

Productivity duration among farmers in semi arid regions in Zimbabwe

Sanderson Abel

Nelson Mandela University, Port Elizabeth, South Africa
Midlands State University, Gweru, Zimbabwe

Julius Mukarati

Midlands State University,
Gweru, Zimbabwe

Pierre Le Roux

Nelson Mandela University,
Port Elizabeth, South Africa

Tendai Maparara

Midlands State University,
Gweru, Zimbabwe

Nzwirashe Magomana

Great Zimbabwe University,
Masvingo, Zimbabwe

Abstract

This paper applied the concept of survival analysis to estimate productivity duration among A1 farmers in Zimbabwe and to identify the main factors influencing the probability of productivity. The Cox hazard model and the Weibull parametric model were applied in this study to analyse farmer productivity and a sample of 176 randomly selected farmers and a questionnaire was administered to solicit information on the wages, education level and the level of government support in terms of input subsidies. The results showed that educated farmers are more likely to be productive and take lesser time to increase their productivity levels compared to less educated farmers. This then pointed to the fact that the government of Zimbabwe should have targeted the education of farmers first before embarking on resettling the A1 smallholder farmers and this can also be considered in future land reforms. The study recommended that there be farmer education initiatives to speed up their graduation from survivor to hazard farmers.

Keywords: Survival analysis, parametric regression, productivity

1. Introduction

Zimbabwe's agriculture has evolved considerably since the country gained independence in 1980. The country had a diverse agriculture sector comprising of large scale commercial farmers and small holder farmers most in reserve areas. The Zimbabwe government conducted the controversial land redistribution exercise to address land ownership, inequalities however, ever since the land redistribution exercise the country remains a notable global food importer. As a consequence of land reform there was a strong decline in domestic agriculture productivity and increased dependence on imported maize.

The Zimbabwe land reform and resettlement programme was implemented in a fast track manner as it drastically reduced the large scale commercial sector while expanding small scale agriculture sector. Models were designed in order to implement the land reform A1 and A2 where A1 farms were given to the landless people who never owned land before. Under the A1 model scheme, homesteads are in villages with common grazing area and they are self-contained, the A1 plots are used for both livestock and crop production. According to the GOZ (2003) a total of 127,192 households were resettled under the A1 model. Despite being credited with overhauling the racial distribution of land in Zimbabwe, the programme however, was implemented in a violent manner and was associated with significant losses in agricultural production and overall economic performance decline and eventual collapse. (Richardson, 2004). The A1 model farmers are also characterised by communal land ownership land tenure system hence they do not have title deed over the land making them also lack collateral for formal credit access hence can also contribute or worsen the lack of capital due to such credit constraints.

Many imperial studies noted that Zimbabwe has a rich history of agriculture production and the country has been the food basket for the southern African region with production primarily been undertaken by small scale farmers which is characterised by low productivity and inefficient production systems due to lack of capital. The agriculture production has been able to meet the country's overall demand. This net demand has led to increased dependence on food imports and increased exposure of the population to the problem of food security.

The increased risks of food security have motivated the government to introduce a number of policies and initiatives to support the resettled farmers and address the problems surrounding inefficient production among farmers. The government that give support to small holder farmers will boost production through increased efficiency. The policy initiatives that are targeted at improving the production efficiencies of small holder farmers have increased significantly while other farmers are still inefficient producers. The Zimbabwean government supports smallholder farmers through initiatives like Operation Maguta, farm mechanisation, presidential input schemes to mention but a few. There are also many Non-Governmental Organisations (NGOs) which are working directly with smallholder farmers for them to increase their productivity and or commercialise such as Christian Care through conservation agriculture, SNV, Microfinance institutions for the provision of

microfinance services (mainly microcredit, microsavings and microinsurance) since the A1smallholder farmers do not have access to formal credit due to lack of collateral security because they do not have title deeds over their small farms.

