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Abstract

Land policy reforms across Africa are expected to address several of the underlying critical issues of food security and economic development, because they can help stabilize food prices by improving future expectations on trade and supply. However, there is an absence of solid empirical research that considers the relationship between food price and land policy reform. This paper simultaneously estimates the impact of food prices and the Land Act of 1999 on rural household welfare. We use panel data from 2008/2009 and 2010/2011. The data contains information on land ownership and the different forms of land titling. This allows us to construct a treatment variable for landownership before and after the Land Act. Then, we use a matching method to estimate the counterfactual effect of both net consumer and producer welfare. The results indicate that rural food producers have not benefited by the post independence land reforms. Furthermore, we found that education and land titling have a major influence on improving household welfare as well as in offsetting food price shocks and reducing rural food poverty. We argue that education attainment can facilitate literacy on land and credit market issues, enabling the rural population to take full advantage of land titling, which can be used as collateral. Finally, we found that although land titling is an important tool in reducing rural food poverty, few poor rural households have land use certification. This is a crucial issue because titling and access to land for the rural poor are essential for food security and rural economic development.

Key Words: Food Price, Education, Household Welfare, Land Ownership, Land Act, Land Titling and Matching Methods.

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1.0 Introduction

The main interest of this paper is to provide empirical evidence on whether the Tanzanian land reforms –and in particular the Land Act of 1999-- are a breakthrough mechanism for improving rural welfare and therefore, can in principle offset the increase in food prices among rural food consumers. Second, we want to determine whether rural food producers have benefited from the land policy reform or not. Finally, we want to establish whether education and land titling tends to have any effect on household welfare due to changes in food price and land policy.

Land and its related issues are at the forefront of the development agenda among policy makers in Africa. The struggle for land reforms, which would guarantee the balance of land for the marginalized and most vulnerable groups in society, such as women and insuring inclusive economic growth, has been on going for the past two decades. However, the recent food crisis in 2007-08[1], which affected Africa[2], reversed much of the effort devoted to concnetrating land into the hands of elites. The reason for this relationship is that rising[3] food prices have a resulted from the increase use of bio-fuel in developed countries and an increase in demand for a more diverse diet amongst the middle class population, which has led to the diversion of land resources and farm inputs in oder to meet this new demand. Consequences, foreign investors, large scale farmers and agro-industrials, buy land for large-scale agricultural production leaving poor rural-households landless.

The global food price of 2008 has made land reform an even more urgent central focus in developing economies due to unprecedented pressure on land resources and increasing demand within land markets, placing aditional pressure on the land tenure systems. As a result, small scale farmers in many part of the region (eg. Tanzania, Kenya, Madagascar), became landlessness due to "land grabbing" (Daniel, 2011). Those most at risk of losing access to land are poor farmers who do not have formal land tenure over the land they own, eg. women who are often denied rights through the customs, laws of the country or even their own families (Kalabamu, 2006). Many countries have created policies designed to stabilize domestic food prices. However, African countries fail to pursue trade and agricultural policies that promote increased agricultural and global food trade. On the other hand, the land policy reforms face serious problems, including titling price, which tends to exclude

[1] The food price crises—in 2007–08 and in 2010— appear to raise poverty in most poor countries and for the world as a whole. The first crisis was estimated to push 105 million people into poverty in low-income countries (Ivanic and Martin, 2008), and the second crisis, 44 million people in low- and middle-income countries (World Bank and International Monetary Fund, 2012).

[2] Africa region was affected the most due to its current food production deficit and over dependence of food aid and imports for food security((Kamara et.al, , 2011)

[3] Rising food prices are the result of complex interplay of several factors both from supply and demand side, including drought in grain producing countries and rising of oil prices. The increase of oil price causes increase of cost of fertilizers, food transportation and industrial agriculture.

the poor from the land registry scheme. Virtually, the price of titling is one of the major impeding factors in the implementation of the land tiling scheme in the developing world, as it discriminates against the poor, preventing broader inclusion of land registry (Ali et al. 2014). In theoretical literature, land titling is assumed to have a positive effect on the income mobility of an individual who owns land, and therefore can enhance the productivity and reduce poverty by increasing the incentives to undertake investment, improving the land market and enabling the use of land as collateral in the credit market (Grimm and Klasen, 2015). Place (2009) argues that households who have benefited from the land reforms can use their land titles as collateral to gain access to credit, which also complements agricultural investments. The land policy reform therefore is expected to facilitate cheaper, more transparent and accessible land titling so as to benefit the rural-poor.

The ongoing land policy reforms across Africa are expected to address the underlying critical issues, which on other hand can stabilize food prices by improving future expectations on trade and supply. However, there is an absence of solid empirical research that considers the linkage between food price and land policy reform, embracing both holistic and nationwide data. Therefore, in order to inform the policy making processes for land and trade reforms, contributions to the literature and research in developing countries such as in Tanzania are vital. Against this backdrop, we use panel data collected in Tanzanaia between 2008 and 2011. For the first time, this study shows how access to land affects the welfare of households in rural Tanzania. In particular, we focus on land ownership and the adoption of formal land titles, which we explain in the context of established legislation in Tanzania, specifically the Land Act of 1999, and its indirect affects on demand for land due to soaring of food prices.

The data has information on the initial land ownership of rural farmers. Households were asked since when they possess agricultural land and addition information regarding the security of their land tenure. Rural farmers who own land before the Land Act came into operation in the year 2001 and those of the post reform are considered as a control and treatment group respectively. Ideally, this is non-experimental data which allows us to estimate causal effects. In order to achieve this our treatment and control groups must be randomly selected based on observed and unobserved characteristics, which we further augment using matching methods. This matching methods tends to balance the distribution of covariates in both treatment and control households so as to replicate the experimental design. As a result, we can estimate the causal effects of participation into land reform,as any differences between the two should will average out **(**Heinrich et al. 2010). We implement matching in a range of covariates characteristics, which may affect a households participation in reform and thus our variables of interest: net welfare changes in households and

household food expenditure. Many of these covariates are household characteristics, including education status of the head of household, the occupation of the household head, distance of a farm plot to the nearest market, distance of farm plot to the nearest road and land size in acreage owned by members of the households.

We use matching methods to estimate the ATT's of the baseline[4] model and extended the model for the outcome variables. Our main results suggest that the welfare loss is higher for the untreated consumers than treated consumers. On the other hand, untreated food producers have higher a welfare gain due to food price than treated food producers meaning that the post-independence land reforms and its implementation haven't benefited rural food producers. We noted that these changes in welfare, are attributed to land access and titling. Indeed, treated households who own land with a title, in particular rich households, have a lower food share than untreated households. We interpret that land reforms and its implementation exclude the majority of the poor from land registration and therefore translates into inefficient resource allocation and less agricultural productivity.

We also examine the role of education on welfare changes by comparing the ATTs of households with higher education with that of less educated households. There are several reasons which can explain why we find it is important to estimate these ATTs. Education is widely seen as one of the most effective ways of increasing individual earnings, it provides greater economic opportunities, especially to the poor (Blanden and Machin, 2004 ; Knight and Sabot, 1990). Better educated individuals are perceived to be better able to cope with technological and environmental changes that directly influence productivity levels. Thus, at the macro level, human capital is an important determinant for labour productivity and eventually economic growth (Tsu-Tan, Fu et.al,2002). Therefore, farmers with a higher education might have access to land and titling because of the perceived benefit of land use certification. Likewise, farmers with a higher level of education might have comparatively more ability to appeal to the land administration in order to obtain better tenant conditions. They might also increase the productivity of the land they work. In a fixed-leasing regime, this could imply that higher-educated farmers might have greater ability to redeem their land after the leasing period has elapsed. Finally, higher-educated farmers might have a stronger incentive

[4] The baseline model is the main model which includes all variables which may influences both participation into the reform and outcome variables. This model excludes the LCUs for the reason that its balanced score is just at the margin of the 5 % bias reduction. Since the variable is important particularly for the comparison basis of the LCUs and non-LCUs we include the variable in the extended model and re estimate the ATTs. The LCUs here can also serve as test of the unobserved confounder in the baseline. If the signs and magnitude of the baseline model differs significant to that of the baseline model. Then, the baseline model suffers from the unobserved characteristics which can bias the ATTs.

to sell their small farm land to a large landowner in order to reap the benefits of their education in other trades. Our results indicate that education also has an influence on the observed difference of the welfare change between land ownership before and after the land reform has been enacted. Through its influence on income mobility and the access of LCUs, education tends to offset prices for the case of consumers, whereas producers with higher education levels, have a comparative advantage in responding to the increase in food prices over producers without or having less education.

The rest of the paper is organized as follows: The next two sections presents a brief overview of land policy reforms in Africa and the background of the Tanzania Land Act of 1999. Next, we present the conceptual framework for the selection of covariates. Then, we present the estimation strategy. A long section is dedicated to our empirical results, and the paper closes with a presentation of our main conclusions.

1.1 Land Ownership, Land Distribution and Reform in Africa. A brief overview

Land is the most important determinant of upward income mobility and wealth in the preindustrial economy. In Africa in particular, the importance of land on economic growth is underlined by the over 70% of the population's dependence on farming and other related activites for their livelihood (Moyo, 2010). For many agricultural households, land is a key asset that constitutes an important dimension of wealth and income creation over a long period of time. Unlike other forms of capital, the value of land is depreciates at a slower pace and can, in principle, remain inherited over generations ensuring landlessness and disparity for those who do not hold land and can lead to significant income inequality for generations (Stephan and Felicitas, 2008). For example, the customary tenure system gives the power to the chief and village leader to allocate land to individuals. As a result, land is inefficiently allocated only to elites and remains concentrated in a few hands --land lords-- it can be easily passed from one generation to another, and thus remain under the clan which has the power over land allocation and redistribution. Griffin et al. (2002) argue that this inefficient allocation of land, can also lower the overall average income and cause wide spread rural poverty.

More prominently, landlessness is emerging in an increasing number of countries and areas due to population growth and unprecedented pressure on land resources and increasing demand

However, results indicated that the baseline and extended model are both of the same signs of the ATTs and the extent to which ATTs of the models differs is not substantial.

within land markets caused by the new tension of global food prices (Headey and Jayne, 2014). Landlessness and unequal distribution of land are major policy issues especially if rich elites, not the rural poor, own the land. And even if the poor own land, inequality in wealth and power relations makes the rural poor more vulnerable to losing their rights. The disparity of land holding leads to significant challenges for economic growth and development in a country. Galor et al. (2006), points out that inequality in the distribution of land ownership can adversely affect the incentive, in terms of educational or institutional in a country, which in turn affects economic growth and contributes to the emergence of income inequality across a country. Inequality in land holding is a major factor in explaining the differences between public provisions of education in the developing world, as large land disparity creates political friction among elites on collective measures on public provision (Mariscal and Sokoloff, 2000).

To some degree, the unequal allocation of land was inherited from colonial land ordinance dominated by the unfair distribution of land in many parts of the continent. According to Holden and Otsuka (2014), colonial powers imposed unequal land holding distribution in Africa deliberately, so as to collect taxes and or extract labour through declaring local population as the tenants on colonial crown land. During the land reform that began in the late 1960s and lasted until the early 1980s, such colonial land tenure continued to exist to some extent in some countries that decided to inherit them, whereas others had only partial inherited them and others partially removed and then reintroduced them (eg.Uganda).

According to the study of the land reform in Africa conducted by Rutten (1997), the land reform in Africa adapted from the late 1960s to the early 1980s is centred in the three major policy lines. First, in some countries reform shifted towards the socialization of land --adopted mainly by socialist administrations-- by way of co-operatives and state farms (e.g. Mozambique). Second, in other countries, the privatization and individualization of land either continued or begun (e.g. Kenya, Malawi). Lastly, some countries adopted the existing colonial tenures and modifyied the relations between the tribal chiefs and the state e.g. Gambia and Lesotho (Rutten 1997). In general, the second line of policy promoted during "the land reform decades" in African, emphasized some form of private "property rights". Individual private property rights replaced customary systems, which were thought to not be providing the necessary security to ensure agricultural investment and productive use of the land (Bassett, 1993) .

