to the nearest growth point as the exclusion restrictions. In Zimbabwe a significant proportion of the population still stays in the rural areas. It is common for people in the rural areas to receive groceries or remittances through post offices or at growth points. However if the distance to the post office or growth point is long it makes it difficult to receive remittances. We therefore hypothesize that distance to the post office or growth point is negatively related to the probability of receiving remittances, particularly for those in the rural areas. We however do not think that distance to the post office or growth point is directly related to household expenditure. We separately include the variables distance to the post office and distance to the growth point in the selection equation but not in the outcome equation. These first stage results are presented in Table 13 (when using the distance to the post office) and Table 15 (when using the distance to the growth point). The results indicate that distance to the post office or to the growth point both affect the probability of receiving remittances, especially domestic remittances.

Tables 14 and 16 show the second stage results when using distance to the nearest post office and distance to the nearest growth point as the exclusion restrictions (using 2011 data[24]). Table 14 results are not very different from Table 11 results (Table 11 results do not include any instruments). For example, just as in Table 11, Table 14 results indicate that receiving domestic remittances increases expenditure on durables (2.7%) and health (0.9%), and reduces expenditure on food (4.8%). The results based on the IV however indicate that receiving domestic remittances reduces expenditure on education (0.5%), unlike the results in Table 11 which indicate a positive relationship between

24 We could not get data on distance to the post office or growth point when using the 2017 survey. The results using instrumental variables are therefore based on the 2011 survey data.

domestic remittances and education. The impact of international remittances when using instrumental variables compared to the previous ones shown in Table 11 (when not using the IV method) did not change.

Tables 16 presents second stage results obtained when using distance to the nearest growth point as the exclusion restriction. Just as in the previous set of results that did not use exclusion restrictions, the second stage results indicate that domestic remittances have a positive effect on expenditure on durables (2.7%), education (0.4%) and health (0.9%). However, we found no effect of domestic remittances on food expenditure when using distance to the nearest growth point as the exclusion restriction. Table 16 also shows that international remittances stimulate expenditure on education (1.5%) but reduce expenditure on food and durables. It must however be noted that distance to a post office may be a weak instrument since the correlation between receiving remittances (particularly international remittances) and distance to the post office is quite low (see Table 13). The same applies to distance to a growth point (see Table 15). Given the above we consider the propensity score matching results to be more reliable. According to McKenzie et al. (2010) and McKenzie and Sasin (2007) in the absence of a good IV the PSM, compared to other quasi-experimental approaches, performs quite well and may even be better than a poor instrument (Randazzo and Piracha, 2019).

6. Conclusion

The study uses the propensity score matching and multinomial treatment regression approaches to investigate the impact of remittances on household expenditure using Zimbabwe's 2011 and 2017 household survey data. The study findings suggest, and corroborate the view in the extant literature, that remittances help reduce credit constraints faced by households. Also, the results suggest that households perceive domestic and international remittances differently.

The results from the PSM approach suggest that remittances, in general, tend to stimulate all categories of household expenditure (food, durables, education and health), indicating that remittances tend to reduce liquidity constraints faced by households in Zimbabwe. This outcome is evident when using both the 2011 and 2017 survey data. In an attempt to assess the separate or differential effects of domestic and international remittances we used receipt of domestic remittances only or international remittances only as treatment. The results suggest that domestic remittances increased expenditure on food and healthcare but had no impact on durables and education. International remittances, on the other hand, stimulated the expenditure on all expenditure categories (including on durables and education). However households that received international remittances witnessed larger increases in all categories of expenditure, compared to domestic recipients. This suggests that international remittances are important in

not only reducing household liquidity constraints but in stimulating expenditure on important household investment in durables and education. Furthermore, even though both domestic and international remittances seem to positively stimulate expenditure on healthcare, international remittances have a larger impact than domestic remittances. Given the difficult economic condition faced by most households in Zimbabwe, the above results support the general view that those in the diaspora are playing a very important role in alleviating poverty in the country. In the recent past the education and health sectors have seriously deteriorated, and remittances (particularly international remittances) are helping reverse a situation that could have seriously worsened.

We also found corroborating evidence when using the robustness checks from the multinomial treatment regression approach. For example, as with PSM approach, we found that domestic remittances were positively related to expenditure on durables, health and education[25]. When using 2017 data we also found that although both domestic and international remittances stimulate expenditure on durables and education, international remittances have a larger positive impact, with the impact on durables expenditure strengthening over time, but weakening for the rest of the expenditure categories.

Other than the stated weaknesses of the PSM and the MTR approaches[26] there are other weaknesses, and hence possible areas for future research. First, the study uses cross-sectional data. This makes it difficult for one to better investigate the dynamics around remittances and their impact. Future studies can be done using panel data and richer datasets that allow for the creation of better instruments. Second, an important issue is whether the impact of remittances on household expenditure depends on the gender of the household head. Third, there is need to investigate the impact of remittances on poverty in Zimbabwe.

7. Policy recommendations

It is quite evident that remittances are playing an important role in reducing the liquidity constraints faced by Zimbabwean households. It is also evident that the impact of international remittances is larger than that of domestic remittances. There is therefore need for the government to encourage the inflows of international remittances. One major problem is that sending remittances to Africa (or within Africa itself) is quite expensive (World Bank, 2006; Cirasino, 2013). For example, sending remittances through major corridors such as the US to Mexico may cost about 5% of the amount remitted, while sending remittances to Africa or within Africa can cost as much as 20% of the amount remitted (World Bank, 2006). One way to encourage the inflow of international

25 The 2017 results from the multinomial treatment regression approach however indicate a negative relationship between remittances and expenditure on food.

26 Including the weaknesses of the two suggested instruments.

remittances is therefore to significantly reduce the cost of sending remittances to Africa and within the continent. Most transfers are conducted through private players, like Western Union, MoneyGram, so it may be difficult to reduce their costs. The government can however encourage competition in the sector using a number of strategies. First, they need to reduce barriers to entry. Second, they need to allow competition between Money Transfer Operators (MTOs) and commercial banks. Third, they need to reduce capital requirements and other burdensome legal and compliance requirements for new MTOs (World Bank, 2006). There is also a need to open up the postal networks to the MTOs, join hands with G8 and G20 countries which are coming up with programmes to reduce the remitting cost to 5% of the remitted amount, and to develop an efficient modern payment infrastructure (World Bank, 2006; Cirasino, 2013). Increasing competition among all players involved in remittance transfers will help reduce costs, which is beneficial to both the remitters and the MTOs involved. Lower costs will incentivise remitters to send more money home while increasing the volume of business for the MTOs (Cirasino, 2013). The government also needs to create better investment opportunities for those in the diaspora (e.g. the issuance of diaspora bonds to finance infrastructure) so that such resources are also used for long-term investments like housing and infrastructure (road, hospitals, schools, etc). It is also argued that enfranchising those in the diaspora may also encourage them to send money back home.

Another policy option for the government is to increase digital financial inclusion for remittance recipients as well as better access to remittance receipt services in rural areas. More than 65% of the country's population stays in the rural areas. Therefore, initiatives to increase financial inclusion, particularly for those in the rural areas, will a long way in making it easier for people to receive remittances at low costs.

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TABLES

Table 1: Remittances in Zimbabwe: 2009 - 2019

Year	Remittances[27] (USD in Millions)	GDP[28] (USD in Millions)	Remittance as % of GDP
2009	1205.66	10 061.94	11.98
2010	1413.25	12 041.66	11.74
2011	1919.48	13 750.84	13.96
2012	2113.58	16 042.47	13.17
2013	1890.28	16 361.64	11.55
2014	1903.97	16 750.54	11.37
2015	2046.58	17 048.68	12.00
2016	1856.04	17 177.55	10.81
2017	1729.88	17 985.58	9.62
2018	1729.88	18 854.23	9.18
2019	1773.49	17 327.04	10.24

Source: WDI Online Database

27 Constant 2010 USD in millions.

28 Constant 2010 USD in millions.

Table 2: Summary statistics 2017

	Overall					Non- recipient household					Remittance receipient household				
	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Treatment variables															
Remittances domestic ($)	29 555	12.5	53.5	0.0	900	24 856	0.0	0.0	0.0	0.0	4 699	70.7	109.8	0.0	900
Remittances international ($)	29 555	6.7	47.7	0.0	1 500	24 856	0.0	0.0	0.0	0.0	4 699	38.1	108.1	0.0	1 500
Remittances (domestic + international - $)	29 555	19.3	72.8	0.0	1 500	24 856	0.0	0.0	0.0	0.0	4 699	108.8	142.1	0.5	1 500
HH remittances recipient	29 555	0.18	0.38	0.0	1.0	24 856	0.0	0.0	0.0	0.0	4 699	1.00	0.00	1.0	1.0
HH remittances recipient (domestic)	29 555	0.14	0.35	0.0	1.0	24 856	0.0	0.0	0.0	0.0	4 699	0.81	0.39	0.0	1.0
HH remittances recipient (international)	29 555	0.04	0.20	0.0	1.0	24 856	0.0	0.0	0.0	0.0	4 699	0.23	0.42	0.0	1.0
Outcome variables:															
Food exp. ($)	29 555	87.0	61.3	5.2	1 089	24 856	85.6	60.1	5.2	859	4 699	93.2	65.9	6.8	1 089
Non-food exp. ($)	29 555	170.4	187.5	5.0	1 937	24 856	161.1	182.4	5.0	1 937	4 699	213.8	203.8	7.9	1 657
Total exp. ($)	29 555	257.4	220.7	21.3	2 363	24 856	246.7	215.5	21.3	2 363	4 699	307.0	237.1	23.6	1 816
Education exp ($)	19 843	18.9	30.6	1.2	831	16 532	17.6	24.8	1.2	532	3 311	24.6	47.9	1.4	831
Health exp. ($)	29 555	4.6	28.6	0.0	1 430	24 856	4.0	25.3	0.0	1 430	4 699	7.3	40.6	0.0	744
Durables exp. ($)*	29 555	77.5	167.8	0.0	2 000	24 856	74.7	166.2	0.0	2 000	4 699	90.8	174.4	0.0	1 950
Per capita food exp. ($)	29 555	25.4	23.1	4.8	556	24 856	25.0	22.5	4.8	363	4 699	27.5	25.7	4.8	556
Per capita total exp. ($)	29 555	78.6	86.8	8.0	1 703	24 856	75.3	83.3	8.0	1 703	4 699	94.1	100.2	9.6	1 427
Food share to total exp.	29 555	0.40	0.17	0.01	0.96	24 856	0.41	0.17	0.01	0.96	4 699	0.36	0.17	0.02	0.89
Other characteristics:															
Male headed hh	29 555	0.63	0.48	0.0	1.0	24 856	0.68	0.47	0.0	1.0	4 699	0.43	0.50	0.0	1.0
Female headed hh	29 555	0.37	0.48	0.0	1.0	24 856	0.32	0.47	0.0	1.0	4 699	0.57	0.50	0.0	1.0
Age (head) 16-19 years	29 398	0.01	0.08	0.0	1.0	24 724	0.01	0.07	0.0	1.0	4 674	0.01	0.12	0.0	1.0