Despite the government initiatives to support smallholder A1 resettled farmers in Zimbabwe, many smallholder A1resettled farmers are still producing for their consumption or for their survival without contributing to the national silos. This is evidenced but huge maize and food imports which cumulatively grow from the inception of the Fast Track Land Resettlement exercise in 2000. On other note, the balance of payments position of the nation is dwindling from period to period due to excessive imports including agricultural commodities. Despite the unproductiveness being exacerbated by droughts and floods due to even climate change, under normal circumstances given the period from FTLR exercises, the nation would have been concentrating on the importation of only capital goods rather than agricultural goods and food. From the period the smallholder farmers were resettled, they come to be able to produce beyond consumption at different points in time which we may refer to as graduation from producing only for or below their consumption levels (survivor farmers) to produce in excess for sale (hazard farmers) in line with the description provided in this study. This can also be referred to as commercialisation of smallholder farmers from the output side according to the definition by Osmani & Hossain (2015).

Soon after resettlement most of the farmers were net buyers of food meaning they started producing significantly less than their annual consumption needs and graduated to be able to produce enough for consumption and further graduated to produce in excess of their consumption needs meaning ability to earn income from farming. However it cannot be denied also that some of the farmers are not yet able to produce enough for their consumption meaning they are still net buyers of food while others are also producing only enough for their consumption with others now producing beyond consumption. For the thrust of this study, those farmers who produce on or below their annual consumption needs are considered as survivor farmers while those who graduated to produce in excess are the considered as the hazard farmers.

There is vast empirical literature but mainly concentrated to examining the determinants of commercialisation of smallholder farmers in different parts of the world (Gödecke & Qaim 2020, Rubhara & Mudhara 2019, Ogutu & Qaim. 2019, Carletto et al. 2017; Muricho et al. 2017, Falola et al 2014, Abu 2015, , Berhane & Moti 2010, Davidova et al 2009, Gabre-Madhin et al 2007). The studies reveal that commercialization of smallholder agriculture results in improved productivity, improved incomes, employment growth and poverty reduction. Despite these potential benefits of commercialization, the side risk to the process relatively high costs of investments needed in inputs, labour and machinery and in accessing different markets for sales and processing, among other factors. It is not all the farmers who have the capacity to increase their resilience in line with the different risks which might force them to revert to subsistence agriculture with the pathway dependent on

household asset ownership, especially with imperfect functioning of agricultural factor markets. The commercialization has different effects with lower levels of commercialization associated with lower food availability, access, utilization and stability increasing with intensity of commercialization (Kissoly, Fasse & Grote, 2020). The current study differs from the majority in that instead of examining the determinants of commercialisation of smallholder farmers, it goes further to examine the determinants of the duration taken by smallholder farmers to produce beyond survival/consumption. That is the determinants of the duration smallholder farmers to commercialise of resettled A1 farmers not smallholder farmers in general as anchored from the period of FTLR exercise of 2000.

There are also other studies in Zimbabwe but also examined the determinants of commercialisation of smallholder farmers. Likewise, Kabiti *et al* (2016) examined the factors that enhance smallholder agriculture commercialization in Munyati resettlement area in Zimbabwe. This however was closer to the current study in that it examined resettled farmers but differs in its scope of examination that is it was centred on determinants of commercialisation of smallholder resettled farmers while the scope of this study is on the determinants of the duration taken by smallholder farmers from survivor farmers to hazard farmers.

Most studies of resettled farmers tried to address the determinants of productivity, asset accumulation, diversification, consumption smoothing, welfare indicators or livelihoods (mainly health and child nutrition), food security, gender dimensions, the role of government services and access to and use of resources. In this study, we intend to evaluate the determinants of the duration taken by the resettled farmers to produce beyond their consumption levels that is evaluating the impact of wage rate, government subsidy/support and education levels on the duration taken by the resettled farmers to commercialise through the output route (transition from survivor to hazard farmers).