Peters (2009), emphasized that many of the land policy reforms and titling programs of the 1970s and early 1980s did not manage to achieve the excepted increase of agricultural productivity and the long term investment decisions. Indeed, the reforms failed to help small famers use their

land as collateral in the financial market rather than increasing speculation and demand for land from outsiders and therefore excluded the majority of the rural poor from land ownership and an access of land titles. These programs ignored the overlapping and multiple rights and uses of land and as a result, exacerbated land related problems and also reinforced patterns of unequal access to land based on gender, age, ethnicity and class (Peters, 2009; Rutten, 1997). The distribution of land has become more unequal in recent decades e.g. in Ethiopia, Kenya, Mozambique and Rwanda (Jayne et al. 2003). During this era of land policy reform and its implementation, there have appeared unresolved complex land problems, such as farm-pastorals conflicts, "land grabbing" and government bureaucracy, which disrupt productivity.

By the late 1990s African countries undertook major land policy reforms in response to persistent complex land problems, struggles for access to agriculatural land and livelihoods, so as to meet the ongoing political, economic, social and environmental objectives. The new path of land reform in Sub-Saharan Africa was toward decentralized, human-centred, pro-poor, market friendly and involving other stake-holders rather than based on individualization (see Bernstein, 2004 and Toulmin and Quan, 2000). It was this reform that brought land more freely into the market place and made it more accessible to foreign investors. This was the initial motivation for state-led reforms in Mozambique, Tanzania, Uganda and Zambia. More importantly, the reform accepted the advantages of communal and customary tenure over formal individual titles regarding cost effectiveness and equity. It emphasized that titling needs a range of other conditions, such as access to capital and credit, in order to be effective. It also suggested the possibility of building on existing land tenure systems rather than state-led intervention in land tenure systems (Deininger and Binswanger, 1999 cited in Peters, 2009 , pg. 8).

In the literature, the use of formal land rights is assumed to be a critical tool in the fight against poverty and unemployment through the following economic channels. Access to well defined land tenure can directly lead to efficient agricultural productivity and income generation through trade resulting in food security and reducing vulnerability to hunger and poverty (ECA/SDD/05/09, 2004). Furthermore, formal land rights have a positive impact on household economic behaviour. These include increasing the security of land tenure and improving access to credit where land can be used as collateral. These formal land rights prevent land disputes that arise from competing claims and often lead to uncompensated expropriation and also reduce vulnerability to food price shocks and facilatate financial gain in the land market (Kennedy et al. 2013). Similarly, land security increase land-holding famer's confidence to engage in long-term investment in sustainable agricultural practices. For example, allowing land to remain fallow for a long-period of time results in an increase

in soil fertility. Furthermore, long-term investment in land may reduce the cost of agricultural labour after the initial planting, thus enabling farmers to allocate labour to off-farm activities (Do and Iyer, 2008). Theoretically, strong rule of law for land ownership, tenure security can increase agricultural output and food security, resulting in rural economic development.

1.2 Land Reform in Tanzania. A brief review

Tanzania has undergone several land reforms which form the basis of national land policy commissioned in 1995 and ultimately culminated in the newly established Land Act and Village Act of 1999. The history of the land tenure system can be traced back to 1923, when the British colonial passed the Land Ordinance, which remained the principal piece of land legislation in the country. Prior to this Land Ordinance, all land in Tanzania was owned under a customary tenure system, controlled by clan and tribal traditions. In principle, elders of a clan and tribe were bestowed powers to allocate land and resolve land disputes whenever they arose. The 1923 Land Ordinances made racial changes of land ownership and use pattern, which existed under the customary land tenure. It stated that all land in Tanzania and use rights were under the control of the British governor, meaning that any use of land must be subject to the will and permission of the governor. The local land administration and traditional institutions were replaced by a colonial administration. The law introduced a new form of land ownership through granted rights of occupancy. Although the law recognized land ownership under customary rights through deemed rights of occupancy, where natives enjoyed security of the land they owned. In principle, the two pieces of land legistration differ substantially. The deemed rights were considered to have low-value and unenforcable compared to granted rights. Consequently, between the 1920's and 1960's, the majority of local people who owned land under customary tenure lost their land to the colonial state in favour of the introduction of commercial farming.

Tanzania's continued to remain strongly reliant on the British Land Ordinance,even after its independence in 1961. After independence, no radical changes in land tenure were made other than the replacement of the governor with a president. Also, the Post-Colonial Land Law stated that all land in Tanzania is public, but vested to the president on behalf of all the citizens. However, misuse and abuse arose by administrative machinery who acted on behalf of the president to reinforce decisions and ownership of land. As a result, cases of land acquisition without compensation between natives and the state appeared throughout the 1970's and 1990's (Myenzi, 2005).

Other various land laws, such as the land acquisition Act of 1967, was enacted to reinforce the decisions of the land administration. The law gave the president power to acquire land in any part

of the republic of Tanzania for "national interests". A national interest was geared towards established state owned corporations, which in many cases took land away from villagers and reallocatted to more favorable foreign investors and was labelled as being in the national interest. Morevever, the establishment of the Arusha Declaration in 1967 and the Village and Ujamaa Act of 1975 led to new developments. For example, the Arusha Declaration declared that all major means of production had to be owned and managed by the public to bring equality on access and ownership of national resources and services. Under the Arusha Declaration, small producers and villagers were forced to move from their settlements to the new Ujamaa villages. More strikingly, the Land Acquisition Act of 1967 was purposively introduced to empower the president to acquire land from anyone for the purpose of national interests. The enforcement of this law brought about much criticism because it encouraged the misuse of presidential powers over serving the public interest. Consequently, land alienation and conflict arose. In order to resolve these complex problems and land conflicts embedded in the previous enacted laws, in combination with the ongoing political and economic pressure, the National Land Policy of 1995 and ultimately the Land Act and Village Act of 1999 was established.

The Land Act and the Village Land Act came into enforcement in early 2001 after their translation into Swahili and the promulgation of their accompanying regulations. This legislation is perceived to contain significant elements of change by delegating land access and ownership to the lower level of the land registration system, providing titling and dispute settlement at the village level and the recognition of customary land rights, which were dismissed after the British Colonialism Crown Land Act and under socialism ideology (Knight R. S., 2010 ,pg. 153-185; Kironde, 2009; Sundet, 2006 and Wily, 2011). In practice, this means that a person or group holding a deemed right of occupancy[5] can apply for a certificate of customary right of occupancy (CCRO) for village land that they hold under customary law or have received as an allocation from the village council. The newly established Act grants legal protection and land rights to various vulnerable groups such as women. According to the assessment report on land-based investments in Tanzania, conducted by Makwarimba and Ngowi (2012), the new Land Law established a quota for female participation in the key decision making bodies and requires that there be at least 25% female representation on the Village Council, 4 female members on the adjudication committee and at least 3 on the Village Land Council. The VLA 1999 also makes provisions for pastoralists to secure rights to land for extensive

[5] A deemed right of occupancy is defined as a title granted to an individual or group of persons the rights of using or occupying land under and in accordance with customary law

grazing systems. However, until recently, land and resource tenure for pastoralists was generally limited in the real world practice and implementation of the law.

During implementation of the provision, villages have to demarcate their land, register their rights and obtain certificates in order to provide evidence of their ownership and their rights. The demarcation of a village required a village to divide its land into three broad land use categories (VLA 1999, s 12) as follows: i.) Communal land which is land available for common use ii.) occupied land which is land being occupied or used by an individual or family or group of people under customary law and iii.) the land is reserved or available for future use as individualized or communal land. The provisions in the VLA 1999 can be viewed as a potentially positive move towards the protection of land rights of smallholder farmers, livestock keepers and vulnerable groups.

Nevertheless, the salient feature of the laws and recent reforms and their implications, indicates that land has value and must be used to serve commercial interests so as to attract foreign investors. The reforms ease and facilitate land marketing and mortgaging and allow the sale of bare land and set conditions favourable for land investment. Foreign investment on land was also facilitated by the establishment of the land bank, which continued to provide the primary data base for information on arable land potential for investment. Furthermore Tanzania's land tenure formalization was also bestowed through the Kilimo kwanza strategy of ASDP (Agricultural Sector development programme). The Kilimo kwanza strategy (agriculture first) is the national agricultural development strategy comprised of policy instruments to modernize and commercialize agriculture in Tanzania. It was launched in 2009 as a central pillar in realizing the country's 2025 vision. Prior to the Kilimo kwanza strategy, the MKURABITA[6] program was envisaged by the Government in 2004, with the objective of creating a unified legal and institutional framework that recognized that secure and accessible property rights constitute a major role in wide range of economic benefits available in the formal market. The program's core aim was to bring in formal land titles and business registration to the poor so that they can be used in the land market and as collateral for formal credit. While MKURABITA remains active, the majority of poor people in rural areas have no formal land titles for the land they hold, even in urban areas, formalization is extremely limited, only less than 15% of the proportion of land covered by a formal title is transferrable and can be used as collateral

[6] MKURABITA is a Swahili acronym for Property and Business Formalization Program. MKURABITA establishment was directly influenced[6] by Hernando de **Soto** who emphasized withdrawal of "dead capital" providing catalyst to economic development and in turn generate tax revenue for the state (Sundet, 2006). Former Tanzanian president Benjamin Mkapa (1995-2005) invited De Soto to Tanzania to help establish a "Property and Business Formalization Programme"

in the formal credit market (Ali et al. 2014). While, Tanzania's land formalization is seen as being important to the overwhelming investment interests on rural land for food production, bio-fuels and forests, and in solving chronic land conflicts inherent in the land and village act**.** The recent land formalization and access of CCROs for small scale farmers is demand-driven and therefore raise concerns on the impact of information asymmetries in access to information on the land laws and titling processes. Therefore, this paper attempts to estimate the impact of land access as a result of the land laws and titling process on welfare and poverty. We use education attainment as a proxy tool for a person being able to access rights and the perceived benefit of land titling.

1.3 Selecting Variables

Our estimation is based on a national panel data collected in two waves, 2008/2009 and 2010/2011. The data has information on the initial land ownership of rural farmers. Households were asked since when they possess agriculture land plots. Rural farmers who owned land before the Land Act came into place in 2001 and the post Land Act are considered as the control and treatment groups respectively. In both groups, we have aggregate net welfare outcome variables, household food production and consumption. Following the Deaton (1989 and 1997) and the Friedman and Levinsohn (2002) approaches, the net welfare is computed as a compensating money metric retaining households at their initial utility level when the price of food has increased. Also, we use food share over total household expenditure as our outcome in order to examine if land reform has managed to improve household income and thus reduced the share of income spent on food resulting in poverty reduction.

A key observed variable, which can affect both participation in land reform and welfare change, is household size. In particular, older members of households are more likely to be assigned to the land ordinances before the Land Act than on the newly established Land Act. Furthermore, to avoid a potential bias due to unobservable variables, a "hidden bias" in the language of Rosenbaum (2002), we implement a matching technique on a range of covariates characteristics which may affect the participation and welfare outcome variables. These should be potential variables which can increase agricultural productivity and improve rural livelihoods through various economic channels. Many of these are household characteristics and include the education status of the household head and their occupation. We also control for land ownership attributes, which characterize important dimension of landed wealth, such as the distance from a farm plot to the nearest market and the nearest road and the land size in acreage owned by the household. The effect of land size on land productivity has been widely known since 1950 through the publication of the

Indian Farm Management Studies, which found an inverse relationship between farm size and land productivity (Cornia, 1985). In small scale farming, a large farm size will eventually lead to reduced yields per acre. Therefore, we include a square term for land size in the matching process to account for this. We also include higher order interaction terms for some demographic variables. We use the Hosmer Lemeshow Goodness Test to facilitate selection of the higher order term and at the same time to ensure that the covariates are balanced within the propensity score blocks.