20-29 years	29 398	0.14	0.35	0.0	1.0	24 724	0.14	0.35	0.0	1.0	4 674	0.14	0.35	0.0	1.0
30-39 years	29 398	0.28	0.45	0.0	1.0	24 724	0.29	0.45	0.0	1.0	4 674	0.22	0.42	0.0	1.0
40-49 years	29 398	0.22	0.41	0.0	1.0	24 724	0.22	0.42	0.0	1.0	4 674	0.19	0.39	0.0	1.0
50-59 years	29 398	0.14	0.34	0.0	1.0	24 724	0.13	0.34	0.0	1.0	4 674	0.14	0.35	0.0	1.0
60-64 years	29 398	0.07	0.25	0.0	1.0	24 724	0.06	0.25	0.0	1.0	4 674	0.09	0.29	0.0	1.0
≥ 65 years	29 398	0.15	0.36	0.0	1.0	24 724	0.14	0.35	0.0	1.0	4 674	0.20	0.40	0.0	1.0
No schooling (head)	29 555	0.06	0.24	0.0	1.0	24 856	0.06	0.24	0.0	1.0	4 699	0.05	0.21	0.0	1.0
Primary educ. (head)	29 555	0.34	0.47	0.0	1.0	24 856	0.34	0.47	0.0	1.0	4 699	0.34	0.47	0.0	1.0
Secondary educ. (head)	29 555	0.48	0.50	0.0	1.0	24 856	0.48	0.50	0.0	1.0	4 699	0.50	0.50	0.0	1.0
Tertiary education (head)	29 555	0.12	0.32	0.0	1.0	24 856	0.12	0.33	0.0	1.0	4 699	0.11	0.32	0.0	1.0
Hh. has member with tertiary educ	29 538	0.08	0.26	0.0	1.0	24 842	0.07	0.26	0.0	1.0	4 696	0.10	0.30	0.0	1.0
Female share (16years+)	29 538	0.34	0.23	0.0	1.0	24 842	0.33	0.22	0.0	1.0	4 696	0.38	0.24	0.0	1.0
Elderly share (65 years+)	29 538	0.07	0.18	0.0	1.0	24 842	0.06	0.18	0.0	1.0	4 696	0.09	0.20	0.0	1.0
Unemployed (head)	27 884	0.03	0.16	0.0	1.0	23 831	0.02	0.13	0.0	1.0	4 053	0.07	0.25	0.0	1.0
Number of unemployed hh. members	29 538	0.13	0.44	0.0	6.0	24 842	0.11	0.40	0.0	6.0	4 696	0.22	0.57	0.0	5.0
Share of unemployed adults in hh.	29 538	0.04	0.15	0.0	1.0	24 842	0.04	0.13	0.0	1.0	4 696	0.08	0.21	0.0	1.0
Household size	29 538	4.20	2.09	1.0	10.0	24 842	4.22	2.08	1.0	10.0	4 696	4.15	2.10	1.0	10.0
Number of adults (16 years +)	29 538	2.40	1.20	1.0	10.0	24 842	2.41	1.18	1.0	10.0	4 696	2.39	1.28	1.0	9.0
Number of children < 6 years	29 555	0.72	0.82	0.0	9.0	24 856	0.73	0.81	0.0	9.0	4 699	0.67	0.85	0.0	7.0
Per-capita household income	29 538	86	263	0	5 000	24 842	88	278	0	5 000	4 696	78	172	0	4 552
Household owns land	29 555	0.43	0.49	0.0	1.0	24 856	0.44	0.50	0.0	1.0	4 699	0.36	0.48	0.0	1.0
Urban	29 538	0.34	0.47	0.0	1.0	24 842	0.31	0.46	0.0	1.0	4 696	0.47	0.50	0.0	1.0
Bulawayo	29 538	0.06	0.23	0.0	1.0	24 842	0.04	0.20	0.0	1.0	4 696	0.11	0.32	0.0	1.0
Manicaland	29 538	0.14	0.35	0.0	1.0	24 842	0.14	0.35	0.0	1.0	4 696	0.14	0.34	0.0	1.0
Mashonaland Central	29 538	0.09	0.29	0.0	1.0	24 842	0.11	0.31	0.0	1.0	4 696	0.03	0.18	0.0	1.0
Mashonaland East	29 538	0.12	0.32	0.0	1.0	24 842	0.12	0.33	0.0	1.0	4 696	0.09	0.29	0.0	1.0
Mashonaland West	29 538	0.11	0.31	0.0	1.0	24 842	0.11	0.32	0.0	1.0	4 696	0.09	0.29	0.0	1.0
Matebeleland North	29 538	0.05	0.22	0.0	1.0	24 842	0.05	0.21	0.0	1.0	4 696	0.06	0.23	0.0	1.0
Matebeleland South	29 538	0.05	0.22	0.0	1.0	24 842	0.06	0.23	0.0	1.0	4 696	0.03	0.16	0.0	1.0
Midlands	29 538	0.11	0.31	0.0	1.0	24 842	0.10	0.30	0.0	1.0	4 696	0.16	0.37	0.0	1.0
Masvingo	29 538	0.12	0.33	0.0	1.0	24 842	0.12	0.33	0.0	1.0	4 696	0.10	0.30	0.0	1.0
Harare	29 538	0.15	0.36	0.0	1.0	24 842	0.15	0.35	0.0	1.0	4 696	0.19	0.39	0.0	1.0

Source: Own calculations from the PICES 2011 and 2017 Survey Data

Table 3: Summary statistics 2011

	Overall					Non- recipient household					Remittance recipient household				
	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Treatment variables															
Remittances domestic ($)	29 652	16.1	65.0	0.0	535	23 045	0.00	0.00	0.0	0.0	6 607	69.0	120.1	0.0	535
Remittances international ($)	29 652	10.0	76.4	0.0	1 775	23 045	0.00	0.00	0.0	0.0	6 607	42.9	153.4	0.0	1 775
Remittances (domestic + international - $)	29 652	26.2	100.1	0.0	1 935	23 045	0.00	0.00	0.0	0.0	6 607	111.8	182.3	0.2	1 935
HH remittances recipient	29 652	0.23	0.42	0.0	1.0	23 045	0.00	0.00	0.0	0.0	6 607	1.00	0.00	1.0	1.0
HH remittances recipient (domestic)	29 652	0.19	0.39	0.0	1.0	23 045	0.00	0.00	0.0	0.0	6 607	0.81	0.39	0.0	1.0
HH remittances recipient (international)	29 652	0.05	0.22	0.0	1.0	23 045	0.00	0.00	0.0	0.0	6 607	0.22	0.41	0.0	1.0
Outcome variables:															
Food exp. ($)	29 649	102.8	69.7	1.9	556	23 043	100.4	68.3	2.2	556	6 606	110.7	73.7	1.9	556
Non-food exp. ($)	29 652	180.6	241.3	0.0	1 990	23 045	168.1	229.6	0.0	1 990	6 607	221.4	272.0	0.0	1 984
Total exp. ($)	29 652	283.3	278.0	20.0	2 515	23 045	268.5	266.0	20.0	2 515	6 607	332.1	309.4	25.5	2 298
Education exp ($)	29 652	14.6	62.2	0.0	956	23 045	13.9	61.6	0.0	956	6 607	16.7	64.2	0.0	956
Health exp. ($)	29 652	4.9	27.8	0.0	1 293	23 045	4.5	27.0	0.0	1 067	6 607	6.3	30.2	0.0	1 293
Durables exp. ($)*	29 652	21.2	69.3	0.0	1 865	23 045	20.8	68.8	0.0	1 865	6 607	22.6	71.2	0.0	1 369
Per capita food exp. ($)	29 629	31.5	36.1	0.5	556	23 025	30.5	35.5	0.5	556	6 604	34.6	37.8	0.5	556
Per capita total exp. ($)	29 632	86.5	122.0	2.5	2 169	23 027	80.9	114.7	2.5	2 169	6 605	104.9	141.8	3.2	1 772
Food share to total exp.	29 649	0.46	0.20	0.00	1.00	23 043	0.47	0.20	0.0	1.0	6 606	0.43	0.20	0.0	1.0
Other characteristics:															
Male headed hh	29 632	0.62	0.49	0.0	1.0	23 027	0.63	0.48	0.0	1.0	6 605	0.60	0.49	0.0	1.0
Female headed hh	29 632	0.38	0.49	0.0	1.0	23 027	0.37	0.48	0.0	1.0	6 605	0.40	0.49	0.0	1.0
Age (head) 16-19 years	29 414	0.01	0.11	0.0	1.0	22 864	0.01	0.11	0.0	1.0	6 550	0.01	0.11	0.0	1.0
20-29 years	29 414	0.16	0.37	0.0	1.0	22 864	0.16	0.36	0.0	1.0	6 550	0.17	0.38	0.0	1.0
30-39 years	29 414	0.26	0.44	0.0	1.0	22 864	0.26	0.44	0.0	1.0	6 550	0.24	0.43	0.0	1.0
40-49 years	29 414	0.19	0.39	0.0	1.0	22 864	0.19	0.39	0.0	1.0	6 550	0.20	0.40	0.0	1.0
50-59 years	29 414	0.15	0.36	0.0	1.0	22 864	0.16	0.36	0.0	1.0	6 550	0.15	0.36	0.0	1.0
60-64 years	29 414	0.06	0.24	0.0	1.0	22 864	0.06	0.24	0.0	1.0	6 550	0.06	0.25	0.0	1.0

≥ 65 years	29 414	0.16	0.37	0.0	1.0	22 864	0.17	0.37	0.0	1.0	6 550	0.16	0.37	0.0	1.0
No schooling (head)	26 795	0.05	0.23	0.0	1.0	20 788	0.05	0.22	0.0	1.0	6 007	0.06	0.24	0.0	1.0
Primary educ. (head)	26 795	0.41	0.49	0.0	1.0	20 788	0.41	0.49	0.0	1.0	6 007	0.40	0.49	0.0	1.0
Secondary educ. (head)	26 795	0.46	0.50	0.0	1.0	20 788	0.46	0.50	0.0	1.0	6 007	0.47	0.50	0.0	1.0
Tertiary education (head)	26 795	0.07	0.26	0.0	1.0	20 788	0.08	0.26	0.0	1.0	6 007	0.07	0.25	0.0	1.0
Hh. has member with tertiary educ	29 632	0.08	0.27	0.0	1.0	23 027	0.08	0.27	0.0	1.0	6 605	0.08	0.26	0.0	1.0
Female share (16years+)	29 632	0.33	0.21	0.0	1.0	23 027	0.33	0.21	0.0	1.0	6 605	0.33	0.21	0.0	1.0
Elderly share (65 years+)	29 632	0.06	0.17	0.0	1.0	23 027	0.06	0.17	0.0	1.0	6 605	0.07	0.17	0.0	1.0
Unemployed (head)	27 903	0.01	0.11	0.0	1.0	21 706	0.01	0.11	0.0	1.0	6 197	0.01	0.11	0.0	1.0
Number of unemployed hh. members	29 632	0.07	0.32	0.0	6.0	23 027	0.07	0.32	0.0	6.0	6 605	0.07	0.32	0.0	4.0
Share of unemployed adults in hh.**	29 548	0.02	0.11	0.0	1.0	22 960	0.02	0.10	0.0	1.0	6 588	0.02	0.11	0.0	1.0
Household size	29 632	4.58	2.30	1.0	15.0	23 027	4.61	2.29	1.0	15.0	6 605	4.49	2.30	1.0	15.0
Number of adults (16 years +)	29 632	2.56	1.31	0.0	12.0	23 027	2.56	1.30	0.0	12.0	6 605	2.54	1.31	0.0	12.0
Number of children < 6 years	29 632	0.67	0.78	0.0	7.0	23 027	0.67	0.78	0.0	7.0	6 605	0.65	0.77	0.0	5.0
Per capita household income	29 632	59.09	196.70	0.0	6 881	23 027	52.00	180.47	0.0	6 000	6 605	82.27	240.91	0.0	6 881
Household owns land	29 652	0.64	0.48	0.0	1.0	23 045	0.64	0.48	0.0	1.0	6 607	0.65	0.48	0.0	1.0
Urban	29 652	0.35	0.48	0.0	1.0	23 045	0.33	0.47	0.0	1.0	6 607	0.42	0.49	0.0	1.0
Bulawayo	29 652	0.06	0.23	0.0	1.0	23 045	0.05	0.21	0.0	1.0	6 607	0.10	0.30	0.0	1.0
Manicaland	29 652	0.15	0.36	0.0	1.0	23 045	0.16	0.37	0.0	1.0	6 607	0.13	0.34	0.0	1.0
Mashonaland Central	29 652	0.09	0.29	0.0	1.0	23 045	0.09	0.29	0.0	1.0	6 607	0.08	0.28	0.0	1.0
Mashonaland East	29 652	0.09	0.29	0.0	1.0	23 045	0.09	0.29	0.0	1.0	6 607	0.09	0.29	0.0	1.0
Mashonaland West	29 652	0.11	0.32	0.0	1.0	23 045	0.12	0.33	0.0	1.0	6 607	0.09	0.28	0.0	1.0
Matebeleland North	29 652	0.05	0.21	0.0	1.0	23 045	0.05	0.21	0.0	1.0	6 607	0.05	0.22	0.0	1.0
Matebeleland South	29 652	0.05	0.22	0.0	1.0	23 045	0.06	0.23	0.0	1.0	6 607	0.03	0.17	0.0	1.0
Midlands	29 652	0.12	0.33	0.0	1.0	23 045	0.12	0.32	0.0	1.0	6 607	0.14	0.34	0.0	1.0
Masvingo	29 652	0.11	0.32	0.0	1.0	23 045	0.11	0.31	0.0	1.0	6 607	0.12	0.33	0.0	1.0
Harare	29 652	0.16	0.36	0.0	1.0	23 045	0.15	0.36	0.0	1.0	6 607	0.17	0.37	0.0	1.0

Source: Own calculations from the PICES 2011 and 2017 Survey Data

Notes: *Consists of expenditure on clothing and footwear, furniture (e.g. stoves, refrigerators, solar panels), transport equipment (e.g. cars, bicycles) and electronics (e.g. radio, television, cell phones, computers). ** Number unemployed (age 16+)/ number of adults in hh (age 16+) : share female= number of females/household size.