2. Method

Participants

Survey data was collected from 176 randomly selected farmers in the Masvingo province. The survey mainly targeted A1 resettled farmers who are the beneficiaries of the government resettlement program (Fast Track Land Resettlement Programme) which commenced in the year 2000. The data was collected using a detailed questionnaire. Variables collected include education level of household head, monthly income, and output level and whether the farmer receives government support.

Procedure

In this study, resettled farmers have different productivity levels depending on the income, level of government support and their education level. To analyse the factors that influenced the survival of the farmers, the study adopted both the non-parametric and parametric model. The survival function $s(t)$ is the probability of an individual

farmer survive (remaining less productive) t unit of hire from the beginning of the analysis. The $S(t)$ can be represented as:

$$s(t) = \Pr(T > t) \quad (1)$$

Where, $s(t)$ gives the population probability of surviving beyond t , where T is a random variable called the lifetime/survival time.

The cumulative distribution of T is;

$$P(t) = \Pr(T \leq t) \quad (2)$$

the probability density function is given by:

$$P(t) = \partial p(t)/dt \quad (3)$$

and thus, the probability survival function is:

$$s(t) = 1 - p(t) \quad (4)$$

The hazard function also assesses the risk of demise at time t , conditional on survival to that time and as given as;

$$h(t) = f(t)/s(t). \quad (5)$$

To estimate the survival function (relationship between survival distributions to co-variables) the study applied the Cox proportion hazards model. The linear model for the log hazard can be represented as:

$$\log h_i(t) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k. \quad (6)$$

Where i -represents observation and x are the co variables α -kind of log-baseline hazard. In order to examine the analysis the effects on a unit increase while other covariates are held constant, we also applied the Weibull model. Under this model, the regression coefficient estimates can have negative or positive signs with coefficients that have different magnitude depending on the value of δ .

The survival function in a Weibull model of T at covariate value v will be represented by:

$$v = (1, v_1, \dots, v_p)^T \quad (7)$$

Which will be given by:

$$s(t/v) = \exp\left\{-\left[te^{-vT\beta}\right]^{1/\delta}\right\} \quad (8)$$

Where $\beta = (\beta_0, \dots, \beta_p)^T$ regression coefficients and the log hazard function can be simplified as by:

$$\log \lambda(t/v) = (\alpha - 1) \log t - \log \delta - z^T (\beta/\delta) \quad (9)$$

Where i -represents observation and x are the co variables α -kind of log-baseline hazard. The log model gives the hazard function $a(t) \log h_0(t)$ as

$\log h_i(t) = \alpha(t) + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_k x_{ik}$ which is a semi-parametric model

3. Results

The initial results carried out were that of the cumulative probability and the results are indicated in Table 1.

Table 1: Hazard Probability

Year of study	Risk at the beginning of time t	Hazards at the end of time t	Probability of hazard	Probability of survival	Cumulative probability of survival	Cumulative probability of hazard
2	15	3	0.2	0.8	0.8	0.2

3	12	3	0.25	0.75	0.6	0.4
4	9	2	0.222222	0.777778	0.466667	0.533333
5	7	1	0.142857	0.857143	0.4	0.6
6	6	0	0	1	0.4	0.6
7	6	1	0.166667	0.833333	0.333333	0.666667
8	5	2	0.4	0.6	0.2	0.8
9	3	1	0.333333	0.666667	0.133333	0.866667
10	2	0	0	1	0.133333	0.866667
11	2	0	0	1	0.133333	0.866667

Table 1 reports the survival and the cumulative hazard function for production duration. The survival function represent the proportion of famers who remain less productive as time proceeds and the cumulative hazard function shows the expected number of failures at each observed time. The results in Table 1 show that at the beginning of the study period all the farmers were not very much productive as they were producing only for domestic consumption with very little or nothing being left for commercial purposes. Thus all the resettled farmers were recorded as survivors. At the beginning of two years, 15 farmers were considered as risk and only 3 of these were considered as hazards with a probability of hazards given as 0.2%. In order to determine the survival time of productivity for the resettled farmers Kaplan-Meier survival function was constructed and the results are indicated in Figure 1.