Matching in a full range of covariates as in our case cannot be easily achieved; we therefore use propensity score methods, which tend to reduce observed information into a single dimension known as a propensity score. The focus of our estimation is not with parameter of the model but to ensure that our estimates of the covatities between the treatment and control sub populations are statistically balanced (Augurzky and Schmidt, 2001). Because of this, the standard concern of collinearity during propensity score estimation does not apply and so we only concentrate on very important balanced covariates in the propensity score. If an imbalance is found in a key variable, we include it in the estimation of the ATT, and disaggregate the sample by such variable. We implement this strategy on variables, such as land rights and education of the household head, becausse we could not find a balanced combination of such covariates.

2.0 Data

This paper uses a national panel data collected in two waves collected from 2008 to 2011. Sampling in the panel was constructed based on the national master sampling frame based on a list of all populated enumeration areas (EAs) in the country, these EAs were established in the 2002 population and housing census. The sample includes a partial sub-sample of households interviewed during the 2006/2007 household budget survey. In the first wave, the panel data was collected between October 2008 and October 2009. A total sample size of 2,063 households in rural areas were collected in EAs. In rural areas, an EA is a cluster defined as an entire village. In the second wave, data collection started in October 2010 and completed in September 2011 and the sample grew to 2,121 households. The panel consists of information on the households, farms and community. Also, there are more than 50 food items on which information on the quantity purchased and consumed by the households was collected in the field.

To facilitate the empirical analysis, we aggregate the major components of food consumption into twelve groups as indicated in the definitions in Table 1. The grouping of the food products is closely related to the classification adopted by the National Bureau of Statistics. In Table 2, we report the descriptive statistics as used in the propensity score. We have a total of 712 treated households

by the Land Act, equivalent to 39% and 1130 control households. In the propensity score we exclude a total of 79 households without reported land ownership and therefore our sample varies depending on the treatment and variables selected for a particular analysis. The demographic characteristics of the household head are dominated by males constituting about 77% of the total number of household heads. Also, we observe that about 78% of household heads with families are married. On average, households have a family with six members and the average age of a family member is 48 years old. Furthermore, the descriptive statistics in terms of land ownership, indicate that farmers who own farm plots walk an average distance of 1.5 kilometers from the farm plot to the nearest road, but they walk further distance to sell their produce;on average, they walk about 7 kilometers to the nearest market. Similarly, rural farmers cultivate 2.6 acres on average. However, few farmers who own agricultural land have land use certificates (LUCs). Results show that only 9.18% of rural households possess LUCs in the form of a letter of allocation by the village government, a letter of village-government witnessed purchase, a certificate of customary right of occupancy, a utility or other bill or a granted right of occupancy. We also note that most of these rural farmers are poor, derive they income and livelihood from farming activities including livestock and they are less educated. Statistics suggests that about 85% of rural households are farm workers and that 90% of rural farmers have only a primary school education. As expected, households spend a relatively larger share of their income on food over their total consumption --approximately 78%-- indicating that rural poverty is wide-spread in the country. Finally, the welfare of food producers is positive but negative for food consumers, implying that food prices have a negative effect on food consumers and a positive effect on food producers. Here, the welfare is measured as an aggregate value for all of the food items produced and consumed within the household. The aggregate welfare gain for food producers is 45% and there is a 36% welfare loss for food consumers.

3.0 Estimation Strategy

3.1 Welfare Analysis

In this section we build a static model to estimate household welfare and the average treatment effect of the treated households when there are changes in food price. We focus on a money metric at a fixed income level to estimate the effect of prices on household welfare. The income needed to maintain the previous level of household utility given a change in prices for the household as a consumer is the compensated variation.

$$CV = e(p^0, u^0) - e(p^1, u^0)$$

Following Friedman and Levinsohn (2002) and Robles and Maximo (2010) $e(p^1, u^0)$, can be approximated by the second order Taylor expansion.

$$CV \approx \sum q_j{}^0 \Delta p_j + 1/2 \sum \sum \partial^2 C(p^0, u^0) / \partial p_j p_i \Delta p_i \Delta_j \qquad 1$$

The derivative of the cost function C is the hicksian demand for the food j. In practice, the concern is on the price change of the group of food items, such as meat products, while the prices of other food groups are fixed (Yu, 2014). Hence, CV when the prices of food group change while other food groups is fixed:

$$CV \approx \sum q_j{}^0 \Delta p_j + 1/2 \sum \sum (\partial^2 C(p^0, u^0) / \partial p_i)(\Delta p_i)^2 \qquad 2$$

We deflated the CV by the initial expenditure x_o so that the compensated income entails a constant utility when prices change. The simplification of equation 2 is given as folows:

$$CV / x_o = \sum CR_i \Delta p_i{}^c + 1/2 \sum \sum \varepsilon_{ip} (\Delta p_i{}^c)^2 \qquad 3$$

Where CR_i is the share of purchases over the total consumption of each food j before the price change, $p_i{}^c$ is the purchase price of the item and ε_{ip} compensated own price elasticity.

A short term or income effect for the consumer is estimated if the last term of equation 3 is ignored. Hence, economic welfare changes of the consumer can be measured only by the information of price and budget shares.

Similarly, we use CV for household as producer by replacing the profit function with the cost function. The profit maximization is given by:

$$\Delta \pi = \pi(p^1, w^0, y) - \pi(p^0, w^0, y)$$

Where $\Delta \pi$ is the change in profit, π is the profit function, w is the vector of input prices for production. p is the vector of output price, p_o and p_1 is the initial price and price after the change respectively, y is a vector of fixed factors for production .

Hence, the profit maximazition is approximated by the second order taylor and deflated by its initial value of production given by

$$\Delta \pi / x_0 = \sum PR_i \Delta p_i{}^r + 1/2 \sum \sum \psi_{ip} (\Delta p_i{}^r)^2 \qquad 4$$

Whereby PR_i is the sales share of production , P_i^r is the producer price and ψ_{ip} is the own-price elasticity of supply. A short term or income effect for the producer is estimated if the last term of equation 4 is ignored.

The money metric M is the compensated variation of equations 3 and 4 combined with the net benefit ratio approach. Hence the net welfare effect M is given by:

$$M = \sum \left(PR_i \Delta p_i^r - CR_i \Delta p_i^c\right) - 1/2 \sum \sum \varepsilon_{ip} (\Delta p_i^c)^2 + \sum \sum \psi_{ip} (\Delta p_i^r)^2 \quad 5$$

Nevertheless, it is difficult to obtain the self-produced price for products in developing countries particularly sub-Saharan countries. As such, the money metric M is derived by equation 5. Thus, we use purchase price within locality to impute the self-produced price, on the assumption that purchase and self-produced price are the same. Also we assume a uniform increase of producer and consumer prices (see, Badolo and Traore, 2015). We simulate the price elasticities of supply on ranges between 0.216 to 0.62 by a uniform distribution. These supply elasticities are taken from the study of Magrini et al. (2016) conducted in sub Sahara African countries including Tanzania. The welfare effect proposed by Deaton (1989) and used in most applications is a simplification of equation 5, by eliminating the last two terms. Hence we have the expression:

$$M = \sum \left(PR_i - CR_i\right) \Delta p_i \quad 6$$

Where by NBR=PR-CR is the net benefit ratio defined as the sales value of a commodity as a proportion of household income. NBR is positive when a rural household is a producer and negative when they are a consumer. A positive sign of M means that price shocks increased initial income realtive more than before the shocks(welfare gain), and a negative sign when there is a welfare loss. Deaton(1989) interpreted the NBR as the short-term elasticity of household welfare with respect to the price of a commodity. The expression is quite useful in applied policy analysis, particularly since it does not require any information on household responses to price changes. We use this expression as the outcome variable to examine the impact of food price and land reform on the household welfare in rural Tanzania.

3.2 Propensity Score and Matching Techniques

Suppose we observe two sub sample units drawn randomly from a large population of households $i = (1,2,3,..,N)$ that are subject to the treatment $W = 1$ or $W = 0$ if not. T denotes the sub

sample of households treated with the Land Act, and C the subsample of control households. Let the variable, $Y_i(0)$ specify the outcome (welfare loss or gain and household food expenditure) under the control treatment and $Y_i(1)$ the outcome under the treatment. We denote Xi as a vector of covariates corresponding to each pair of households. We use demographic variables for household members, such as age, occupation, gender and household size, as characteristics of the covariates. In addition, we include the land-wealth variables, such as the distance from the farm to a road or market and land size. The effect of the treatment on households i is defined as: $\Delta Y_i = Y_i(1) - Y(0)$. As documented by Rubin D. B. (1974, 1977, 1978), the average treatment effect of the treated households i (ATT) can be viewed as causal if the comparison of potential outcomes is conditional on the covariates xi.

$$E(\Delta Y_i / W_i = 1, X_i) = E(Y_i(1) / W_i = 1, X_i) - E(Y_i(0) / W_i = 1, X_i)$$

However, the pre treatment counterfactual outcome $E(Y_i(0) / W_i = 1)$ cannot be observed in a non-experimental design. We can only use the available information of $E(Y_i(0) / W_i = 0)$ to estimate the counterfactual outcome. Thus, as suggested by Rosenbaum and Rubin (1983), the consistent and unbias estimate of the counterfactual can be achieved only if:

$$E(Y_{i,0} / W_i = 1, X_i) = E(Y_{i,0} / W_i = 0, X_i) \qquad 7$$

To achieve the identification strategy in equation 7, we use propensity score matching (PSM) to replicate the experimental design to ensure that assignment to the treatment is random (Wang et al. 2013). PSM is implemented based on the "strongly ignorable treatment assignment" assumption, which assumes that there are no unobserved differences between the treatment and control groups, conditional on the observed covariates (Rosenbaum and Rubin, 1983). To satisfy this assumption, we need to include all variable that are associated with both the treatment and outcome variables (Rubin and Thomas, 1996; Caliendo and Kopeinig, 2008; Heckman et al. 1998). However, matching a full range of covariates is a computational burden due to the "curse of dimensionality" of the covariates (Stuart, 2010). To overcome this problem, we use PSM as an alternative to bias-correction, because the estimated treatment probabilities are matched on a single continuous covariate. Thus, matching is conditional on the propensity score, rather than on covariates so that the average treatment effect is given by:

$$\tau_{ate} = E(Y_{i,1} / W_i = 1, p(X_i)) - E(Y_{i,0} / W_i = 0, p(X_i))$$

The counterfactual outcome of treated units in the absence of treatment is given by:

$$E(Y_{i,0} / W_i = 1, p(x_i) = E(Y_{i,0} / W_i = 0, p(x_i)\,.$$

Finally, when the CIA and overlap assumption are satisfied, the observational data are replicated to produce random assignment to the treatment, where the average treatment of the treated households can be written as:

$$E(\Delta Y_i / W_i = 1, p(X_i)) = \frac{1}{T}\left[\sum Y_i^T - \sum \omega(i,j) Y_j^C\right] \qquad 8$$

ω defines the weights of the matched units; we will elaraborate further on the weights with different weighting scenario on the basis of underlining matching distances. The propensity score is estimated based on balanced covariates in the propensity score.

An estimate of the propensity score is not enough to estimate the ATT, because the probability of observing two units with exactly the same propensity score value is in principle zero because *p*(*X*) is a continuous variable. To overcome this problem, we use three of the most common matching methods proposed in the literature. These *are Nearest-Neighbor Matching*, *Radius Matching* and *Kernel Matching*. For each matching procedure, we impose a maximum caliper restriction of two standard deviations of the linearized propensity score so as to avoid the possibility of bad matches.

Furthermore, we denote C (i) as the set of control units matched to the treated unit *i* with an estimated value of the Propensity score of *pi*. Thus, the nearest-neighbor matching units are defined as:

$$C(i) = \min_j \left\| p(i) - p(j) \right\|$$

For radius matching, we denote a radius r in which all of the control units from the estimated propensity score that fall within that given radius, are matched with a treated household i.

$$C(i) = \left\{ p_j \left\| p(i) - p(j) \right\| \right\} \prec r$$

The formula for both nearest neighbor and radius matching estimators can be defined as:

$$E(\Delta Y_i / W_i = 1, p(X_i)) = \frac{1}{T}\left[\sum Y_i^T - \sum \omega(i,j) Y_j^C\right] \qquad 9$$

We define weight as: $\omega(i,j) = \frac{1}{N_i^C}$ if $j \in C(i)$ and $\omega(i,j) = 0$ otherwise.