Table 4: Expenditure patterns by remittance status in Zimbabwe (per household per month)

	2011					2017				
	non-Recipient	Recipient	diff	t-value	p-value	non-Recipient	Recipient	diff	t-value	p-value
Food exp. ($)	97.0	106.0	9.038	9.7	0.000	84.1	92.4	8.255	8.8	0.000
Non-food exp. ($)	133.1	167.2	34.140	12.7	0.000	130.0	164.9	34.913	15.4	0.000
Total exp. ($)	230.1	273.3	43.171	13.6	0.000	214.1	257.2	43.168	15.7	0.000
Education exp ($)	11.2	13.9	2.661	3.3	0.001	14.9	18.6	3.670	8.6	0.000
Health exp. ($)	4.0	5.9	1.967	4.9	0.000	3.4	5.7	2.292	5.3	0.000
Durables exp. ($)*	16.8	18.5	1.792	2.0	0.045	64.5	75.6	11.104	4.7	0.000
Per capita food exp. ($)	29.4	32.3	-2.916	6.2	0.000	24.0	26.7	2.700	7.8	0.000
Per capita total exp. ($)	69.6	83.6	14.035	10.0	0.000	64.2	77.0	12.760	11.0	0.000
Education share to total exp.	0.027	0.031	-0.003	3.0	0.003	0.071	0.074	0.003	2.0	0.047
Health share to total exp.	0.011	0.015	0.004	5.8	0.000	0.008	0.012	0.003	5.5	0.000
Food share to total exp.	0.504	0.471	-0.033	-12.7	0.000	0.437	0.405	-0.032	-12.2	0.000

Source: Own calculations from the PICES 2011 and 2017 Survey Data

Table 5: Estimation of the propensity score for 2011

VARIABLES	Domestic recipient	International recipient	Remittance recipient
Household size	-0.013	-0.030	-0.016
	(-0.523)	(-0.710)	(-0.646)
Urban	0.087***	0.284***	0.125***
	(3.424)	(7.376)	(5.198)
Tertiary Education HH Head	0.009	0.019	0.018
	(0.262)	(0.350)	(0.545)
Unemployment share	0.074	-0.040	0.048
	(0.682)	(-0.218)	(0.449)
Unemployed head	0.003	-0.011	0.004
	(0.033)	(-0.063)	(0.041)
Adults (>15 years)	0.016*	-0.006	0.014
	(1.656)	(-0.370)	(1.394)
Children (<6 years)	-0.016	0.004	-0.014
	(-1.192)	(0.176)	(-1.072)
Female head	0.845	0.002	0.041**
	(0.958)	(0.055)	(2.033)
Female share	-0.810	0.080	-0.012
	(-0.919)	(0.954)	(-0.244)
Elderly share (> 65 years)	-0.031		
	(-0.556)		
Number of elderly (> 65 years)		-0.054*	-0.020
		(-1.687)	(-1.097)
Provincial control	Yes	Yes	Yes
Constant	-0.875***	-1.987***	-0.996***
	(-28.431)	(-37.214)	(-28.584)
LR Chi2()	232.68***	503.41***	363.25***
Pseudo R-squared	0.09	0.05	0.01
Log-likelihood	-13338.08	-4399.76	-14562.55
Observations	27,842	27,842	27,842

z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimation of the propensity score (probit) for 2017

VARIABLES	Domestic Recipient	International Recipient	Remittance Recipient
Household size	0.058*	0.156***	0.030***
	(1.703)	(4.538)	(5.134)
Urban	0.050	0.480***	0.025
	(1.326)	(11.203)	(0.689)
Tertiary Education HH member	-0.014	0.145**	0.219***
	(-0.275)	(2.325)	(4.375)
Female share (>15 years)	-0.099*	-0.199**	0.390***
	(-1.684)	(-2.473)	(8.080)
Unemployment share	-0.027	0.236**	0.111
	(-0.206)	(2.114)	(0.909)
Pov_emp_member	-0.254***	-0.224***	-0.337***
	(-4.768)	(-2.961)	(-6.549)
Female head	0.422***	0.582***	
	(17.068)	(15.014)	
Own land	0.047*	0.027	0.047**
	(1.898)	(0.721)	(2.010)
Children (<6 years)	-0.011	-0.038*	-0.011
	(-0.732)	(-1.859)	(-0.799)
percap_cons_r	0.001***	-0.000	-0.000
	(3.556)	(-0.879)	(-0.395)
Elderly share (> 65 years)	0.333***		0.271***
	(5.906)		(4.975)
Unemp_head	0.639***		0.579***
	(5.641)		(5.336)
Adults (>15 years)	0.027**		
	(2.144)		
Education	-0.015	0.289***	0.543***
	(-1.132)	(3.911)	(4.691)
Provincial controls	Yes	No	Yes
Education squared		-0.041***	-0.101***
		(-3.518)	(-3.965)
Hsize*female head		-0.013	
		(-1.575)	
Married			-0.221***
			(-9.722)
Tertiary education head			0.246
			(1.268)
Constant	-1.361***	-2.789***	-1.372***
	(-22.397)	(-21.700)	(-9.395)
LR chi2(k)	1150.79***	576.16***	1164.74***
Pseudo R-squared	0.06	0.07	0.052
Log likelihood	-9655.78	-4060.85	-107047.36
Observations	27,884	29,538	27,218

z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7: PSM Estimates of ATT by type of Treatment (Remittance Recipient, Domestic Remittance Recipient, and International Remittance Recipient) for 2011 and 2017 (per household per month)

	Food		Durables		Education		Health	
	2011	2017	2011	2017	2011	2017	2011	2017
Recipient (domestic, international or both)								
Nearest Neighbour	7.576*** (1.15)	5.534*** (1.27)	0.304 (1.10)	10.853** (3.97)	2.051** (1.02)	2.924*** (0.49)	1.810** (0.54)	1.438* (0.59)
Caliper	7.684*** (1.02)	6.264*** (1.10)	0.327 (0.96)	8.527** (3.55)	1.776* (0.91)	1.893*** (0.44)	1.500*** (0.48)	1.308* (2.48)
Kernel	9.964*** (1.13)	6.553*** (1.03)	1.331 (0.89)	8.357** (2.22)	2.606*** (0.82)	2.287*** (0.53)	1.823*** (0.44)	1.401** (0.42)
Domestic Recipient								
Nearest Neighbour	5.688*** (1.18)	2.852* (1.54)	0.926 (1.05)	-4.910 (3.69)	-0.477 (0.99)	0.296 (0.60)	1.196* (0.53)	0.878 (0.74)
Caliper	5.539*** (1.07)	3.946*** (1.13)	-0.459 (0.95)	-2.33 (2.50)	-0.270 (0.89)	0.593 (0.40)	1.141* (0.49)	0.419 (0.59)
Kernel	6.316*** (0.99)	4.769*** (1.12)	0.181 (0.88)	-1.838 (1.31)	0.326 (0.33)	0.954 (0.50)	1.367** (0.48)	0.811 (0.70)
International Recipient								
Nearest Neighbour	18.146*** (2.56)	7.077** (3.09)	5.082* (2.94)	28.123*** (8.24)	9.839*** (2.71)	3.997** (1.79)	3.940** (1.47)	3.480* (1.39)
Caliper	17.943*** (2.31)	14.796*** (2.43)	5.799* (2.75)	42.977*** (6.48)	7.608** (2.59)	6.109*** (1.48)	3.945** (1.39)	2.971* (1.30)
Kernel	20.204*** (2.11)	17.651*** (2.31)	7.430	57.100*** (5.69)	10.297*** (2.68)	9.702*** (1.61)	4.673*** (1.21)	3.851* (1.39)

Notes: Robust standard errors in brackets

Table 8: Quality of matching test for the propensity score matching based on the Nearest Neighbour Matching Estimator

Pscore for each treatment		Treated	**Control**	%bias	**% reduct bias**	**t-test**	p>t	**V(T)/V(C)**
Recipient	Unmatched	0.2325	0.2191	27.1		19.46	0.000	1.27
	Matched	0.2325	0.2325	0.0	100	0.00	1.000	1.00
Domestic	Unmatched	0.19434	0.1863	23.7		14.81	0.000	0.76
	Matched	0.19434	0.19435	-0.0	99.9	-0.01	0.990	1.00
International	Unmatched	0.0633	0.0387	57.4		26.03	0.000	3.21
	Matched	0.0625	0.06326	-0.0	100	-0.00	1.000	1.00

Table 9: Mixed multinomial logit regression for treatments (First Step) for 2011 Data

	Durables		Food		Health		Education	
VARIABLES	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient
log_hsize	-0.011	-0.065	-0.012	-0.074	-0.012	-0.070	-0.013	-0.068
	(-0.219)	(-0.655)	(-0.234)	(-0.754)	(-0.242)	(-0.710)	(-0.252)	(-0.681)
Urban	0.155***	0.585***	0.197***	0.653***	0.187***	0.597***	0.174***	0.592***
	(3.159)	(6.657)	(4.033)	(7.463)	(3.859)	(6.828)	(3.552)	(6.764)
Tertiary Education HH Member	0.020	0.088	0.024	0.099	0.023	0.087	0.025	0.079
	(0.299)	(0.659)	(0.357)	(0.752)	(0.332)	(0.651)	(0.372)	(0.590)
Female head	0.074**	0.089	0.077**	0.106	0.077**	0.092	0.076**	0.091
	(1.968)	(1.190)	(2.026)	(1.431)	(2.024)	(1.220)	(2.016)	(1.214)
Unemp_share	0.129	-0.264	0.136	-0.251	0.122	-0.261	0.137	-0.254
	(0.574)	(-0.575)	(0.599)	(-0.559)	(0.535)	(-0.573)	(0.608)	(-0.554)
Unemp_head	0.053	0.112	0.039	0.101	0.049	0.104	0.041	0.098
	(0.251)	(0.258)	(0.183)	(0.236)	(0.230)	(0.239)	(0.190)	(0.225)
Elderly share	-0.082	-0.408*	-0.080	-0.379	-0.084	-0.406*	-0.083	-0.404*
	(-0.727)	(-1.705)	(-0.701)	(-1.613)	(-0.742)	(-1.699)	(-0.731)	(-1.691)
Adults (> 15 years)	0.029	-0.019	0.029	-0.017	0.029	-0.017	0.029	-0.018
	(1.453)	(-0.453)	(1.442)	(-0.426)	(1.477)	(-0.401)	(1.463)	(-0.427)
Children (< 6 years)	-0.035	-0.002	-0.035	0.002	-0.035	-0.000	-0.035	0.000
	(-1.283)	(-0.034)	(-1.284)	(0.030)	(-1.288)	(-0.000)	(-1.284)	(0.005)
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.868***	-3.312***	-1.876***	-3.324***	-1.875***	-3.314***	-1.869***	-3.313***
	(-29.693)	(-28.322)	(-29.626)	(-28.696)	(-29.677)	(-28.352)	(-29.680)	(-28.344)
Log pseudolikelihood	10853.82	10853.82	-5144.82	-5144.82	29301.19	29302.19	15942.44	15943.44
Wald chi2	2449.43***	2449.43***	14765.67***	14765.67***	1169.71***	1169.71***	1665.41***	1665.41***
Observations	27,687	27,687	27,684	27,684	27,687	27,687	27,687	27,687

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 10: Mixed multinomial logit regression for treatments (First Step) for 2017 Data

	Durables		Food		Health		Education	
VARIABLES	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient
log_hsize	0.147**	0.482***	0.143**	0.480***	0.143**	0.483***	-0.109	0.280
	(2.450)	(4.201)	(2.385)	(4.199)	(2.382)	(4.208)	(-0.970)	(1.430)
Urban	0.051	0.399***	0.056	0.414***	0.053	0.401***	0.060	0.473***
	(0.734)	(3.096)	(0.807)	(3.077)	(0.764)	(3.103)	(0.686)	(3.081)
Tertiary Education HH Member	-0.037	0.188	-0.039	0.176	-0.035	0.190	0.026	0.317*
	(-0.376)	(1.151)	(-0.395)	(1.062)	(-0.359)	(1.160)	(0.249)	(1.826)
Female head	0.865***	1.228***	0.865***	1.231***	0.864***	1.229***	0.871***	1.275***
	(19.465)	(14.342)	(19.437)	(14.328)	(19.432)	(14.345)	(16.090)	(12.453)
Unemp_share	-0.079	0.436	-0.093	0.424	-0.087	0.438	-0.416	0.888*
	(-0.313)	(1.029)	(-0.367)	(0.993)	(-0.345)	(1.033)	(-1.205)	(1.729)
Unemp_head	1.448***	0.900**	1.454***	0.890**	1.456***	0.897**	1.330***	0.435
	(6.779)	(2.340)	(6.780)	(2.304)	(6.803)	(2.336)	(4.809)	(0.927)
Elderly share	0.731***	0.570**	0.724***	0.566**	0.725***	0.570**	0.942***	0.545
	(6.590)	(2.408)	(6.516)	(2.399)	(6.530)	(2.411)	(4.074)	(1.249)
Adults (> 15 years)	0.034	-0.043	0.035	-0.042	0.034	-0.044	0.066**	-0.037
	(1.370)	(-1.000)	(1.406)	(-0.970)	(1.387)	(-1.013)	(2.224)	(-0.737)
Children (< 6 years)	-0.036	-0.032	-0.035	-0.032	-0.035	-0.032	0.030	0.017
	(-1.144)	(-0.536)	(-1.112)	(-0.540)	(-1.114)	(-0.543)	(0.835)	(0.257)
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-3.028***	-5.049***	-3.024***	-5.055***	-3.023***	-5.050***	-2.727***	-4.821***
	(-38.848)	(-31.497)	(-38.726)	(-31.306)	(-38.768)	(-31.480)	(-18.645)	(-17.527)
Log pseudolikelihood	-33356.97	-33355.97	2087.43	2088.43	40641.88	40642.88	14837.3	14838.3
Wald chi2	2301.98***	2301.98***	13438.22***	13438.22***	1778.95***	1778.95***	2278.92***	2278.92***
Observations	27,783	27,783	27,783	27,783	27,783	27,783	18,722	18,722