For kernel matching, the weight $\omega(i,j)$ is the weighted kernel function of the propensity score. Kernel matching uses non-parametric techniques to compare treatment and control households, based on kernel-weighted averages (Caliendo and Kopeinig, 2008). Since the kernel and

bandwidth must be chosen for the kernel matching estimators, we chose the default Gaussian kernel and a bandwidth of 0.06.

Matching is based on the strong assumption of conditional independence or unconfoundedness. If there are unobserved variables which affect assignment into treatment and the outcome variable simultaneously, *a hidden bias* may arise to which matching estimators are not robust. In principle, there are no formal tests for this hidden bias either than estimating the magnitude on which bias can alter the ATTs by a factor Γ . In this respect, there are two popular tests in the evaluation studies for continuous outcome variables. The simulation based test pioneered by Nannicini (2007) and rbound as developed by Rosenbaum (2002). We adopt the rbound test as it is widely used in most of the evaluation literature. Also, the development of the DiPrete and Gangl (2004) stata algorithms, which can be fairly well implemented in the Psmatch codes, makes the test straightforward to apply on matching estimators. The test determines how strongly an unobserved variable must influence the selection process in order to undermine the implications of the matching analysis.

4.0 Empirical Results

4.1 Household Welfare and Land Ownership

In this section we present empirical results by simultaneously analyzing the impact of food prices and land policy reform on household welfare. Land ownership in agricultural based societies play a major role in determining household income. The Maxwell and Wiebe (1998) analytical model conceptualizes the links between land and income within a linear framework, beginning with how access to land can lead to efficient agricultural production and upward income mobility through trade and investment decisions (ECA/SDD/05/09,2004). Indeed, land holding and use certification would give households power to exchange, lease and finance their land. However, as we have seen in the previous section of descriptive statistics, there are very few households who hold land with use certificates. Also, as the results in Table 3 suggest, there is a substantial difference of the LUCs between households who obtained land before the newly enacted Land Act came into enforcement and the post Land Act. The difference is also interesteing when comparing differences across the income distribution. Rural households who have LUCs, tend to fall more under the pre- Land Act than under the post Land Act regime[7]. Furthermore, they are more in the higher tail of the expenditure distribution than in the lower tail under both Land Act regimes. Most likely, the current

Land Act could be a major reason for this, because it attracts investment interest into villages and facilitates land transfer from small farm holders to large scale investors. Such demand for land tends to increase land value in the market, especailly in comparison to the time period before the post independence customary land ordinances. In fact, societal inter-linkages due to population growth and urbanization/modernization, weakened the social relationship among individuals in the society and as a result making difficult those households who obtained land very recently to secure land use certificates under the customary statutory.

We determined the impact of land access and security of tenure on welfare by considering the compensating variation for producers and consumers belonging to two different Land Act regimes. In Table 4, the results indicate that poor net food consumers bore much more of the burden than rich consumers in both control and treatment groups. As expected, this effect is reduced when both income and substitution effects are considered. Generally, an increase in food prices has a larger negative effect on the control group of net food consumers[8] than on the treated net food consumers, however, for richer households --deciles 7-10-- the opposite seems to hold. The different values of welfare loss of the food consumers is likely to be influenced by the unequal distribution of the land size between the treatment and control groups**.** As Table 5 suggests, except for the top deciles, land size in acres is higher for the food consumers in the treatment group than in the control group. It is clear that when food consumers in the treament group hold more land than those in the control group, their welfare loss is also higher, but overall welfare is low when the land size is also low, implying that there is a positive relationship between welfare loss and land size per acre. Here the welfare loss is associated with low productivity as a result of increasing land size for the agricultural production. This relationship mimics the inverse relationship between land size and productivity suggested by Sen (1962 and 1966)**.** While, there has been a long-standing debate on the realtionship between farm size and productivity, some argue that the era of the smallholder farmer is over. In the case of rural Tanzania --a low-income country where there is an absence of economies of scale-- small farms may be more efficient than larger ones because of the favourable incentive structure in self-employed farming and the significant transaction and monitoring costs associated with hired labour (de Janvry et al. 2001). As a result, these factors can potentially offset soaring food prices by increasing household income through increased agricultural productivity.

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[7] In terms of the share of households who own LCUs, we see the same pattern that more LCUs in the pre-Land Act than on post Land Act regime.

[8] It should be very clear that the food consumers in essence are also food producers it is only that the share of purchase exceed the share of sales over the total production.

On the contrary, the welfare gain is higher on untreated than treated food producers when no substitution effect is considered, partiticularly for richer households in deciles 8-10. The untreated net food producers are taking greater advantage of the increasing food prices than food producers in the treatment group, once the second effect is considered. Indeed, the welfare gain increases when both treatment and control producers are allowed to change their consuming behaviour as prices increase, meaning that producers who are on other side --food consumers-- can substitute with cheaper food products when the price of other foods have increased**.** Furthermore, there is a slight difference in the welfare gain across the expenditure distribution between treatment and control groups, and as the total expenditure per capita increases, the welfare gain decreases for the both groups. A plausible explanation could be that at higher expenditure distributions, food producers are more likely to be part-time farmers and as a result they obtain a larger proportion of their income from non-agricultural activities.

4.2 Factors Influencing Landownership on Reform Regimes.

Now, we estimate the average treatment effect of the welfare conditional on selection probability into the Land Act of 1999. We estimate the selection probability of the households into two different land regimes. We use a logit model from a range of covariates characteristics which ought to influences selection of the households. The predicted probability of the logit model is used to estimate the propensity score. As previously discussed, our focus is not with parameter of the estimated model **,** but rather the balanced propensity score. Hence, a balanced propensity score seeks to check if at each value of the propensity score, X has the same distribution for the treatment and comparison groups by dividing the sample into subsamples (blocks) with similar value of propensity score and then testing whether W_i and X_i are independent within each sub block. First, we test whether the mean propensity score of the treatment and control groups are statistically insignificant in all blocks[9] for each given covariate. If one covariate is significant in one block, it implies that it is not balanced in that block. We split the blocks and test again within each sub block. Second, if the propensity score for one covariate is significant in all blocks, we modify the specification of the propensity score by adding an interaction and higher order term and then test again[10]. Having calculated a propensity score, we also check if there are important confounders that we have not measured, as the propensity score will not work, and there is no way of really testing

[9] Results are excluded, only the final number of block is presented

[10] At this stage we do not use the outcome variable so as there is no way of biasing the ATTs estimation. Also point to note that imbalance usually happen, so we focus on key important covariates that are important

this. However, a Hosmer-Lemeshow test will show a significant P-value if the functional form of the logit regression is incorrectly specified. This can suggest that there is non-linearity in the relationship between the confounder and the odds of being treated, or there is a need to include an interaction between the confounders. We run this test and include all 3 squared terms and the interaction term. As a result, the test has a higher P-value when we include the interaction terms and higher order terms for age, household size and the square term for the land size (Table 6). Therefore, we proceed with this specification on to the estimation of the propensity score. It should be noted that for estimating the propensity score, it does not matter whether the explanatory variables are endogenous or not. However, to extend possible, we attempted to include only exogenous variables in the estimation. Also, Table 6 illustrates the covariates used to estimate the propensity score. Holding other explanatory variables fixed, a change in the household occupation from farm occupation to off-farm , is associated with a 30% decrease in the probability[11] of holding land after the enactment of the Land Act, meaning that farmers are less likely to own farm land after the Land Act than non-farmers. Interestingly, we further note that as a unit per acre of landholding increases, households are less likely to have owned land after the enactment of the Land Act. More likely, the land tenure systems before the Land Act have favoured untreated households in terms of land ownership and even land use certification. Tanzania landholding was based on the customary laws of different tribes (120 tribes) before colonialism, whereby customary land rights were decreed by the village chiefs, clan leaders, headmen and elders who had the power of land administration entrusted to them for the community, where land ownership was predominantly communal, owned by a tribe, clan or family (Hayuma and Conning, 2004). While the existence of such power was limited in the newly introduced crown German and later British land tenure systems in which all land was declared to be public, the customary land tenure system still exists though the chiefs, headmen and elders have been replaced by elected village councils since 1963. Therefore, under such land tenure systems it is in principle simple to transfer the ownership of land from one clan or family to another for generations. Thus, family members and clans who inherited farm land are more likely to become farmers and hold large quantities of land. In addition, recent pressure on land investment and current demand for land in the country has caused land to be highly valued in the market. Thereby, non-farmers --who tend to be relatively rich, foreign investors and rich elites tend to buy land from indigenous and small farm holders for investment.

[11] We subtract 1 from the odds ratio indicated in the exponential coefficient column and multiply by 100 (that is, (odds ratio-1) x 100)), this shows the percentage change in the odds for the switching of the indicator variable or a 1-unit change in the x.

Furthermore, our results indicate that farm land, which has a further distance to the nearest market or road is less likely to be owned by untreated households. As previously discussed, the majority of rural farmers who own farm land inherited their land either during the post independence or colonial land tenure systems, when all land belonged to various tribes and the prevailing principle of most tribes was that the land belonged to the tiller of that land (recall Table 3). When a family or clan is not using the land, the chief or clan head gave it to another family (Mtetewaunga, 1986). Farm plots close to homes were preferred and owned by the prestige clan, family, clan head or chief. Similarly, farm plots located further distances from the cultivator's residence are more likely to be on fixed-rent contracts. After the enactment of the Land Act, the landlords preferred to sell their previously rented plots and retain plots close to home for their own cultivation.

Moreover, the selection of treatment also depends on age and gender of the household head; older male are less likely to own land after the enactment of the new Land Act of 1999. There are two possible explanations. First, age and gender of an individual directly correlate with landholding and even the quantity of acreage, because older members of the households tends to be old enough to have lived before the enactment of the new Land Act. They have certainly lived during the colonial period and the post independence land ordinances where household members with individuals of working age received the largest allocations and young children the smallest. Since, female-headed households tended to have fewer adults of working age, female-headed households on average received less land than male-headed households. Given the cultural norms, it became difficult for a female to transfer land to her offspring. Second, the post independence land tenure system marginalized women in terms of land decision and ownership. Gender inequalities on landownership were catalyzed by social norms and cultural traditions in which decisions on farm production and the ownership of assets were primarily made by men. Traditionally, when a husband dies, women had no power to inherit land; a plot of land was transferred to the deceased male clan. Furthermore, customary norms in rural areas are still biased against women as wives, widows, sisters, daughters, divorced and separated women limiting their ownership and control over land resource. The current Land Act promises to guarantee equal rights to acquire, hold, use and deal with land for women and men. As a result, a village council –theoretically-- may not adopt adverse discriminatory practices or attitudes towards women who have applied for a customary right of occupancy (Ingersoll, 2010). In addition, a family member or relative may not marginalize women in terms of land ownership.

Conversely, a married household head is more likely to have owned land after the Land Act. However, the variable is statistically insignificant for selection into the treatment. Even though we

would have included the interaction term between married and gender in the treatment participation in order to examine the direct of effect of land holding between married women and men, the term is not balanced in the estimation of the propensity score. But, the disparity of land ownership between men and women appeal to an intuition that married female-headed households on average could have received less land than married male-headed households and could have been obtained land after enactment of the new Land Act. Finally, with exception of the household size cubed and the interaction between household size squared and age, other higher order terms of the demographic variable are statistically significant in the selection probability model.

4.3 Matching Estimators

An estimate of the propensity score is not enough to estimate the ATTs. Hence, we use the commonly widely proposed matching methods to estimate ATTs on our outcome variables (consumer welfare, producer welfare and food expenditure i.e. food share). These methods use nearest neighbor, kernel and radius matching. In particular, we focus on the one-to-one nearest neighbor method, because it is simple to apply and at the same time it is also the common and preferred method (Stuart, 2010). In one-to-one nearest matching[12], a treated unit is matched with a control unit with the closest propensity score without any replacement. As a result, units which are not matched are discarded in the matching process. Once each treated unit is matched with a control unit, the difference between the outcome of the treated units and the outcome of the matched control units is calculated. The ATT of interest is then obtained by averaging these differences. We use the stata command psmatch2 (Leuven and Sianesi, 2003) to perform the PSM. It also includes routines for common support graphing and covariate balance testing. We perform these tests by using the "quietly" option so that the final estimated ATTs is not bias. As suggested by Rosenbaum and Rubin (1985), the standardized bias should be less than 20% after matching although Caliendo and Kopeinig (2008) later show that the bias should be less than 5% after matching. The estimation results are shown in Table 7.

The balancing tests for all types of our matching methods indicate that all covariates after matching have less than a 5% bias and are statistically insignificant for the net welfare gain (producer) and loss (consumer) outcome variables. The overall means and medians bias are also below 5 %, meaning that the balancing is good for all covariates, indicating that our matching method is effective in building a good control group. As expected, the Pseudo- R square after

[12] A more general nearest neighbor when control unit can be matched for more than one treated unit

matching is low, indicating that the characteristics of households used in matching are balanced. Also, figure 1a indicates the balanced covariates, because after matching the standardized biased aligned very close to the zero vertical line. Similarly, figure 1b indicates balanced covariates because the density of standardized bias is wide spread before matching, but after matching it is concentrated at the centre at the peak of the distribution. To ensure that we improve the quality of matches, we restrict matching to the region of common support. As a result, treatment units that do not belong to the intersection between the treatment and control groups are dropped (bad matches). However, this restriction is not necessarily better (Lechner, 2001), because matches may be lost at the boundaries of common support. We have dropped only one unit that was badly matched, labeled off-support in matching (figure 2a), however, such restrictions have not caused a drop of any matches in other matching methods apart from one-to-one matching.

Table 8 presents the matching estimators on household welfare for producers and consumers. By using one-to-one nearest matching, ATT of the welfare gain is 5.5 **%** lower for the treated food producers, compared to matched untreated producers. ATTs estimation is consistent across different matching methods. The ATTs estimates imply that an increase of the food price have not substantially benefited rural food producers who owned land after the new Land Act in comparison to those who owned land before the Land Act. Arguably, the formalization of land due to the new Land Act had little effect on the increase of agricultural investment decisions and credit access, and as a result, rural farmers have less agricultural productivity and household income. In contrast, the ATT of the welfare loss is 10% lower for treated food consumers compared to the untreated consumers. That being said, consumers holding land after the Land Act was enacted, are less affected by food prices than consumers holding land before the Land Act of 1999. Our result indicates a slightly different ATTs estimation among matching methods, particularly for one-to-one matching when compared to other methods. However, coefficient estimates of the other remaining methods are still positive and consistent. Among other factors, the effect of food prices on household welfare depends on the position of the household in the income distribution. Therefore, we further estimate the ATT's using the one-to-one nearest neighbor and plot the standardize difference of the ATTs against the food welfare distribution. Estimation results are shown in figures 3a and 3b. In figure 3a, **t**he welfare gain is still lower for the treated food producer than untreated producers across the food welfare distribution. Interestingly, the ATTs gradually increased from lower income producers to higher income producers. However, figure 3b indicates a negative sign for the ATTs across the food welfare distribution with the exception of middle-income consumers implying that the welfare loss is much smaller for the treated middle-income consumers than the

treated poor consumers.Since,the overall welfare lose is higher for treated food consumers than untreated consumers across the food welfare distribution. Hence, the observed 10 % positive ATT is most likely coming from middle-income consumer households

Now, we extend the one-to-one nearest matching by estimating the ATT of only producer households in terms of education attainment and land use certification because our estimates for food producers are significant and robust for the different estimation methods. As we have already discussed in the section on descriptive statistics, very few households have post-primary school education and land use certification. Certainly, such limited sample information does not allow us to compare either the influence of primary and post-primary education or use and non-use land certification on welfare, without losing matching power. Therefore, in order to overcome this challenge and to ensure sufficient matches are found for the given covariates, we estimate a sample of primary school education and non-use land certification separately, and then in each case we compare the estimates with the baseline[13] ATTs. Results are found in Table 9. As expected the Pseudo R-square is low and there are no significant difference in the covariates between treated and comparison households after matching. Also, medians and means biased reduced between 2.5 and 3.9 after matching, indicating that our covariates provide good balance for matching of the control households. The extended ATT for the treated households with primary education is still negative and statistically significant. However, if we compare it with the estimated baseline ATTs, the extended ATT is considerably large, indicating that the remaining gap of 2% in ATT, accounts for the influence of both post secondary school and the Land Act on household welfare due to food prices. In other words, an increase in food prices can result in a larger welfare gain for the treated or untreated post primary educated producers than for the treated or untreated primary school educated producers. Certainly, literate farmers with at least a primary education are thought to be more productive and more responsive to new agricultural technologies than illiterate farmers, because education can accelerate the adoption of technology through access of information, resulting in an increase in agriculture productivity, earnings and improved household welfare (Becker 1962 and 1993 ; Schultz 1961 and 1971). Indeed, access of information is a major tool for agricultural decisions in production, finance and marketing. For instance, since village markets are characterized by asymmetric information in which traders are more informed than farmers on the prices in the central or regional markets, it makes information searching very expensive (Tadesse and Bahiigwa, 2015). Food price information can easily be accessed through mobile phones and ICTs related technology.

[13] It is initial ATTs estimation where education and land use certification were excluded in the propensity score.

While rural households are constrained by infrastructure facilities when adopting and using ICTs. Mobile phone coverage and ICTs programs for agriculture are expanding widely in rural areas (Aker and Mbiti, 2010). Therefore, education plays a major role on its adoption, use and access of information. As a result, rural producers with at least secondary school education can have better access to food prices through mobile phones and other related ICTs technology. In doing so, rural farmers can have better market access, enabling them to better realize the gains from trade and maximize farm income through cost reductions stemming from time saved on market research, thus devoting greater resources to production and leading to greater overall productivity (Tadesse and Bahiigwa, 2015).

Generally, education can directly impact productivity, employability and earning capacity, thereby improving welfare (Schultz 1961 and 1971; Becker G. S., 1962 and 1993; Psacharopoulos, 1973). Consequently**,** literate farmers are more likely to have a land title simply because demand for non-transferable titles from the Land Act of 1999 is very low due to the extremely high cost of titling in Tanzania, though bureaucratic red tape is also a significant part of the fixed costs of surveying in Tanzania. Also, low demand for land licensing is due to the perceived low benefit of securing documentation that is valid for protecting against eviction. Illiterate farmers have little knowledge of the importance of land certification, which can also be used as collateral for a bank loan and also guarantee better agriculture investment decisions and thus increase productivity and household income. We estimate the ATT for households without land titling and compare it with the baseline estimate. As shown in Table 9, the estimate of the ATT indicates that land titling increased the welfare gain for producers from 4.3% to 5.5%. While this result is insignificant, an important point for policy implications, is that land titling for rural producers influences the improvement of household welfare. Similar results have been found in Vietnam, where land tilting was found to improve household welfare through increasing household expenditure and the probability of self-employment in agriculture and poverty reduction (Kennedy et al. 2013).

4.4 Influences of Land Ownership on Food Consumption

In this section we present the estimates for the share of income spend on food over total household consumption to measure the ATTs in terms of food poverty. The general idea of using this measure is that households are better off when share of income spend on food decreases as income increases.We use a baseline treatment participation model (without land use certification (LCUs) and the extended model when controlling for land use certification. We further test the imbalance of covariates for the two different models and estimates the ATTs. In Table 10 the baseline treatment

model has all covariates balanced with less than a 5% reduction in selection bias and the overall selection bias was reduced to 1.7 for the mean and 1 for the median after matching. As expected, the difference between the treatment and control units is statistically insignificant after matching. The R-square falls substantially, indicating that our matching was successful. However, the extended model indicates that a few covariates have a selction bias just above 5%. The selction bias for the distance to market has a relatively large reduction. Nevertheless, the overall mean and median selction bias are less than 5% after using the matching method.

Table 11 presents the matching estimators for households with and without land use certification. In the baseline model, the one-to-one nearest neighbor estimator is positive, indicating that treated households spend a larger share of their income on food than the comparison untreated households. This indicates that the new Land Act has less favored households who obtained land after the Land Act, enabling them to smooth household consumption, which in turn can not fall in poverty.However, as figure 4a indicates, the positive ATTs is much more predominant on the lower tail of expenditure, declining slightly and remaining positive on the middle of the distribution, then it tends to move in a negative direction at the higher tail of expenditure, suggesting that the new Land Act has benefited rich households more than poor households. As expected, the effect of the Land Act on the treatment group's proportion of income spent on food –the food share outcome variable-- declines from 3.5% for households without LUCs to 2.6% with LUCs. These results suggest that land ownership and use certification play a major role in consumption smoothing and as a result, households are not trapped by poverty.

Furthermore, we plot figure 4b for the food share ATTs to explore the effect of the Land Act on households who own land and who have a land use certificate**.** We observe a similar trend for the ATTs, although at the lower distribution of the expenditure, the ATTs is not as positive as for those households without a land use certificate, indicating that with certification, the share of income spent on food among the treated households --even at the lower distrbituion level of expenditure—declined slightly. However, we still observe positive ATTs for low- and middle-income households, implying that in the category of households with and without land certification, the treated low- and middle-income households, have not been favoured by the new Land Act and we do not observe a reduction in food consumption over total consumption. It is worth mentioning the implementation of the Land Act of 1999 generally has no positive impact on low-income households. Hence, economic shocks, such as food price increases,disproportionally increase rural household welfare.Similarly, food poverty does not substantially decrease for the treated low-income households as compared to the treated high-income households.

4.5 Sensitivity Analysis

In this last section, we present sensitivity checking of the ATTs estimators. To estimate ATTs we used matching approaches, which essentially are based on the conditional independence or unconfoudedness assumption. This identification assumption requires an absence of unobserved characteristics which can simultaneously affect treatment assignment and the outcome variable. Such an assumption is important because estimators will no longer be robust if there is any hidden bias. Therefore, checking for such an indentifying restriction has become a major topic in any evaluation study. We check the validity of this assumption by using the rbound test proposed by Rosenbaum P. R.(2002).The rbound test allows us to determine how strongly unobserved characteristics must influence the treatment participation in order to weaken the implications of the matching analysis. We implement the test based on the ado-file (rbound), which allows users to check the sensitivity of the continuous outcome variable. Since most evaluation studies in the existing literature recommends a gamma range between 1.2 to 2 for robust sensitivity check. We also perform a sensitivity check for the lowest critical value of gamma up to 2. The results are found in column three of Table 9 and Table 12 . The overall lowest critical value of the gamma values, range from 1.2 to 2, and varies significantly between Hodges-Lehmann and the 95% confidence interval. A sensitivity check indicates that the lowest critical value of gamma is 2 for the following outcome variables: food consumption, producer's welfare, food producers with primary school education and households without land use certification. The critical value of gamma 2 would require a 100% difference in the odds of participating to deviate the estimated ATTs, implying that the effects of food prices and the Land Act on the outcome variables are not affected by the presence of a hidden bias. However, the lowest critical value ranges between 1.2 and 1.4 for food consumers, implying that the estimated ATT be would altered by the presence of a hidden bias when there is only a 20% to 40% difference between participating and not in the Land Act, 1999. Nevertheless, it should be noted that the insignificanse of the rbound test at gamma 1 presents the worst scenario of the sensitivity analysis. Accordingly, we provide the ATT's for only the food producers, even though our results bears meaningful policy lessons since most food consumers in rural areas are also food producers.