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 11: Selectivity corrected estimated of budget share equations (2011)

VARIABLES	Durables	Food	Health	Education
Domestic recipient	0.025***	-0.037***	0.009***	0.019***
	(12.488)	(-3.673)	(8.427)	(10.796)
International recipient	-0.025***	0.092***	-0.001	-0.002
	(-6.723)	(12.002)	(-0.521)	(-0.538)
log_hsize	-0.001	-0.002	0.001	-0.001
	(-0.424)	(-0.615)	(1.169)	(-0.510)
log_tot_exp	0.043***	-0.102***	0.011***	0.032***
	(35.377)	(-63.726)	(16.366)	(28.536)
Urban	0.009***	-0.101***	0.001	0.001
	(4.250)	(-33.855)	(0.695)	(0.451)
Tertiary Education HH Member	-0.000	0.003	0.000	-0.002
	(-0.164)	(0.832)	(0.130)	(-1.018)
Female head	0.001	-0.000	-0.000	0.000
	(0.969)	(-0.195)	(-0.510)	(0.439)
Unemp_share	0.004	0.007	0.006	-0.007
	(0.539)	(0.568)	(1.341)	(-1.387)
Unemp_head	-0.010**	0.010	-0.004	0.003
	(-1.980)	(0.896)	(-1.042)	(0.499)
Elderly share	0.002	-0.004	-0.000	0.000
	(0.490)	(-0.686)	(-0.169)	(0.032)
Adults (> 15 years)	-0.001	0.001	-0.001**	0.000
	(-1.046)	(1.339)	(-2.264)	(0.586)
Children (< 6 years)	0.001	-0.002	-0.000	0.002**
	(1.083)	(-1.394)	(-0.073)	(2.349)
Provincial controls	Yes	Yes	Yes	Yes
lnsigma	-2.507***	-2.281***	-3.102***	-2.653***
	(-185.496)	(-33.090)	(-115.340)	(-162.896)
lambda_category2	-0.037***	0.034***	-0.008***	-0.024***
	(-21.044)	(3.117)	(-9.833)	(-15.882)
lambda_category3	0.007***	-0.119***	0.002*	0.003*
	(2.776)	(-18.991)	(1.812)	(1.680)
Constant	-0.185***	1.016***	-0.050***	-0.148***
	(-22.832)	(96.954)	(-12.732)	(-21.172)
Observations	27,687	27,684	27,687	27,687

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 12: Selectivity corrected estimated of budget share equations (2017)

VARIABLES	Food	Durables	Education	Health
Domestic	-0.022**	0.060**	0.009***	0.001
	(-2.436)	(2.403)	(4.378)	(0.461)
International	-0.059***	0.083***	0.010***	-0.002
	(-2.901)	(3.217)	(2.590)	(-0.799)
log_hsize	0.052***	-0.097***	0.062***	-0.005***
	(20.809)	(-10.128)	(21.624)	(-6.993)
log_tot_exp	-0.071***	0.066***	-0.027***	0.016***
	(-39.126)	(11.098)	(-26.010)	(17.848)
Urban	-0.090***	0.079***	0.039***	-0.005***
	(-31.307)	(5.944)	(16.190)	(-4.945)
Tertiary Education HH Member	-0.040***	0.112***	0.016***	0.000
	(-10.808)	(6.568)	(5.556)	(0.077)
Female head	-0.002	-0.042***	0.011***	0.001*
	(-1.050)	(-6.322)	(9.867)	(1.958)
Unemp_share	-0.055***	-0.051	-0.037***	0.003
	(-5.636)	(-1.122)	(-4.956)	(0.893)
Unemp_head	0.026***	0.027	0.007	-0.000
	(2.682)	(0.624)	(1.003)	(-0.110)
Eldershare	0.016***	-0.174***	-0.023***	0.003**
	(3.080)	(-12.295)	(-4.001)	(2.566)
Adults (> 15 years)	-0.004***	0.003	-0.003***	-0.000
	(-3.777)	(0.747)	(-5.072)	(-0.319)
Children (< 6 years)	0.007***	0.030***	-0.017***	0.000
	(5.513)	(7.315)	(-24.817)	(0.335)
Provincial controls	Yes	Yes	Yes	Yes
lnsigma	-1.974***	-0.678***	-2.687***	-3.334***
	(-66.989)	(-19.968)	(-73.212)	(-109.365)
lambda_category2	0.021**	-0.066**	-0.007***	0.000
	(2.232)	(-2.489)	(-5.490)	(0.152)
lambda_category3	0.027	0.018	0.001	0.001
	(1.329)	(1.212)	(0.428)	(1.096)
Constant	0.719***	-0.070*	0.140***	-0.071***
	(71.307)	(-1.885)	(14.859)	(-15.618)
Observations	27,783	27,783	18,722	27,783

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 13: Mixed multinomial logit regression results for treatments using distance to the Post Office as the Instrumental Variable (First Step) for 2011 Data

	Durables		Food		Health		Education	
VARIABLES	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient
log_hsize	-0.013	-0.066	-0.014	-0.072	-0.013	-0.070	-0.012	-0.070
	(-0.255)	(-0.662)	(-0.273)	(-0.734)	(-0.256)	(-0.708)	(-0.245)	(-0.700)
Urban	-0.090*	0.585***	-0.056	0.675***	-0.053	0.588***	-0.048	0.588***
	(-1.672)	(5.873)	(-1.049)	(6.943)	(-0.997)	(5.910)	(-0.892)	(5.899)
Tertiary Education HH Member	0.031	0.094	0.034	0.112	0.033	0.094	0.033	0.094
	(0.447)	(0.707)	(0.499)	(0.850)	(0.481)	(0.706)	(0.480)	(0.701)
Female head	0.073*	0.092	0.075**	0.109	0.075**	0.091	0.075**	0.091
	(1.942)	(1.224)	(1.977)	(1.470)	(1.988)	(1.215)	(1.976)	(1.215)
Unemp_share	0.134	-0.354	0.129	-0.321	0.130	-0.357	0.144	-0.356
	(0.592)	(-0.764)	(0.567)	(-0.706)	(0.570)	(-0.773)	(0.636)	(-0.770)
Unemp_head	0.049	0.159	0.037	0.140	0.041	0.158	0.034	0.158
	(0.232)	(0.367)	(0.173)	(0.326)	(0.190)	(0.365)	(0.157)	(0.363)
Elderly share	-0.083	-0.404*	-0.082	-0.382	-0.083	-0.406*	-0.077	-0.406*
	(-0.734)	(-1.693)	(-0.717)	(-1.631)	(-0.727)	(-1.702)	(-0.679)	(-1.701)
Adults (> 15 years)	0.027	-0.019	0.027	-0.019	0.027	-0.018	0.026	-0.018
	(1.348)	(-0.467)	(1.363)	(-0.473)	(1.353)	(-0.428)	(1.327)	(-0.433)
Children (< 6 years)	-0.035	-0.001	-0.035	0.001	-0.036	-0.000	-0.035	-0.001
	(-1.296)	(-0.021)	(-1.266)	(0.013)	(-1.306)	(-0.005)	(-1.285)	(-0.010)
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to post office	-0.008***	-0.000	-0.009***	0.000	-0.008***	-0.000	-0.008***	-0.000
	(-10.928)	(-0.281)	(-10.843)	(0.366)	(-10.743)	(-0.290)	(-10.623)	(-0.290)
Constant	-1.564***	-3.300***	-1.554***	-3.341***	-1.574***	-3.298***	-1.579***	-3.298***
	(-22.649)	(-25.703)	(-22.121)	(-26.749)	(-22.653)	(-25.650)	(-22.665)	(-25.649)
Observations	27,631	27,631	27,628	27,628	27,631	27,631	27,631	27,631

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 14: Selectivity corrected estimates of budget share equations (2011) IV corrected using distance to post office as the instrumental variable

VARIABLES	Durables	Food	Health	Education
Domestic	0.027***	-0.048***	0.009***	-0.005**
	(13.643)	(-6.805)	(7.433)	(-2.229)
International	-0.021***	0.096***	0.001	0.001
	(-5.783)	(12.535)	(0.363)	(0.171)
log_hsize	-0.001	-0.002	0.001	-0.001
	(-0.407)	(-0.684)	(1.158)	(-0.564)
log_tot_exp	0.043***	-0.102***	0.011***	0.032***
	(35.297)	(-63.964)	(16.348)	(28.478)
Urban	0.009***	-0.100***	0.001	0.001
	(4.249)	(-33.589)	(0.716)	(0.736)
Tertiary Education HH Member	-0.001	0.003	0.000	-0.002
	(-0.379)	(0.804)	(0.146)	(-0.948)
Female head	0.001	-0.000	-0.000	0.001
	(0.816)	(-0.176)	(-0.504)	(0.736)
Unemp_share	0.004	0.007	0.006	-0.007
	(0.605)	(0.540)	(1.353)	(-1.375)
Unemp_head	-0.011**	0.011	-0.004	0.003
	(-2.019)	(0.925)	(-1.040)	(0.554)
Eldery share	0.002	-0.004	-0.000	-0.000
	(0.531)	(-0.718)	(-0.161)	(-0.027)
Adults (> 15 years)	-0.001	0.002	-0.001**	0.000
	(-1.010)	(1.397)	(-2.229)	(0.838)
Children (< 6 years)	0.001	-0.002	-0.000	0.001**
	(1.091)	(-1.328)	(-0.084)	(2.185)
Provincial controls	Yes	Yes	Yes	Yes
lnsigma	-2.515***	-2.412***	-3.100***	-2.604***
	(-182.561)	(-27.457)	(-115.745)	(-171.467)
lambda_category2	-0.039***	0.049***	-0.008***	0.003
	(-22.391)	(6.363)	(-8.743)	(1.445)
lambda_category3	0.003	-0.125***	-0.000	0.000
	(1.114)	(-18.844)	(-0.239)	(0.009)
Constant	-0.186***	1.018***	-0.050***	-0.144***
	(-22.897)	(97.840)	(-12.696)	(-20.730)
Observations	27,631	27,628	27,631	27,631

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 15: Mixed multinomial logit regression results for treatments using the growth point as the IV (First Step) for 2011 Data

	Food		Health		Education		Durables	
VARIABLES	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient	Internal Recipient	International Recipient
log_hsize	0.020	-0.067	0.020	-0.066	0.020	-0.068	0.020	-0.064
	(0.380)	(-0.618)	(0.377)	(-0.609)	(0.370)	(-0.630)	(0.369)	(-0.594)
Urban	0.296***	0.547***	0.288***	0.543***	0.293***	0.531***	0.258***	0.537***
	(5.355)	(5.398)	(5.267)	(5.424)	(5.345)	(5.275)	(4.659)	(5.349)
Tertiary Education HH Member	0.001	0.100	0.000	0.106	0.001	0.112	-0.001	0.108
	(0.011)	(0.685)	(0.005)	(0.731)	(0.016)	(0.773)	(-0.018)	(0.746)
Female head	0.073*	0.067	0.073*	0.069	0.073*	0.070	0.070*	0.069
	(1.834)	(0.826)	(1.838)	(0.847)	(1.827)	(0.864)	(1.772)	(0.845)
Unemp_share	0.240	-0.399	0.224	-0.399	0.238	-0.387	0.235	-0.393
	(1.016)	(-0.773)	(0.947)	(-0.772)	(1.008)	(-0.751)	(1.002)	(-0.761)
Unemp_head	-0.057	0.149	-0.047	0.150	-0.056	0.147	-0.041	0.151
	(-0.252)	(0.302)	(-0.208)	(0.305)	(-0.247)	(0.300)	(-0.185)	(0.308)
Eldery share	-0.095	-0.336	-0.097	-0.328	-0.094	-0.329	-0.095	-0.330
	(-0.794)	(-1.301)	(-0.808)	(-1.267)	(-0.780)	(-1.272)	(-0.796)	(-1.276)
Adults (> 15 years)	0.018	-0.020	0.018	-0.019	0.018	-0.019	0.018	-0.020
	(0.877)	(-0.427)	(0.881)	(-0.422)	(0.864)	(-0.413)	(0.869)	(-0.438)
Children (< 6 years)	-0.029	0.028	-0.030	0.028	-0.029	0.028	-0.029	0.028
	(-1.016)	(0.498)	(-1.061)	(0.488)	(-1.033)	(0.494)	(-1.034)	(0.483)
Provincial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to growth point	-0.005***	-0.001	-0.005***	-0.001	-0.005***	-0.001	-0.005***	-0.001
	(-9.045)	(-0.751)	(-9.148)	(-0.767)	(-9.039)	(-0.721)	(-9.274)	(-0.729)
Constant	-1.667***	-3.281***	-1.665***	-3.283***	-1.667***	-3.280***	-1.655***	-3.284***
	(-23.556)	(-24.648)	(-23.622)	(-24.745)	(-23.616)	(-24.728)	(-23.614)	(-24.743)
Observations	25,423	25,423	25,426	25,426	25,426	25,426	25,426	25,426