5.0 Conclusion

In this paper we have shown that food consumers tend to lose welfare while gaining welfare as food producers due to an increase in food prices. The welfare gain is much more profound for the poor- and middle-rural producers than it is for rich producers. We argue that rich producers are more likely deriving their income from off farm activities because we observed that as households expenditure

increase the landholding per acres tends to decrease. Furthermore, we estimate the effect of the Land Act on household welfare by using matching methods; we found that the welfare loss is higher for the untreated consumers than for the treated consumers. In particular, treated poor consumers bore much of the burden of the increase in food prices as compared to the treated rich consumers. Conversely, untreated food producers have benefited from the Land Act more than the treated food producers. The effect of the Land Act is wider at the high-end of food expenditure for both food producers and consumers, meaning that the Land Act is not pro poor agricultural based growth. Indeed, rich treated consumers are benefiting from the land reform and so offset the food price shocks. We further analyse the extended model which includes producers' primary education in the ATTs. When we compare the extended model and the baseline (includes both primary and secondary education), we found that the ATTs on the baseline is larger than that of the extended model. We argue that the remaining gap of the ATTs indicate the effect of secondary school on the producer welfare. In other words, treated food producers with at least secondary school, tend to pull away the benefits of food price from the untreated and therefore reduces the ATTs, in comparison to the treated and untreated food producers. In a nutshell, treated food producers with at least a secondary school education, are better off than treated producers with a primary school education. Likewise, untreated food producers are better off than treated food producers, but when producers have at least a secondary school education, the gap between the treated and untreated is reduced significantly. Furthermore, we found that treated households who own land with a title, and in particular rich households, have lower food consumption than untreated households.However, rural food producers have not seen their welfare improve. This is a crucial point, especially in a country where agriculture is the main economic activity, access to land is a fundamental means by which the poor can ensure household food supply and generate income. Rural poverty is strongly associated with poor access to land, either in the form of landlessness or because of insecure and contested land rights. If there is any intervention, then it should target the majority of the poor in terms of a land registry scheme and the redistribution of land. Social provisions, such as education, which seem to improve rural household income, should be emphasized to empower farmers through the acquistion of agricultural skills and improved marketing skills for their products. Education can enhance the understanding of the benefits of holding farm land with well-defined tenure security. Holding land with use certification can encourage an increase in agriculture output and long-term investments, while also saving labour. In doing so, the vulnerability of food price shocks on the rural poor can be reduced. Finally, the post-independence land policy reform led to some challenges being inherited from the previous strucutres, such as farm-pastorals conflicts, land grabbing and bureaucratic

barriers when applying for the Land Use Certificate. Most likely, these have hindered the breakthrough in rural development, and impeded the ability to absorb shocks such as increases in food prices. When these challenges are clearly addressed, rural farmers may benefit from land policy reform.

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Appendix

Table 1: Definition of commodity food group

Group	Group name	Goods/items
1	Rice	all types of rice, paddy and grains
2	Wheat	Bread and dried, all types of Pasta, cookies, cakes, wheat ,flour wheat
3	Beans	beans,
4	Seeds	Legumes and Pulses ,Lentils, peas , other legumes, flour made from legumes, soya beans
5	Cassava	sweet potato, cassava, cassava flavour and other tubers
6	Maize	Maize grains and flavour
7	Vegetables and fruit	Onions, tomatoes, carrots, pumpkins, celery, chilli peppers, and other vegetables, Lemon, papaya, orange, tangerine, banana, apple, pineapple, grape, melon, watermelon, mango, other fruits, cooked banana, ripe banana
8	Meat	dairy Beef, pork, chicken, eggs, other poultry, beef and poultry giblets (liver, tripe, etc), meat by-products (hot dog, sausage, ham, bacon, etc), fresh , Fish, sardines, canned fish, seafood, and other types of fish
9	Milk	milk (evaporated, fresh, powdered ,etc), cheese, yogurt, cream
10	Sugar	Sugar, honey, chocolate, jams, sweets
11	Fats and Oils	Fats and oils, lard, butter, margarine, "mawese", sunflower oil
12	Other food	Salt, tea, coffee, cocoa, foods or meals prepared outside the home, spices , beverages,

Source: Author's formulation and National Bureau of Statistics classifications

Table 2: Descriptive summary

outcome variable	Mean	Std.
Net benefit value (food producers)	0.45	0.79
Net benefit value (food consumers)	-0.38	1.29
Food share	0.78	0.16
variable		
Household size	5.47	2.95
age of head of the household	47.61	15.73
Land size in acre	2.62	5.15
Farm distance to the nearest market (km)	7.13	8.36
Farm distance to the nearest road (km)	1.49	2.74
Male headed household	0.77	0.42
Married headed household	0.78	0.42
*Primary school (head of household)	0.90	0.29
Agriculture work (head of household)	0.85	0.36
*Land use certification (LCU)	0.09	0.28
Treatment		
Treated post Land Act, land ownership	0.39	0.49

Notes: Observations : 1894, Interpretations of the variables are in percentage, variables are dummies 1 and 0 for the corresponding variable, zeros are excluded from the table, The net benefit value is the first order welfare measure, and Agriculture work includes agriculture, livestock and fishing activities.
*Variables used in the extended model, excluded in the baseline model
Source: Author's computation

Table 3: Farm land certification of use(LUC)

		Yes	No	Total
before the Land Act(Control)		125	1,330	1,455
after the Land Act (treatment)		66	559	625
Quintile	1	9	190	199
	2	5	202	207
	3	8	204	212
	4	14	192	206
	5	11	184	195
	6	15	194	209
	7	23	189	212
	8	24	186	210
	9	43	180	223
	10	39	168	207
Total Households		191	1,889	2,080

Source: Author's computation

Table 4: Net compensated variation

Quintile	first order effect				Second order effect			
	Net consumer		Net producer		Net consumer		Net producer	
	Control	treatment	Control	treatment	Control	treatment	Control	treatment
1	-0.64	-0.53	0.49	0.76	-0.15	-0.12	0.87	1.08
2	-0.25	-0.25	0.65	0.51	-0.12	-0.07	1.06	1.12
3	-0.56	-0.28	0.44	0.46	-0.14	-0.06	0.85	0.63
4	-0.55	-0.19	0.55	0.23	-0.10	-0.01	1.08	0.86
5	-0.46	-0.25	0.60	0.35	-0.15	-0.08	0.89	0.78
6	-0.58	-0.19	0.49	0.29	-0.08	-0.25	0.95	0.82
7	-0.24	-0.51	0.47	0.55	-0.10	-0.08	0.99	0.95
8	-0.55	-0.32	0.55	0.37	-0.06	-0.16	0.85	0.69
9	-0.03	-0.45	0.31	0.21	0.03	-0.18	0.86	0.42
10	-0.27	-0.40	0.35	0.25	-0.06	-0.14	0.76	0.57

Source: Author's computation

Table 5: Farm land size (acre) holding for consumers

Quintile	Control	treatment
1	1.95	1.34
2	1.83	1.80
3	2.63	1.88
4	2.49	1.83
5	1.94	2.63
6	2.41	3.53
7	3.12	3.26
8	2.55	2.69
9	3.62	4.97
10	7.32	2.96

Source: Author's estimation

Table 6: Estimate of logit regression

Variables	Coeff.	Exp. Coeff.
Farm occupation	-0.36***	0.70***
	(0.09)	(-3.89)
Male	-0.31**	0.73**
	(0.11)	(-2.82)
Farm distance to nearest road	0.02	1.02
	(0.01)	(1.83)
Married	0.15	1.16
	(0.12)	(1.22)
Farm distance to nearest market	0.00	1.00
	(0.00)	(0.94)
Household size	-0.50***	0.60***
	(0.14)	(-3.57)
Age	-0.10***	0.91***
	(0.02)	(-6.48)
Land size	-0.02	0.979
	(0.01)	(-1.64)
Land size squared	0.00	1.00
	(0.00)	(0.45)
Household size squared	0.02*	1.025*
	(0.01)	(2.16)
Household size and age	0.01**	1.01**
	(0.00)	(3.15)
Age squared	0.00**	1.00**
	(0.00)	(3.03)
Household size cubic	-0.00	1.00
	(0.00)	(-0.67)
Household size squared and age	-0.00	1.00
	(0.00)	(-1.89)
Constant	4.25***	
	(0.51)	
N	1817	
Chi square	316.0	
r2_p	0.130	
Goodness-of-fit test		
Hosmer-Lemeshow Chi-square (8)	8.72	
Prob > chi2 =	0.37	
Balancing property	Satisfied	
# of blocks	6	

Notes: figures in brackets are the standard errors ,
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Author's estimation

Table 7: Balancing test (Matching estimator- nearest neighbour)

	food producers				food consumer			
	Mean				Mean			
Variable	Treated	Control	%bias	p value	Treated	Control	%bias	p value
Farm occupation	0.82	0.84	-4.50	0.44	0.85	0.87	-6.30	0.29
Female	0.76	0.78	-4.70	0.37	0.77	0.78	-1.90	0.74
Distance to nearest road	1.58	1.56	0.90	0.87	1.65	1.59	2.10	0.70
Married	0.79	0.80	-2.70	0.60	0.79	0.81	-3.50	0.53
Distance to nearest market	7.55	7.42	1.50	0.78	7.37	7.34	0.30	0.96
Household size	5.03	4.94	3.00	0.53	5.06	4.96	3.20	0.52
Age	41.02	41.05	-0.20	0.97	40.92	40.96	-0.30	0.96
Land size	2.14	2.13	0.20	0.95	2.24	2.25	-0.20	0.96
Land size squared	15.90	12.29	1.00	0.47	17.47	13.53	1.10	0.48
Household size squared	31.40	30.96	0.70	0.80	31.80	31.10	1.10	0.71
Household size and age	212.27	209.16	1.80	0.69	212.76	209.08	2.20	0.65
Age squared	1874.70	1879.90	-0.30	0.94	1865.20	1870.00	-0.30	0.95
Household size cubic	235.63	234.26	0.10	0.95	240.99	233.27	0.30	0.75
Household size squared and age	1375.90	1365.00	0.30	0.91	1387.80	1358.20	0.80	0.76
	Ps R2	p>chi2	Mean Bias	Median Bias	Ps R2	p>chi2	Mean Bias	Median Bias
Unmatched	0.13	0.00	23.4	17.00	0.126	0.00	23.6	15.5
Matched	0.004	0.938	1.6	1.00	0.005	0.808	1.7	1.1

Source: Author's estimation

Table 8: The Impact of the Land Act and food price on household welfare

	NN1		NN5		Kernel		Radius	
	ATT	S.E.	ATT	S.E.	ATT	S.E.	ATT	S.E.
Food producers	-0.055*	0.027	-0.064**	0.023	-0.062**	0.022**	-0.055**	0.020
		(0.024)		(0.022)		(0.019)		(0.018)
Without	-0.050**	0.020						
		(0.019)						
Food consumers	0.105*	0.057	0.056	0.047	0.048	0.044	0.061	0.040
	0.105	0.051		(0.047)		(0.041)		(0.038)
Without	0.081*	0.040						
	0.081	(0.040)						

Notes: First order welfare effect, figures in brackets are the bootstrapping standard errors ,
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$
Source: Author's estimation

Table 9: The Impact of the Land Act and food price on food producers' welfare-extended model

	Matching estimator nearest neighbor			% bias reduction			
				Matched samples		P-value	P-value
	ATT	S.E.	Gamma	Mean	Median	Matched	Umatched
Primary school	-0.075*	0.034 (0.030) (0.127)	2	3.3	2.5	0.297	0.000
Without LUCs	-0.043	0.029 (0.030)	2	3.9	3.7	0.89	0.000

Notes: We estimated the ATTs for the post primary and LUCs households directly, it turn out that we lose matching power given our covariates characteristics because of limited sample.
figures in brackets are the bootstrapping standard errors ,
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$
Source: Author's estimation

Table 10: Balancing test for nearest neighbour matching - food consumption

	Baseline model				Extended model			
	Mean				Mean			
Variable	Treated	Control	% bias	P-value	Treated	Control	% bias	P-value
Farm occupation	0.82	0.84	-5.30	0.35	0.82	0.87	-14.20	0.04
Female	0.76	0.78	-4.40	0.41	0.78	0.76	4.90	0.45
Distance to nearest road	1.58	1.55	1.10	0.83	1.65	1.64	0.30	0.96
Married	0.79	0.80	-2.80	0.60	0.81	0.80	2.50	0.69
Distance to nearest market	7.58	7.51	0.80	0.89	7.67	6.87	9.10	0.14
Household size	5.04	4.96	2.90	0.54	5.06	4.91	5.30	0.35
Age	41.04	41.03	0.00	0.99	40.53	40.50	0.20	0.97
Land size	2.13	2.10	0.50	0.88	2.41	2.48	-1.40	0.76
Land size squared	15.79	11.71	1.20	0.42	20.47	18.57	0.50	0.81
Household size squared	31.54	31.00	0.90	0.76	31.71	30.60	1.80	0.60
Household and age	213.00	209.38	2.10	0.64	212.48	204.49	4.70	0.40
Age squared	1873.10	1879.40	-0.40	0.93	1833.60	1841.40	-0.50	0.93
Household size cubic	237.23	232.80	0.20	0.85	240.24	228.04	0.60	0.65
Household size squared and age	1384.50	1361.10	0.70	0.80	1390.40	1320.40	2.00	0.53
Land right	-	-	-	-	0.10	0.08	5.70	0.37
	Ps R2	p>chi2	Mean Bias	Med. Bias	Ps R2	p>chi2	Mean Bias	Med. Bias
Unmatched	0.13	0	23.4	17	0.14	0.00	23.20	11.40
Matched	0.004	0.935	1.7	1	0.02	0.18	3.60	2.00

Source: Author's estimation

Table 11: Estimates of the impact of the Land Act on food expenditure (whole sample)

	NN1		NN5		Kernel		Radius	
	ATT	S.E.	ATT	S.E.	ATT	S.E.	ATT	S.E.
Baseline model	0.035*	0.013	0.020	0.010	0.019	0.009	0.013	0.009
		(0.015)		(0.012)		0.011		0.009
Without replacement	0.011	0.009						
		0.008						
Extended model	0.026	0.014	0.024	0.011	0.022	0.010	0.016	0.010
		(0.015)		0.013		0.011		0.010
Without replacement	0.017	0.010						
		0.009						

Notes: First order welfare effect, figures in brackets are the bootstrapping standard errors ,
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
The extended model include land right in the propensity score while the baseline does not include land right
Source: Author's estimation

Table 12: Rosenbaum bounds sensitivity analysis of the outcome variables

	Food producers		Food consumers		Food share	
	95% confidence interval		95% confidence interval		95% confidence interval	
Gamma	Maximam	Maximam	Maximam	Minimum	Maximam	Minimum
1	0.000	0.000	0.036	0.162	0.016	0.050
1.1	0.000	0.000	-0.003	0.201	0.007	0.060
1.2	0.000	0.000	-0.040	0.238	-0.002	0.069
1.3	0.000	0.000	-0.073	0.273	-0.010	0.077
1.4	0.000	0.000	-0.103	0.304	-0.017	0.085
1.5	0.000	0.000	-0.132	0.335	-0.024	0.092
1.6	0.000	0.000	-0.158	0.362	-0.031	0.099
1.7	0.000	0.000	-0.183	0.388	-0.037	0.105
1.8	0.000	0.000	-0.208	0.414	-0.042	0.110
1.9	-0.250	-0.250	-0.230	0.438	-0.048	0.116
2	-0.250	-0.250	-0.251	0.460	-0.053	0.122

Notes: Rosenbaum bounds are the maximum and minimum point 95% confidence intervals. The critical values corresponding to the lowest value of Gamma that produces a confidence interval that encompasses zero.
whole sample of producers and consumers used in estimation for the food share
Source: Author's estimation