Robust z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16: Selectivity corrected estimates of budget share equations (2011) using distance to the growth point as IV

VARIABLES	Food	Health	Education	Durables
Domestic	-0.035	0.009***	0.004**	0.027***
	(-1.214)	(8.102)	(2.046)	(13.473)
International	-0.060*	0.002	0.015***	-0.022***
	(-1.869)	(0.818)	(3.995)	(-5.470)
log_hsize	-0.003	0.000	-0.000	-0.000
	(-1.146)	(0.398)	(-0.360)	(-0.021)
log_tot_exp	-0.101***	0.011***	0.031***	0.044***
	(-59.412)	(15.763)	(26.989)	(34.260)
Urban	-0.099***	0.001	0.002	0.010***
	(-30.168)	(0.752)	(1.096)	(4.413)
Tertiary Education HH Member	0.004	-0.000	-0.002	0.000
	(0.992)	(-0.231)	(-1.352)	(0.050)
Female head	-0.001	-0.000	0.001	0.001
	(-0.248)	(-0.382)	(0.587)	(0.958)
Unemp_share	0.001	0.006	-0.010**	0.003
	(0.082)	(1.356)	(-1.966)	(0.471)
Unemp_head	0.011	-0.004	0.005	-0.011**
	(0.946)	(-1.218)	(0.946)	(-1.984)
Eldery share	-0.007	-0.000	-0.001	0.002
	(-1.081)	(-0.215)	(-0.177)	(0.679)
Adults (> 15 years)	0.002	-0.001	0.000	-0.001
	(1.602)	(-1.531)	(0.646)	(-1.020)
Children (<6 years)	-0.002	0.000	0.001**	0.001
	(-1.467)	(0.567)	(2.026)	(1.223)
Provincial controls	Yes	Yes	Yes	Yes
lnsigma	-1.887***	-3.110***	-2.647***	-2.531***
	(-23.975)	(-109.747)	(-157.563)	(-181.030)
lambda_category2	0.031	-0.009***	-0.008***	-0.039***
	(0.965)	(-10.197)	(-3.877)	(-22.388)
lambda_category3	0.041	-0.001	-0.016***	0.004
	(1.252)	(-1.315)	(-6.581)	(1.452)
Constant	1.029***	-0.052***	-0.151***	-0.206***
	(79.657)	(-11.949)	(-19.468)	(-22.261)
Observations	25,423	25,426	25,426	25,426

Robust z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1: Data description for the used variables

Variable	Description
Domestic recipient	Dummy variable: 1 if household received domestic remittances, 0 otherwise.
International recipient	Dummy variable: 1 if household received international remittances, 0 otherwise.
Tot_exp	Total household expenditure
Age	Age of household head
Household size	Number of people in a household (hh)
Urban	Dummy variable: 1 if household is located in the urban area, 0 otherwise
Tertiary Education HH Member	Dummy variable: 1 if household has a member with tertiary education, 0 otherwise.
Female share (>15)	Number of females aged 16 years or in the hh divided by household size
Unemployment share	Number of household adults unemployed divided by household size
pov_emp_member	Dummy variable: 1 if household has a paid employee working in a registered/licensed establishment
Female head	Dummy variable: 1 if household head is female, 0 otherwise
Own land	Dummy variable: 1 if household owns a piece of land, 0 otherwise
Children (<6)	Number of household children aged 6 years or less.
percap_cons_r	Total household consumption expenditure divided by household size
Elderly share (>65 years)	Number of adults aged 65 years or more divided by household size
unemp_head	Dummy variable: 1 if household head is unemployed, 0 otherwise
Adults (> 16 years)	Number of adults in the family (16 years or more)
Provincial controls	Control for the provinces in Zimbabwe
Married	Dummy variable: 1 if household head is married, 0 otherwise
Tertiary Education HH head	Dummy variable: 1 if household head has a tertiary level of education, 0 otherwise
Distance to growth point	The distance from the growth point to the household
Distance to post office	The distance from the post office to the household

Assessing the Multi-Dimensional Risk of Stunting Amongst Children Under Five Years in Zimbabwe

An Application of Machine Learning and Advanced Econometrics Techniques on Population Survey Datasets in Zimbabwe

Chenjerai Sisimayi, Malvern Mupandawana
Munjira Mutambwa, Thenjiwe Sisimayi
Handrea Njovo

Abstract

Background: Despite the commendable decline from a peak of 35% in 2005 (Zimstat 2005), child stunting in Zimbabwe remains high, at 23.5% (Zimstat/UNICEF 2019). The stunting prevalence nevertheless remains considerably lower than the sub-Saharan average of 34.1% in 2017 (WDI 2018). Despite the increasing knowledge on the patterns of stunting, a lot more is still to be established regarding the determinants of stunting in Zimbabwe. Global evidence and literature has provided a framework for understanding the determinants and pathways for child malnutrition.

The major causes of malnutrition include immediate causes that are anchored on the inadequate intake and utilisation of food that has the right nutrient content and is safe for human consumption; and the poor health status of individuals. Food insecurity, limited knowledge about diets, and sub-optimal child feeding and care practices contribute to the inadequacy of quality food intake and utilisation. Poor health status is largely driven by limited access to health care services that have an impact on nutrition and a range of environmental factors. Although this understanding provides a sound basis for policy formulation, the extent to which these policies are translated into sound strategic actions depends to a large extent on a robust understanding of the role of the sub-components of these domains of influence and their interactions within the Zimbabwe context. This study sought to identify the key predictors of child stunting, quantify the multi-dimensional risk exposure amongst children in Zimbabwe as well as explore the interplay of stunting

predictors and poverty.

Methods: In order to achieve the above, the study used Machine Learning and Artificial Intelligence techniques as the core tools of analysis. Specifically, the analysis focused on three interrelated steps: i) feature selection using the Random Forest (RF) Model; ii) development of the Multi-dimensional Malnutrition Risk Index (MMRI) using selected features; and iii) decomposition of the MMRI and exploratory analysis (including spatial mapping). This entailed initially selecting the most important predictor variables (feature selection) using the RF and Boruta Models, followed by using the selected features to compute a risk index, MMRI, based on a child's concurrent deprivations against these features and subsequently using the computed index scores in exploratory analysis with poverty measures.

Findings: The study reveals that child stunting in Zimbabwe is influenced by an interplay of a complex web of factors that align to the domains of health (status, behaviour, family planning and utilisation), biological, socio-economic, demographic and environmental factors as well as direct factors such as feeding/caregiving practices. The extent to which children were exposed to the desired state for each of the selected predictor variables varies and the top most common areas of deprivations are related to breastfeeding practices, child care and maternal health care. In general, the analysis shows that the drivers of child malnutrition in Zimbabwe go beyond deficiencies in food consumption to include child care and feeding practices, health related behavioural practices, access to and utilisation of quality health care, socio-economic determinants and poverty induced inequities. The multiple concurrent exposure to deprivations with respect to the identified determinants (key predictors) is heterogenous in Zimbabwe.

1. Introduction

Key Messages

Child malnutrition in Zimbabwe is driven by a range of factors that go beyond deficiencies in food consumption to include health related behavioral practices, access to and utilisation of quality health care, socio-economic determinants and poverty induced inequities. Multiple concurrent exposures to deprivations across these determinants heighten the risk of stunting amongst children.

- The programmatic response to the malnutrition burden should prioritise the continued provision of high impact nutrition interventions that aim to improve access and uptake of services noted to reduce stunting in children.
- There is scope to strengthen the capacity of sub-regional structures and adopt a sequenced geographical targeting approach for nutrition focused financing/ investments and programme implementation recognising the potential for scale-up of interventions in line with the varying intensity of stunting risk across the country.
- The multi-dimensional nature of the risks of stunting including the association with poverty underpins the need for a multi-sectoral response and coordination.
- Improving investments in nutrition specific interventions and efficiently allocating these in line with local needs provides a huge opportunity to accelerate the reduction in stunting prevalence.
- Advancements in technology present a low-hanging strategic opportunity that may be leveraged for strengthening data-driven decision making, including for targeting and adaptive learning from implementation.

Country Context

Zimbabwe is land-locked country in Southern Africa bordering with Botswana, Mozambique, South Africa and Zambia. It covers 390,757 square kilometres and had a total population of 13,061,239 according to the 2012 National Census. This translates to a population density of 33 persons per square kilometre. Women and girls account for 52% of the population whilst slightly over two thirds (67%) reside in the rural areas. The total fertility rate is estimated at 4 children per woman, and the age-specific fertility rate for women aged 15-19 years is 110 births per 1,000 (Zimstat/UNFPA 2015). The population growth rate is estimated at 2.0% per year (ibid.). Youths represent over 50% of the population. While progress has been made in reducing malnutrition compared to other countries in the region, child stunting in Zimbabwe remains high at 23.5% (Zimstat/UNICEF 2019).

Figure 1: Geographical Location and Map of Zimbabwe

Nearly two decades of economic difficulties that started from the early 2000s and peaked in 2007/2008 left the country in a low-income food-deficit status and led to a decline in key human development indicators. Zimbabwe ranked 156th of 189 countries in the 2018 Human Development Index (HDI) and 107th of 119 countries in the 2018 Global Hunger Index. Life expectancy at birth is estimated at 61.7 years, the expected and average years of schooling at 10.3 and 8.1 years respectively as well as the estimate of the Gross National Income (GNI) per capita of $1,683 contributed to the HDI ranking. The 2019 Mini-PICES showed that in 2019 an estimated 57% of Zimbabweans were living below the poverty line, with 38% in extreme poverty. The latter marks an 8-percentage increase from the 2017 estimate of households living in extreme poverty. In rural areas, 51% of the population is extremely poor, and 72% is poor, compared with 28% poor in urban areas (Zimstat 2019). Although gender inequalities have decreased, they remain significant in some sectors; the 2018 Human Development Report gives a Gender Inequality Index of 0.534, placing Zimbabwe 128th of 189. Most sectors were severely weakened and have remained constrained as a result of the protracted economic crisis. The health sector, in particular, suffered from out-migration of skilled personnel and inadequate investments in pharmaceuticals and infrastructure, which led to a sharp decline in key health outcomes in the early years of the last decade.

Despite improvements in most health outcomes following collective efforts and investments in select high impact interventions in the last five years, the progress has been slow and respective indicators continue to fare poorly with respect to progress against

milestone targets. For example, the Multiple Indicator Cluster Survey (MICS) of 2019 estimated the maternal mortality ratio at 462 maternal deaths per 100,000 live births, which remains high relative to the 2015 target of 300 maternal deaths per 100,000. Under-5 mortality is currently at 69 deaths per 1,000 births and neonatal mortality has increased from 29 deaths per 1,000 live births in 2015 to 32 deaths per 1,000 live births in 2019 (Zimstat/UNICEF 2019). The table below provides a summary of key health outcomes in the past decade.