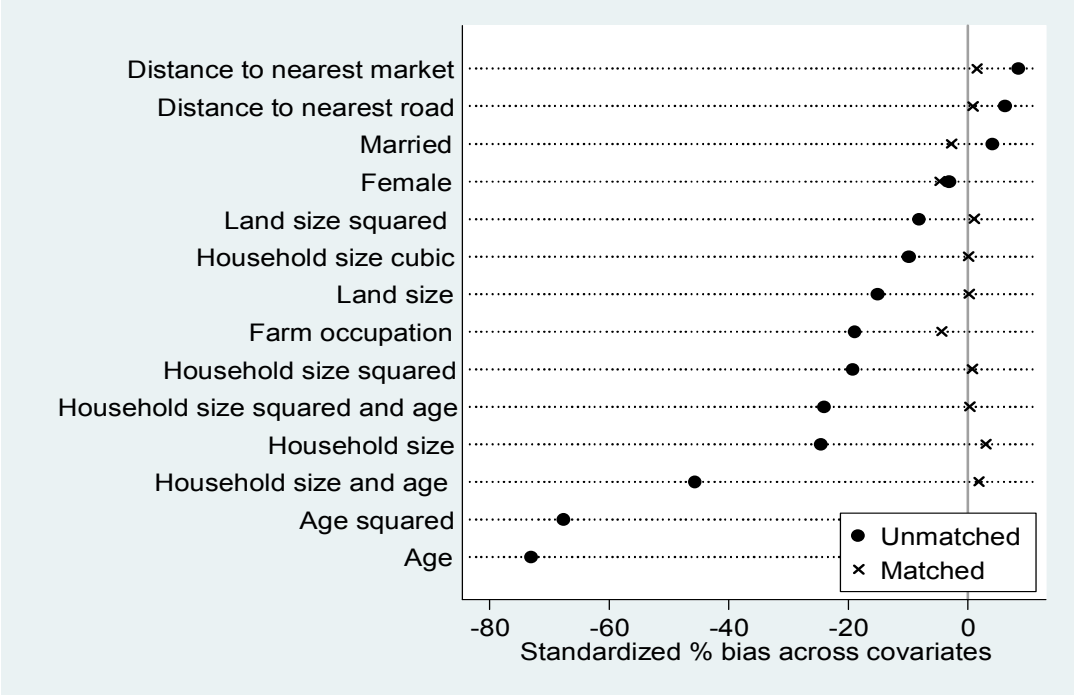

Figure 1a: Bias reduction of the covariates

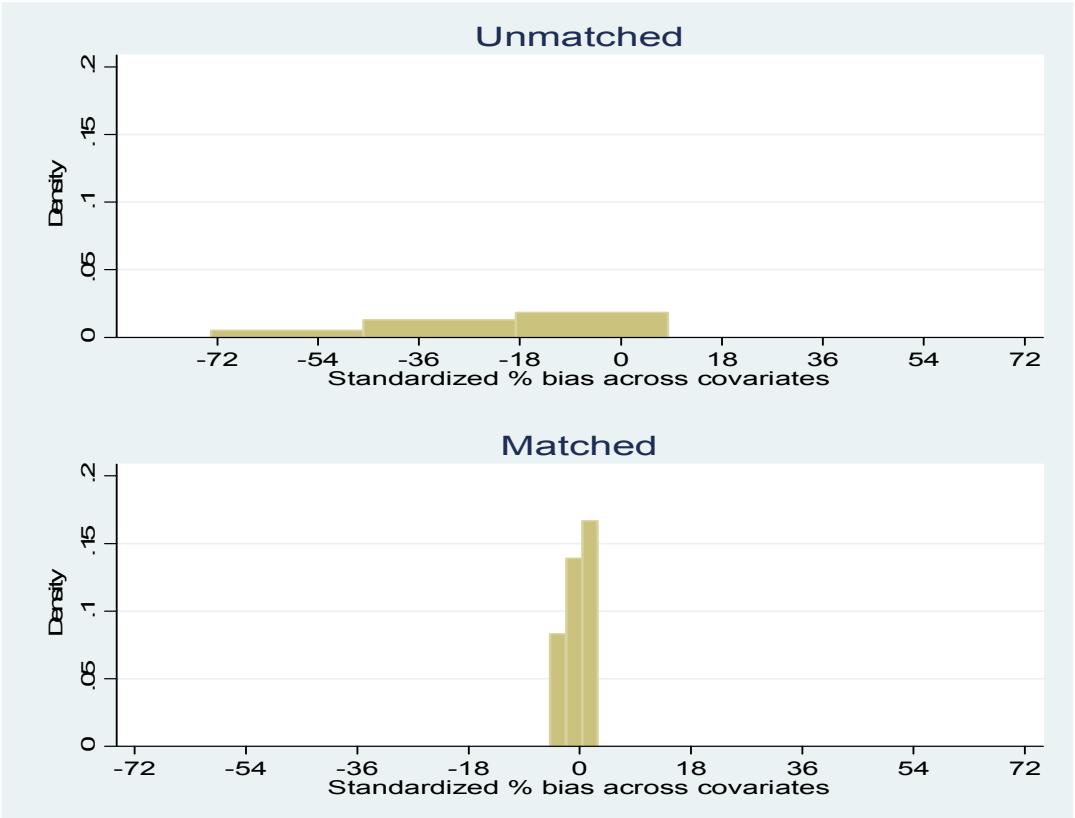

Figure 1b: Bias reduction of the covariates

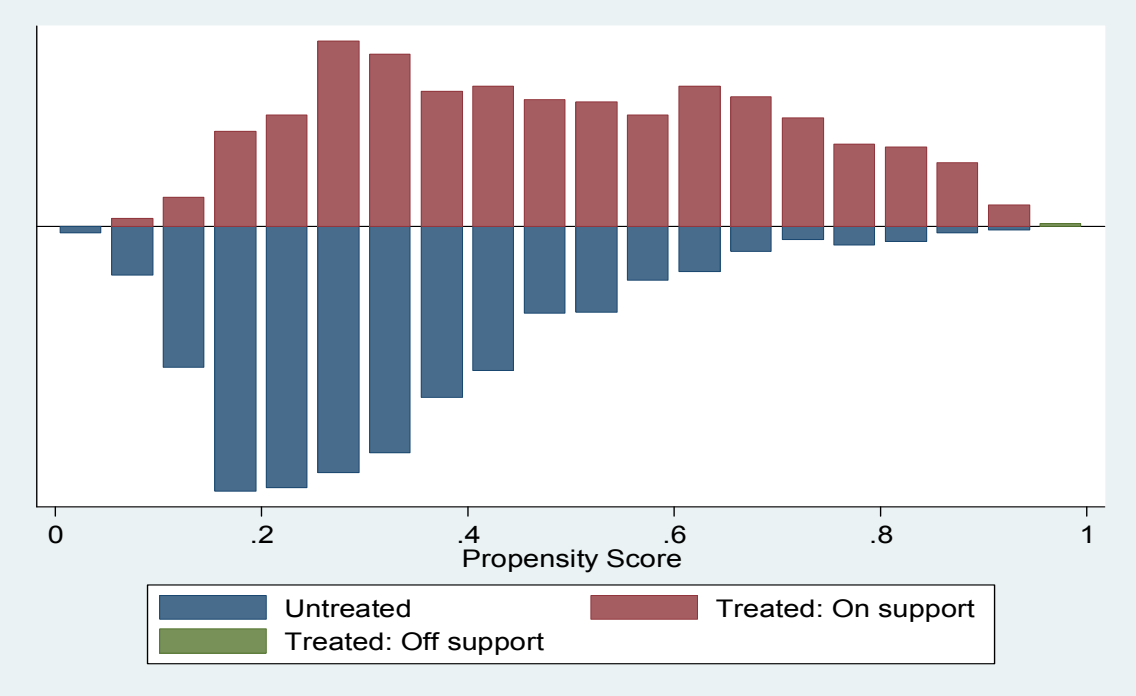

Figure 2a: Balancing test of common support propensity score

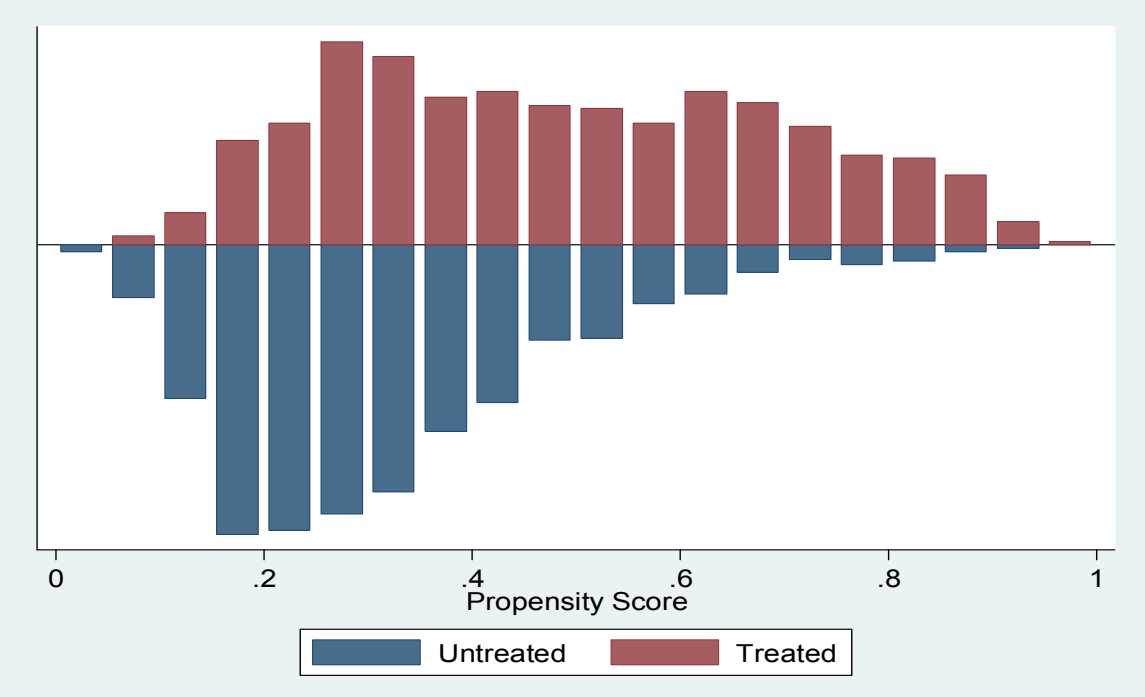

Figure 2b: Balancing test for the propensity score

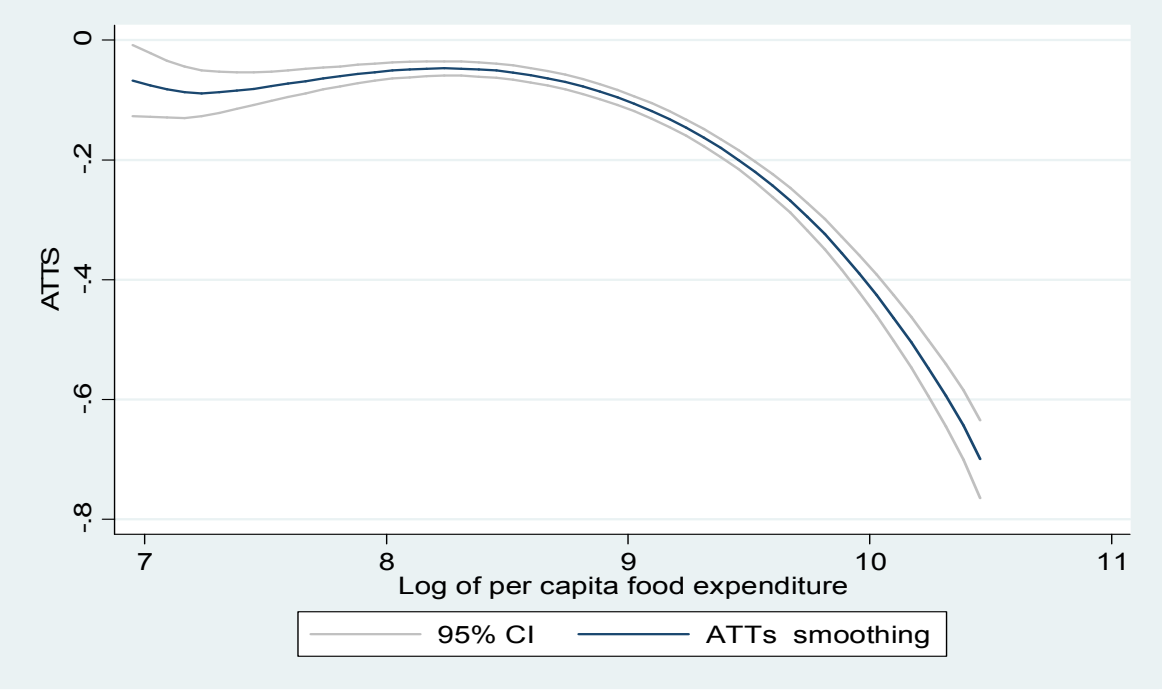

Figure 3a: ATTs for food producers

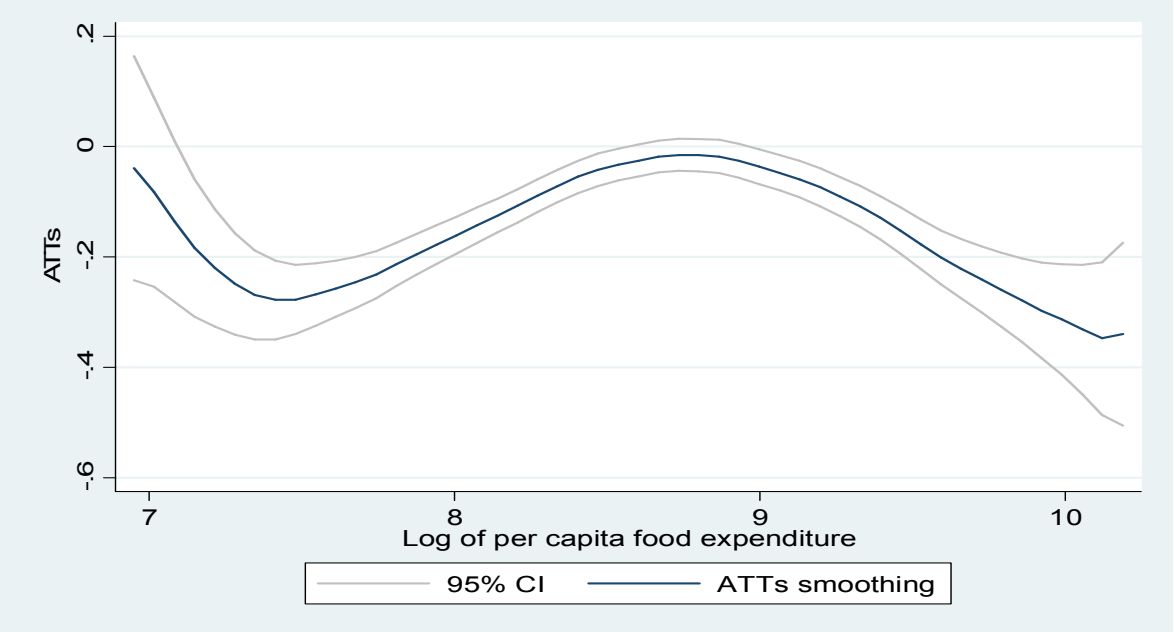

Figure 3b: ATTs for food consumers

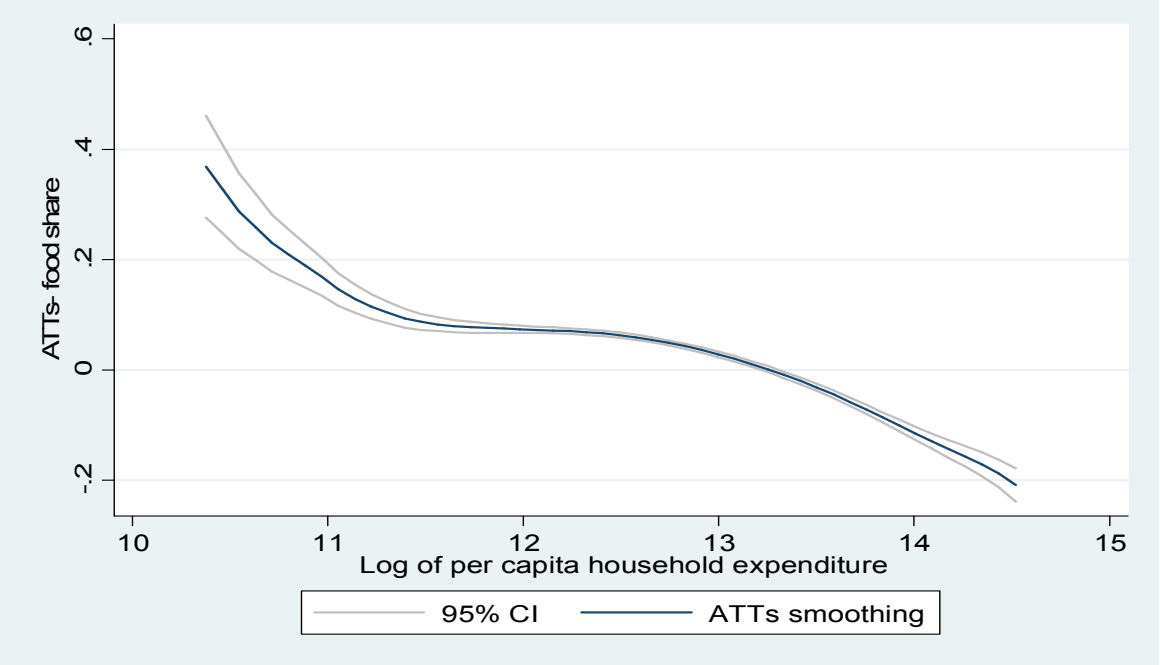

Figure 4a: ATTs of food share (Households without LUCs)

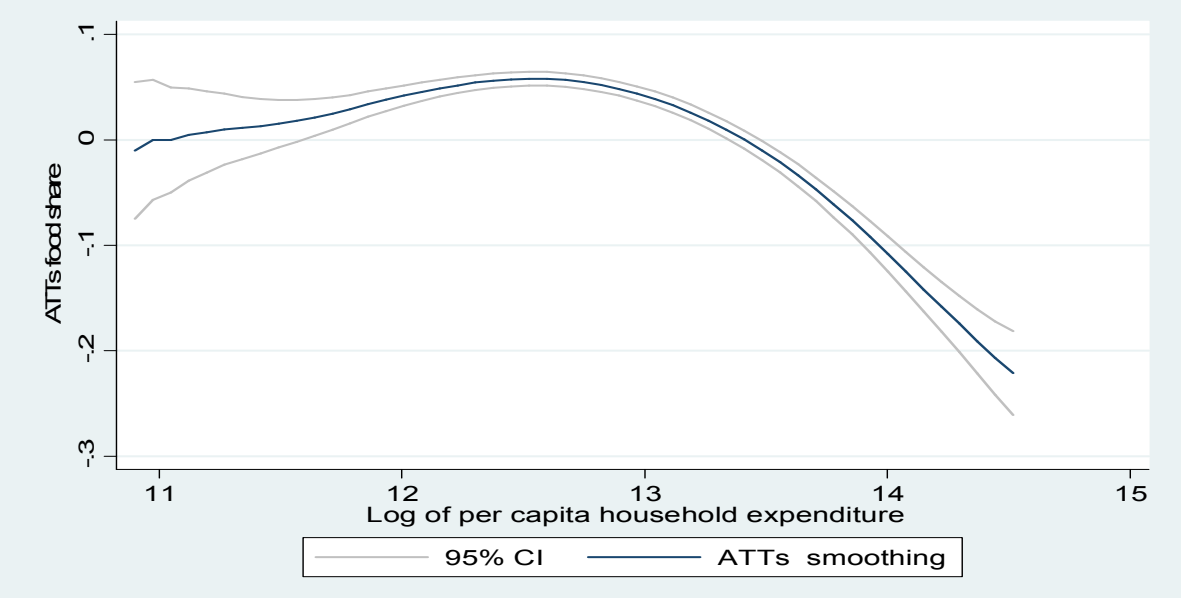

Figure 4b: ATTs of food share (Households with LUCs)