Table 1: Key Health Outcomes

Indicator	Measure and Source	ZDHS 2010-11	ZDHS 2015-16	MICS 2019 /Other
Maternal Mortality Ratio	Maternal Deaths per 100,000 Live Births	960	651	462
U5 Mortality	Deaths per 1,000 Live Births	84	69	65
Neonatal Mortality	Deaths per 1,000 Live Births	31	29	32
Stunting for Children U5	Prevalence (%)	32%	27%	23.5%
Adolescent Fertility Rate[1]	Live Births per 1,000 Adolescent Women	115	110	108
Teenage Pregnancy Rate[2]	Prevalence (%)	24%	22%	
Family Planning (FP) Coverage	Population Coverage (%)	59%	67%	68%
Unmet FP Needs	Prevalence (%)	13%	10%	8%
Adult HIV Prevalence	Prevalence (%)	15.2%	13.8%	12.7%
Malaria Incidence	Incidence Per 1,000 Population		29	19

Regional and Country Situation on Chronic Child Malnutrition (St ting

Malnutrition, in all its forms, includes undernutrition (wasting, stunting, and underweight), inadequate vitamins or minerals, overweight, obesity, resulting diet-related non-

communicable diseases (NCDs). Globally 1.9 billion adults are estimated to be overweight or obese, while 462 million are underweight. Forty-seven million children under 5 years of age are wasted, 14.3 million are severely wasted and 144 million are stunted, while 38.3 million are overweight or obese. Around 45% of under-five mortality is linked to undernutrition, mostly occurring in low- and middle-income countries. The developmental, economic, social, and medical impacts of the global burden of malnutrition are serious and lasting, for individuals and their families, for communities and for countries.

Globally, in spite of the evidence of growing increase in knowledge on the patterns of stunting, the prevalence remains unacceptably high, with Low- and Middle-Income Countries (LMIC) continuing to be disproportionately affected, with rates of 30-50% (Reinhardt and Fanzo 2015). In Sub-Saharan Africa, stunting rates have stagnated even in countries where economic growth has been observed (SADC 2019, UNICEF/WHO/World Bank 2021). In 2019, nine of the SADC Member States had stunting prevalence rates of above 30%, which according to the WHO are classified as very high (SADC 2019). The body of evidence around the causes of stunting and its pervasive persistence are multiple and variable and have been widely understood using the UNICEF conceptual framework on undernutrition (UNICEF 2013, 2021). The framework outlines that undernutrition is the impact of three levels: the basic, underlying, and immediate causes.

According to this framework, basic causes of malnutrition are linked to systemic-level challenges that reflect the structural and political processes in each society. These include social, economic, environmental, and political issues that lead to the lack of or imbalanced distribution of natural (e.g. productive land), human, physical, social and financial resources. On underlying causes, the framework places emphasis on household food security, adequate care and feeding practices, access to health services, and residing in a healthy environment. The immediate causes emanate from the impact of the basic and underlying causes at the individual level through inadequate food quality intake and disease. This framework is also used to guide interventions from a multi-sectoral and multi- dimensional perspective, moving from macro to micro-levels of focus.

Box 1: Global Nutrition Targets

To address these global nutrition challenges and recognising that accelerated global action is needed to reduce the persistent and vicious problem of malnutrition, in 2012 the World Health Assembly Resolution 65.6 recommended a comprehensive implementation plan on maternal, infant and young child nutrition, which specified a set of six global nutrition targets that by, 2025, aim to:

- Achieve a 40% reduction in the number of children under-5 who are stunted;
- Achieve a 50% reduction of anaemia in women of reproductive age;
- Achieve a 30% reduction in low birth weight;

- Ensure that there is no increase in childhood overweight;
- Increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%;
- Reduce and maintain childhood wasting to less than 5%.

To buttress the global efforts towards achieving Global Nutrition Targets by 2025 the United Nations (UN) General Assembly proclaimed 2016–2025 the United Nations Decade of Action on Nutrition. It sets a concrete timeline for implementation of the commitments to meet a set of global nutrition targets and diet-related NCD targets by 2025, as well as relevant targets in the Agenda for Sustainable Development **by 2030**, particularly Sustainable Development Goal (SDG) 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) and SDG 3 (ensure healthy lives and promote wellbeing for all at all ages).

Stunting continues to be a major public health and socio-economic problem in Zimbabwe affecting mostly children under the age of five years and women of child bearing age. Stunting prevalence amongst children under five years remains high despite a commendable decline from a peak of 35% in 2005 (Zimstat 2005) to 26% in 2018 (FNC 2018) and now 24% (Zimstat/UNICEF 2019). The rate of decline has however not been fast enough to meet the target regional and international thresholds. Malnutrition, in all its forms, includes undernutrition (wasting, stunting, and underweight), inadequate vitamins or minerals, overweight, obesity, and resulting diet-related non-communicable diseases (NCDs).

Child stunting is a key contributor to the Human Capital Index (HCI) – a measure of the amount of human capital that a child born today can expect to attain by age 18 given the risks of poor health and poor education that prevail in the country where s/he lives. Zimbabwe's Human Capital Index was 0.44 in 2017, placing it in a moderate position relative to other countries in Africa. Zimbabwe is a signatory to the international and regional agreements on the fight against malnutrition, therefore it is also tracking its performance towards the 2025 Global Nutrition Targets. The Zimbabwe Constitution recognises the right to adequate food and nutrition coupled with access to basic health care and social services

Figure 1. Nutrition Trends - Zimbabwe

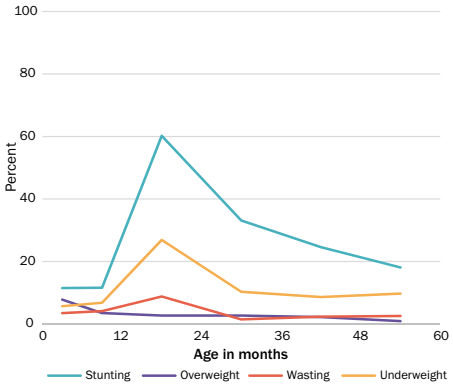
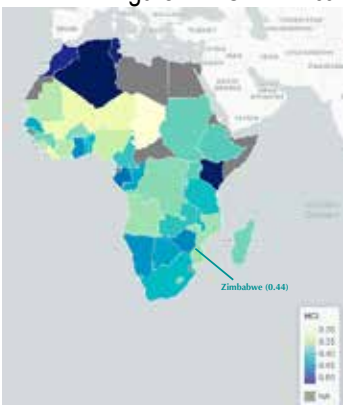


Figure 2. HCI in Africa



Source: MICS2019 Source: Author Using WB HCI Report Data

Previous analysis of survey data in Zimbabwe has shown some demographic and geographic variations in the country over years**.** Stunting is higher in rural areas (26.5%) than in urban areas (22.7%) and varies by Province with Manicaland having the highest (31.2%) whilst Matabeleland South had the lowest (24.2%) (FNC 2018). Boys are more undernourished than girls, largely because boys are weaned at an earlier age; children in rural areas are significantly more malnourished than children in urban areas.

Evidence drawn from the malnutrition framework has often been mirrored to shape the narrative of the determinants and pathways for child malnutrition without sufficient adaptation to local settings. In that regard, interventions have been broadly fashioned to address the major causes of malnutrition as per the malnutrition framework (UNICEF 2019, Black et al. 2020). Unfortunately, interventions that have been loosely developed based on this framework fall short on the specifics of what needs to be done in the current context, and how to do it, due to a lack of robust understanding of the role of the sub-components of the frameworks' domains of influence and their local interactions. Current responses have had small and often poorly targeted (outside of the 1,000 days window) investments in nutrition programmes, and this has consistently resulted in very slow and marginal improvements with stunting prevalence improving by 3% between 2015 and 2019 (Zimstat/UNICEF 2019).

Additional knowledge of the determinants of stunting in the local context, therefore, remains a key priority for refining efforts to accelerate progress against the backdrop of constrained resources. A comprehensive understanding of the determinants of stunting, including the inter-relationships across these factors at the local level, is essential in crafting the appropriate response package and delivery in a targeted manner. Although the understanding of the broader malnutrition framework provides a sound basis for policy formulation, the extent to which these policies are translated into sound strategic actions depends to a large extent on a robust local understanding of the role of the sub-components of these domains of influence and their interactions. Prior evidence has generally adopted a singular approach in validating associations or predictors of malnutrition based on the framework and other literature (Black et al. 2020). This is partly due to limitations in some standard analytic approaches that may not sufficiently address the architecture of big data and the likely correlations across multiple variables.

Zimbabwe has made good progress in establishing the appropriate policy environment to facilitate a national response to malnutrition in the country. Various legislation, policies and guidelines are in place to promote and safeguard access to services, safe products and sound practices that ensure good nutrition for the population. These have been supported by relevant structures that include a Food and Nutrition Council that is mandated to promote a cohesive national response to prevailing food and nutrition insecurity through co-ordinated multi-sectoral action, and the Ministry of Health and Child Care that leads

the implementation of nutrition specific interventions, collaboratively with other line ministries and development partners in a multi-sectoral approach. A number of inhibitors to the response have been noted and these include the recent climatic and pandemic shocks that have compounded the already vulnerable health service delivery system owing to the protracted macro-economic challenges. This has further heightened the call to enhance the effectiveness and efficiency of the response to child malnutrition in order to accelerate the decline in prevalence against the backdrop of limited fiscal space in the country.

Study Focus and Policy Question

The study aimed to identify the key predictors of child stunting and quantify the multi-dimensional risk exposure amongst children in Zimbabwe. The analysis sought to answer the following policy questions:

1. What is the nature and extent of interplay between demographic, environmental, social, economic and health related factors that predispose households to the increased risks of child stunting in Zimbabwe?
2. What are the priority target interventions to be considered in constituting a package of responses to address inequities in child stunting in Zimbabwe?
3. What is the extent of alignment of the geographical distribution of current development investments focused on mitigating child stunting to the hotspots of the risk of child stunting in Zimbabwe?

In line with the above focus, this paper has been structured to provide an overview of findings and key policy considerations drawn from the analysis of determinants of stunting in Zimbabwe. The findings of the artificial intelligence (AI) enabled analysis of household survey data have provided additional insights into the key predictors of child stunting, the scope, scale and spread of multi-dimensional stunting risk exposure as well as the interplay between these determinants and poverty in driving stunting.

METHODOLOGY

Data Sources

This study is based on the 2018 National Nutrition Survey (FNC 2018) data and the Poverty Income and Consumption Expenditure Survey (2017). The Zimbabwe National Statistics Agency, in partnership with the Food and Nutrition Council of Zimbabwe and Ministry of Health and Child Care, conducted the survey with funding and technical support from development partners in health, food security and nutrition.

The NNS is a nationally representative survey that covers the entire population and is based on a two-stage stratified sampling framework. Stratification was based on the separation of urban and rural areas in each of the 10 provinces. The sample design was such that key food and nutrition indicators, particularly stunting prevalence, could be reported

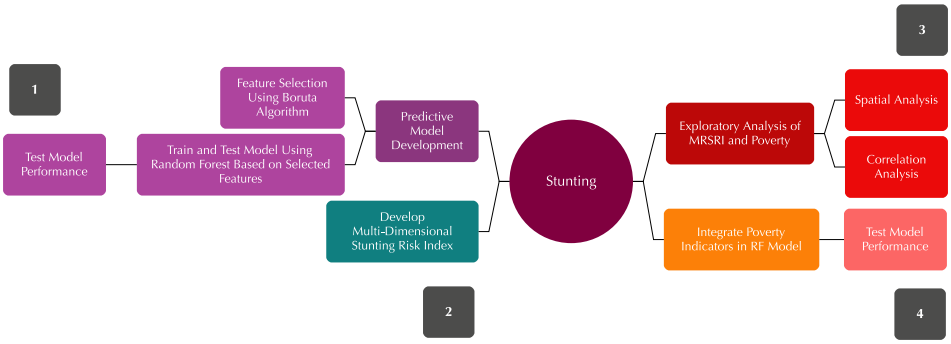
at domain level (60 rural and 4 urban) with at least 95% confidence. Stunting prevalence as the chosen key indicator for the survey informed the sample design as well as the sample size. The 2012 Zimstat master sampling frame was used to draw 30 enumeration areas (EAs) for each domain using the Probability Proportional to Population Size (PPS) method. A total of 30 households to be enumerated were selected using systematic random sampling from a randomly selected village within the sampled EAs. Households with children under the age of 5 years were the sampling units. All children under 5 years in the households were considered for anthropometric measurements as well as key child nutrition and health indicators.

The NNS 2018 successfully held interviews for a total of 28,464 households and 34,714 children aged 6-59 months were measured. Of these children, the study used 31,704 for whom complete, credible anthropometric and age data were non-missing. The standard WHO definition for stunting based on the Height-for-Age, which is regarded as a measure of linear growth retardation and cumulative growth deficits was adopted and used for the study. All children whose height-for-age Z-score (HAZ) is below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age (stunted), or chronically undernourished.

Analysis Approach

The analysis focused on three interrelated steps: i) feature selection using the Random Forest Model; ii) development of the Multi-dimensional Malnutrition Risk Index (MMRI) using selected features; and iii) decomposition of the MMRI and exploratory analysis (including spatial mapping). Figure 3 outlines the sequencing of the analysis, which entailed initially selecting the most important predictor variables (feature selection) using the RF and Boruta Models, followed by using the selected features to compute the MMRI and subsequently in exploratory analysis with poverty measures. The section below provides a detailed description of each of the methods and how they were integrated in the analysis pipeline.

Figure 3. Steps in Analysis



a) Feature Selection Using the Boruta and Random Forest Algorithms

The identification of determinants was based on ML algorithms – Boruta and Random Forest Model (RF) applied on the NNS 2018 data. The RF algorithm was developed by Breiman (2001) to classify data using a set of decision trees. A multitude (k) of trees is built from an initial sample that corresponds to N records with F studied features, represented by a matrix of size (N, F). For each tree node f features are then randomly pulled among the F features (f is equal to rounded square root of F). A key property of the RF is that it enables the assessment of the importance of each feature through the computation of the OOB (Out of Bag) error (%).

The analysis process entailed partitioning data into 70% training dataset and 30% test dataset. Modelling is done on the training dataset to construct the predictive classifier whilst the test dataset is applied to evaluate performance of the classifier. The importance of variables (features) is then evaluated by measuring the decrease in prediction performance, which is reported as either accuracy or the Gini index. In order to improve the performance of the RF, we used the Boruta Algorithm, which is a wrapper algorithm based on the Random Forest that has greater strength in feature selection as it creates a classification model based on shadow and original attributes to assess importance. The Boruta is able to confirm those attributes regarded as important and reject others. In this analysis, the RF was then used as a second step as it was applied on only those features that Boruta had identified as important. The process was aimed at improving precision in the feature selection.

The use of the machine learning approach in this analysis was deemed appropriate and robust due to its ability to handle many features, capture nonlinear pattern relationships and provide more robust discriminant power compared to classical statistics when analysing a huge number of variables. A total of **230 independent variables/features** that ranged from demographics, socio-economic, environmental, geographic, health utilisation and other factors fitting in the framework for determinants of malnutrition were included in the modelling. The RF model has shown good performance in variable selection (Genuer et al. 2010) and demonstrates the ability to handle the problem of multi-collinearity that would arise when using other methods such as the classical Ordinary Least Squares (OLS) regression technique.

b) Computation of the Multi-dimensional Malnutrition Risk Index (MMRI)

The set of the selected variables were then transformed into binary variables coded as 1 representing a deprivation in a particular variable and 0 for non-deprivation. The classification of deprivation was based on evidence and policy. For example, the global recommendation for breastfeeding is to have exclusive breastfeeding for at least six months, and in that regard every child who was not exclusively breastfed for six months was considered as deprived and therefore awarded a code=1. Coding for every selected indicator and against every child

allowed for the application of the Alkire-Foster (AF) Headcount approach in determining a Multi-dimensional Malnutrition Risk Index.

The AF method is typically used to measure the Multi-dimensional Poverty Index (MPI), an index designed to measure acute poverty. The MPI was used to measure children experiencing multiple deprivations, children who, for example, are not breastfed and do not have clean drinking water, adequate sanitation or electricity. The MPI combines two key pieces of information in its measure: the incidence of the negative outcome, e.g. stunting, or the proportion of people (within a given population) who experience multiple deprivations, in this case the incidence of multiple exposure to malnutrition risk, and the intensity of their deprivation – the average proportion of (weighted) deprivations they experience. The two measures are relevant and valuable as they can easily be interpreted and comparisons across regions and other sub-populations can be determined. Using insights from the exploratory data analysis with a focus on the mean deprivations, a cut-off k=0.5 was applied, implying the analysis provides information on the incidence of 18 or more concurrent exposures to malnutrition risks (Ho - Incidence) and the intensity (MMRI).

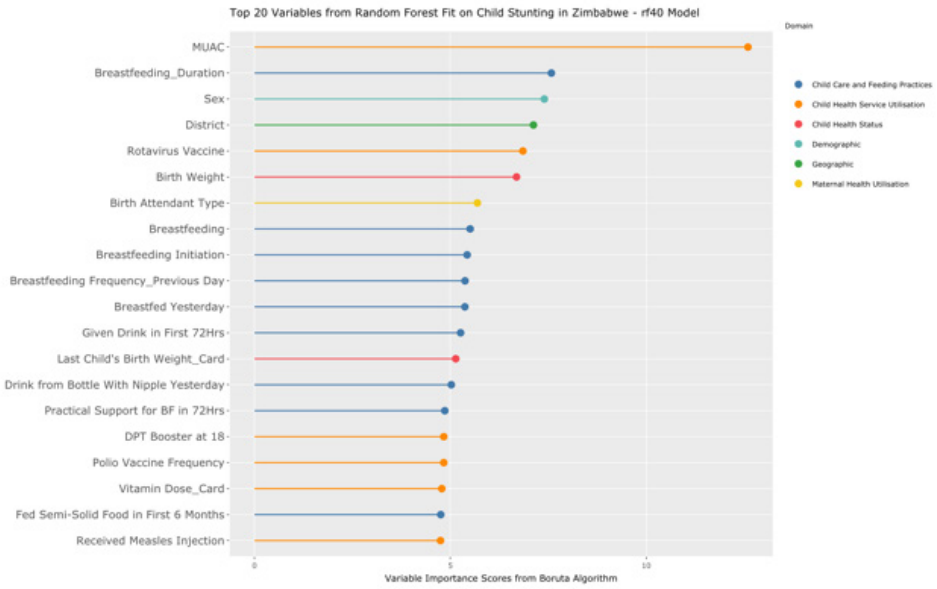
c) Exploratory Analysis of the Multi-dimensional Malnutrition Risk Index (MMRI)

Based on the computed MMRI and the incidence of multi-dimensional nutrition risk exposure, we conducted exploratory data visualisations to assess the decomposition of the index and determine contributions of the domains. Furthermore, spatial analysis was conducted using district level estimates of the stunting and MMRI derived from the NNS 2018 data as well as poverty estimates (proportion of poor and extremely poor households) drawn from the Poverty Income Consumption and Expenditure Survey (PICES).

Findings - Determinants of Stunting

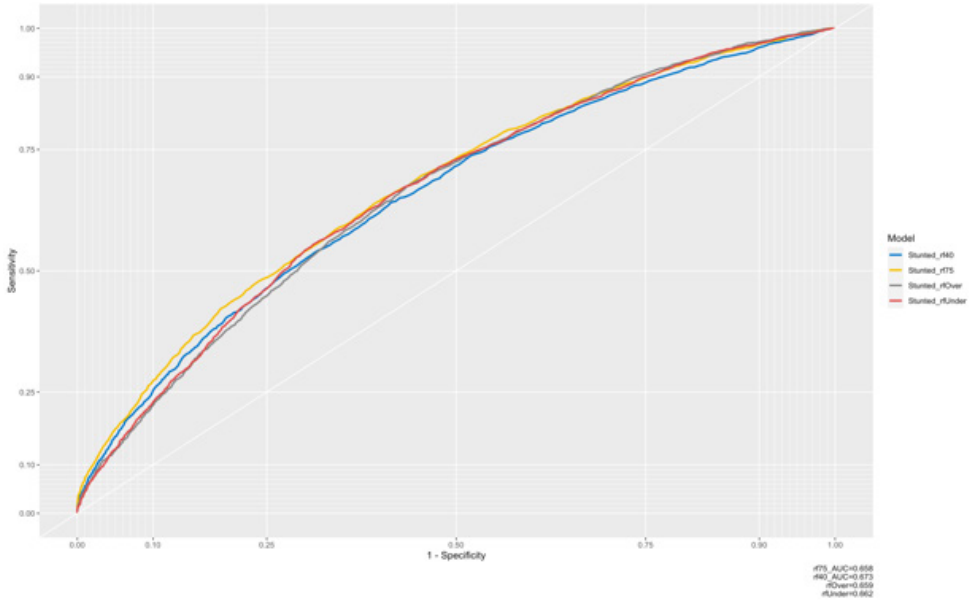
Child stunting in Zimbabwe is influenced by a complex web of factors that align to the domains of health (status, behaviour, family planning and utilisation), biological, socio-economic, demographic and environmental factors, as well as direct factors such as feeding/caregiving practices**.** The analysis showed that stunting could be accurately predicted by a modelled combination of children's and household characteristics. A total of 95 variables or features from the 320 in the NNS 2018 dataset were confirmed as important predictor variables for stunting. Two predictive models, the rf75 and rf40, with 75 and 40 variables respectively were successfully trained to predict stunting. These variables belong to several domains that confirm the multi-dimensional nature of stunting determinants and validate the strong alignment with the UNICEF Malnutrition Framework. Figure 4 provides a summary of the top predictors of stunting based on Boruta and Random Forest Model, and shows Mid-Upper Arm Circumference as the top predictor, which is not surprising but remains critical given the role of growth monitoring in the nutrition response.

Figure 4: Variable Importance Plot Showing Top 20 Predictor Variables



The performance of the two models showed similar accuracy therefore justifying the use of the trimmed-up model with less variables. The rf75 and rf40 have accuracy of 72% and 71% and precision of 61% and 56% respectively. The precision estimates for the two models show that both models performed well in predicting the true negatives (Specificity) but poorly for the positives (Sensitivity). This was observed to have arisen from a 'class imbalance problem' because the outcome of interest, stunting, is found in only a quarter of the children in the dataset. Some adjustments to the imbalance were made to the model through the use of an adjustment algorithm, the Random Over-Sampling Examples (ROSE), and this improved the Sensitivity from 15% to 62%. The Area Under Curve (AUC) estimates for the different models, including those obtained by adjusting through over-sampling (rfOver) and under-sampling (rfUnder), were similar at 66% implying that the adjustments that led to better Sensitivity did not negatively affect overall model performance (see Figure 6). Given that the focus of the Boruta and RF analysis in this study was predominantly for feature selection and not development of a stand-alone prediction model, focus was placed on identifying the list of priority predictors of stunting for use in subsequent steps.

Figure 5: Receiver Operator Curve Characteristic (ROC) Curve Showing Model Area Under Curves

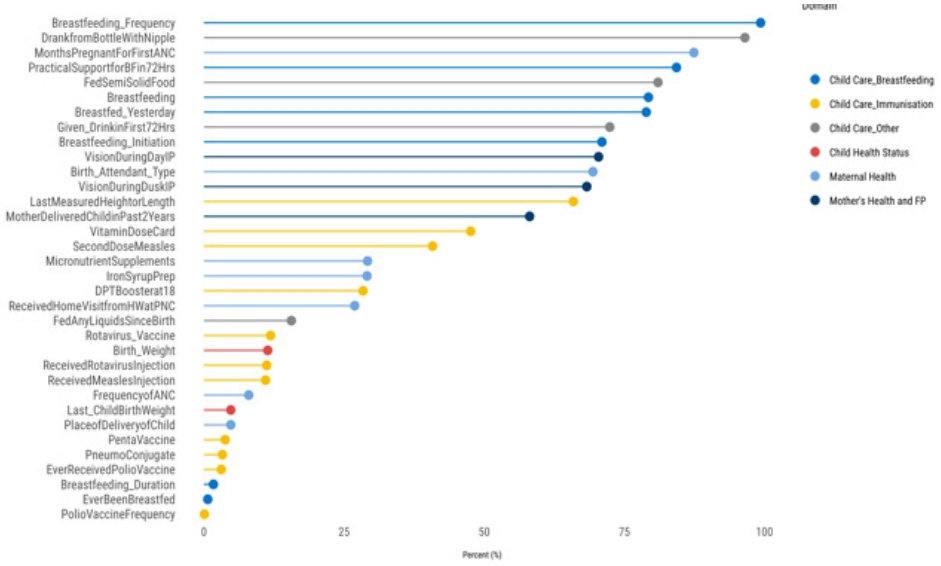


Dominant features in driving stunting in Zimbabwe reflect the need to prioritise child care feeding practices, utilisation of child care services including immunisation, and strengthening maternal health services including the health of the mother. The analysis shows that access to immunisation is highly predictive of stunting status, e.g. receiving Vitamin A supplementation is associated with children's growth and suggests that Vitamin A supplementation may be protective against stunting. Missing vaccination doses is observed as a less likely predictor of stunting in children, contrary to other literature. Vitamin A deficiency in pregnancy is a predictor of stunting. The health status of children (including at birth) and that of mothers contributes to the nutrition status of children. Children who had early initiation of breastfeeding, whose mother received support with 72 hours, and were breastfed frequently are less likely to be stunted. Mothers who book early and receive skilled birth attendance at delivery are less likely to have stunted children. The occurrence of geographic features such as districts and provinces amongst the list of important predicters affirms the heterogeneity in stunting prevalence in the country, with the spatial patterns of severity reflecting some moderate consistency between the current status (NNS 2018) and previously in 2015.

The assessment of the extent to which children were exposed to the desired state for each

of the selected determinants[1] shows that the top most common areas of deprivations are related to breastfeeding practices, child care and maternal health care utilisation. The ranked list shows inadequate breastfeeding frequency (99%), non-use of bottle with nipple (97%), delayed attendance of first antenatal care checkup for mother (87%), inadequate practical support for breastfeeding in the first 72 hours (84%) and non-exclusive breastfeeding (79%) as the top areas of deprivations. Although immunisation related variables were identified amongst the key predictors of stunting, the frequency of deprivations amongst these was observed to be relatively lower for most of the variables with the exception of Vitamin A doses (less than 6 monthly) and growth monitoring (last measured more than three months), which had 66% and 48% deprivations respectively.

Figure 6: Frequency of Deprivations Amongst Children

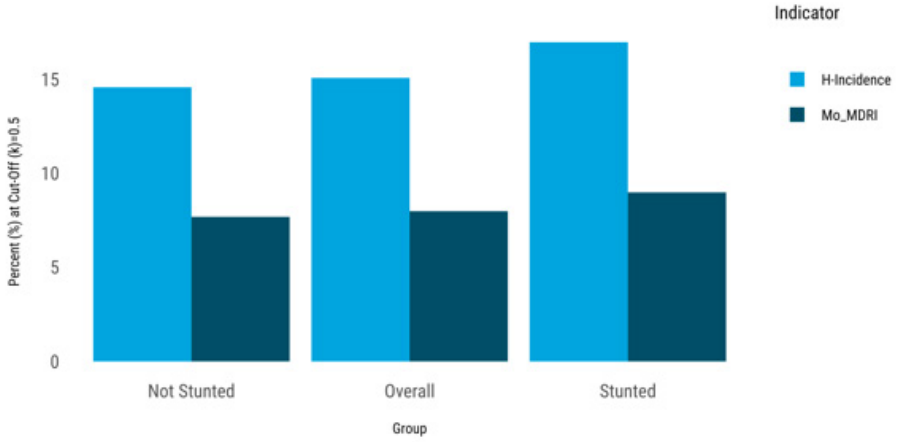


The concurrent occurrence of deprivations (having multiple deprivations at the same time for each child) is higher amongst children who are stunted. The incidence of multi-dimensional deprivation (child with deprivations in 50%+ of the set of top 34[4] predictor variables) was observed to be higher amongst children who are stunted (17%) than those not stunted (14.6%) and the overall group (15.1%) – Figure 7. Similarly, the Multi-Dimensional Stunting Risk Index is higher for stunted children (9%) though with only a

1. Note that variables such as Sex and District are predictors but not necessarily regarded as drivers or determinants as they only foretell the state but do not determine it.

percentage point difference relative to the other reference groups. Deprivations are more frequent for initiation and frequency of breastfeeding, utilisation of maternal health services (early ANC booking and frequency of ANC etc.), mother's health during pregnancy (e.g. vision challenges) and other child care practices.

Figure 7: Incidence of Deprivations and Multi-dimensional Malnutrition Risk Index



Food consumption and dietary diversity are important considerations in understanding the prevalence of stunting in Zimbabwe. Though relatively lower in the ranking of predictor importance, food security and dietary intake related variables remained amongst the list of important predictor features in the rf75 predictor model. Zimbabwe's food and nutrition situation is classified as 'serious' in the 2018 Global Hunger Index (Score - 32.9). The country failed to reach Goal One of the 2015 Millennium Development Goals (MDGs) – halving extreme poverty and hunger by 2015.

The interplay between poverty, food security and the multi-dimensional risk of deprivation to the stunting determinants also provides useful insights regarding its importance as a contributor to stunting. The heterogenous nature of poverty in Zimbabwe is well documented, e.g. through the Zimbabwe Poverty Atlas and PICES Reports. Specific districts and regions show much higher proportions of poor households. The pattern is however not distinctively correlated to the stunting risk or prevalence at the district level, as illustrated by the spatial maps (Fig 8) and the scatter plot (Fig 9) below. However, though moderate, inequities in stunting are widened when stunting risk (as measured by the MDRI) is combined with poverty. Figure 10 shows that the Concentration Index for the weighted MDRI is 0.07, which is positive, and given the distribution scale it means that children who are exposed to more poverty and higher stunting risk scores are more likely to be stunted than their counterparts. Furthermore, a visual inspection of the spatial pattern of the combined Poverty Prevalence and MDRI (Map 3) reflects some moderate alignment to the distribution of stunting in Zimbabwe.

Figure 8: Spatial Patterns of Poverty, MDRI, Stunting and Poverty-Weighted MDRI

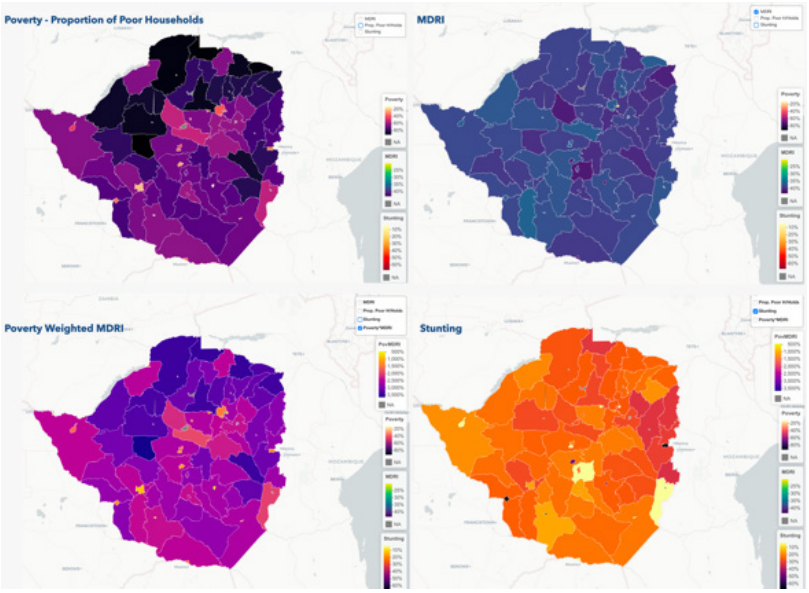


Figure 9: Scatter Plot of District Level Poverty and Stunting Prevalence

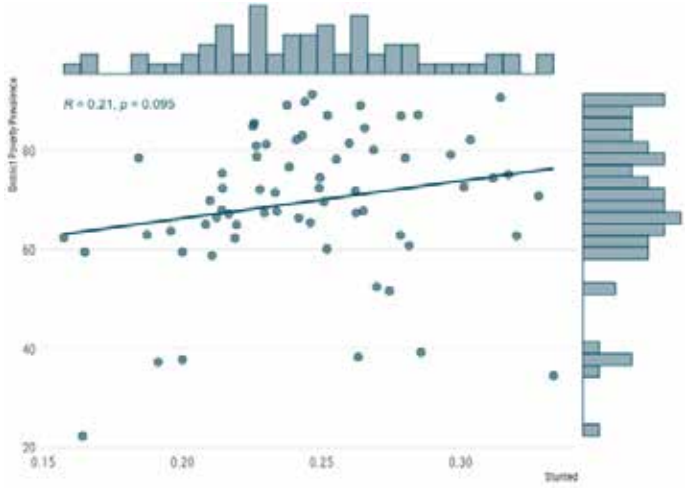
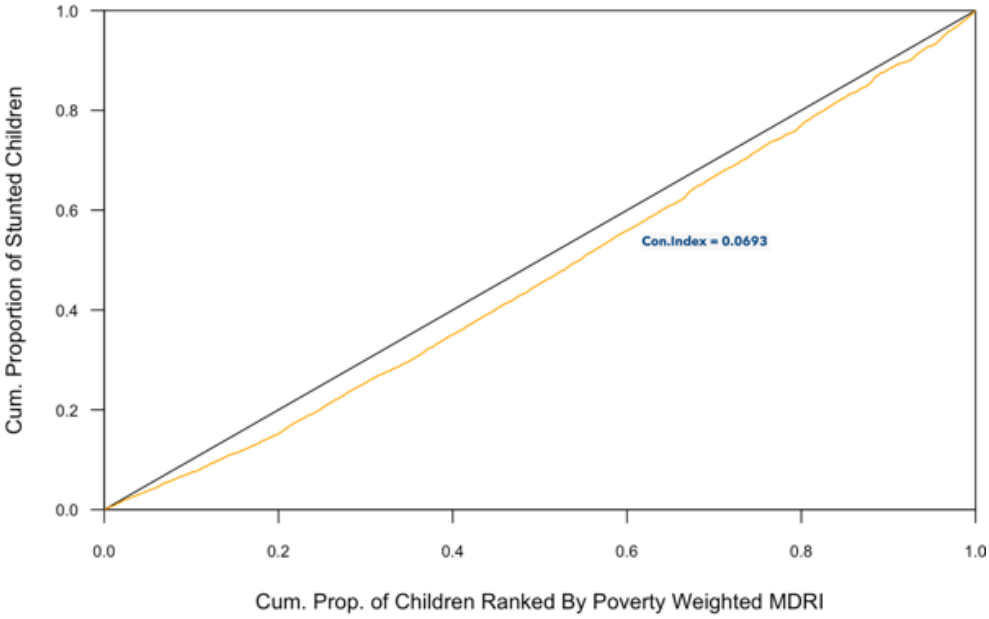


Figure 10: Concentration Curve Showing Poverty Weighted MDRI and Stunting Amongst Children



The findings show that child malnutrition in Zimbabwe is driven by a range of factors that go beyond deficiencies in food consumption to include health related behavioral practices, access to and utilisation of quality health care, socio-economic determinants and poverty induced inequities. Multiple exposures to these determinants further compound the risk of stunting in children. An effective national response to the stunting burden calls for a multi-sectoral approach and targeted interventions that aim to reduce exposure and break the complex linkages across these factors.

Policy and Strategic Considerations Going orward

The following key considerations are proffered in view of the evidence on the determinants of stunting and recognising the operational and policy related bottlenecks in the response.

The programmatic response to the malnutrition burden should prioritise the continued provision of high impact nutrition interventions that aim to improve access and uptake of services noted to reduce stunting in children. There are opportunities to leverage already existing programmes such as the Results Based Financing (RBF) and Community Based Management of Acute Malnutrition (CBMAM) in terms of structure, systems and lessons learnt to accelerate:

- Improvements in access to Vitamin-A Supplementation (VAS) for U5s
- Introduction and adoption of adolescent micronutrient supplementation

- Uptake of early ANC booking and further reducing home deliveries
- Improvements in Infant and Young Child Feeding support structures from health facilities to the community

Given the potential disruptions in the provision of health services arising from the COVID-19 pandemic, it is important that Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCAH) services are prioritised as essential services requiring measures to safeguard their continuity in service provision.

The evidence supports adopting a sequenced geographical targeting approach for nutrition focused financing/investments and programme implementation that recognises the current stunting burden with potential for scale-up in line with the varying intensity of stunting risk across the country. The heterogenous representation of stunting prevalence in the country justifies the need for a targeted approach in the national response. However, the composite multi-dimensional risk (as shown by the MDRI) is not distinctively varied across the country, implying that districts with low stunting prevalence may still also have moderate to high risks and would still require some relative exposure to interventions that minimise stunting. The heterogeneity reflected at the level of the MDRI domains (decomposed index) gives credence to the need for localised adaptation of national response frameworks to meet the priority needs specific to sub-regional levels (wards, districts and provinces). There is therefore scope to strengthen the capacity of sub-regional structures in priority setting based on a review of local level performance status against drivers of stunting and adaptation of national guidelines/frameworks to craft a customised response.

The multi-dimensional nature of the risks of stunting, including the association with poverty, underpins the need for a multi-sectoral response. The potential compounding effect of poverty on the risk of stunting provides additional pathways to addressing the underlying determinants of stunting by tackling the structural drivers of poverty. The involvement of all stakeholders in a collective response would therefore serve to address all potential bottlenecks across the pathways of change.

Improving investments in nutrition specific interventions and efficiently allocating these in line with local needs provides a huge opportunity to accelerate the decline in stunting prevalence. Increasing the allocation of resources to the nutrition response with strategic allocation to both programmatic needs and towards the country's national multi-sectorial response (including for the coordination, planning, monitoring and evaluation) would re-position the country to be on course to achieving the 2025 Global Nutrition Target on stunting.

It will be strategic for Government and stakeholders to consider leveraging advancements in technology to strengthen data driven targeting and adaptive learning from implementation to enhance effectiveness and efficiencies in the response. Building on this study's use of machine learning, there are opportunities to use technology to scale the reach in health and nutrition promotion (e.g. awareness about early breastfeeding initiation, duration and

frequency), and apply AI and machine learning models to facilitate:

- Households' self-assessments/screening of child stunting risk and uptake of correction action. For example, using the models developed in this study, Mobile Apps or Chatbots can be developed that allow for self-assessment and based on obtained scores guidance be provided for triaging and advice on courses of action for immunisation, care practices, ANC, etc.
- Vulnerability assessments and household targeting for national programmes.

In order to facilitate the realisation of the optimal use of data for decision making in the national response, it will be important to invest appropriately in relevant Information Systems as well as policies for data access, privacy and utilisation.

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