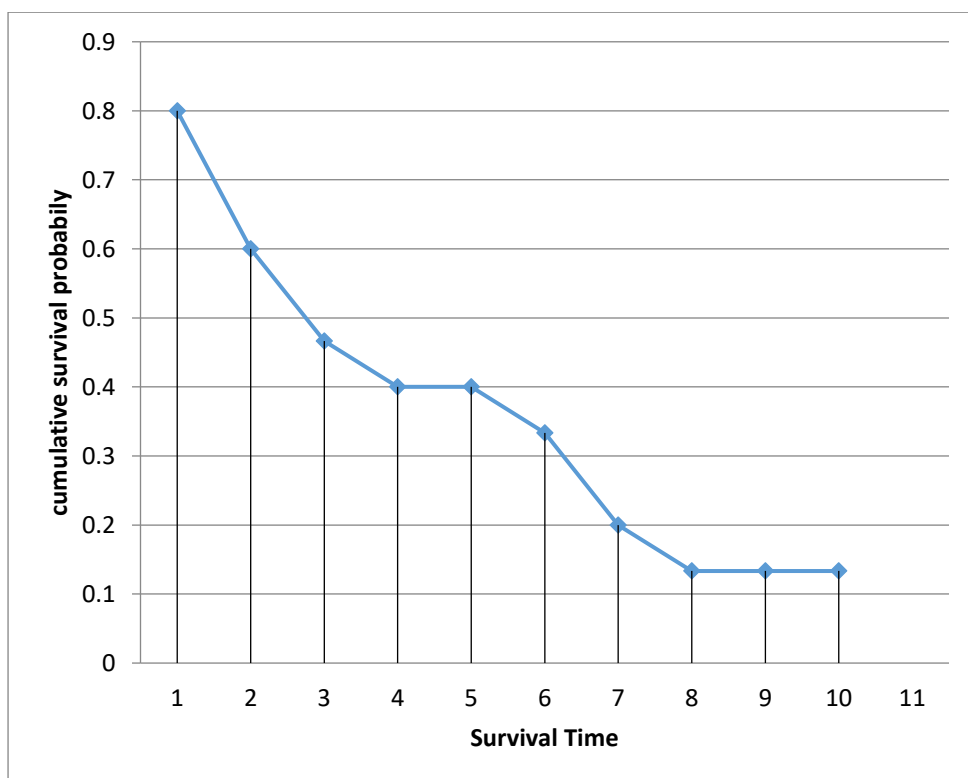


Figure 1: Kaplan-Meier Survival Function

The Kaplan –Meir function measures the fraction of subjects living for a certain amount of time after treatment. As shown in figure 1 above, about 13 percent of the farmers are still surviving after 11 years meaning that the concerned farmers are still not producing enough for both domestic consumption and leaving some for commercial purposes.

Table 2: Parametric regression model

Survival	Cox proportional model	Exponential regression model	Weibull regression model	Gompertz regression model
Log wage	0.537	0.54	0.0095**	0.0303***
Gvt subsidy	-0.636	0.68	-0.6553**	0.1655***
Education	3.3105**	0.074*	1.926*	0.23

Note ***, **, * denotes significance @ 1%, 5% and 10% respectively

The study conducted a number of parametric regression models to analyse the factors that influence the survival of resettled farmers. The results in table-2 showed that only education covariate has a statistically significant coefficient implying that educated farmers have a high probability of increasing the productivity compared to less educated farmers. However, the level of government subsidy and wage was found not be significant.

The exponential regression results (column 3 on Table 2) represent the multiplicative effects of the covariates on the hazard. Thus, holding other covariates constant, increasing education level covariate by one increase the hazard of productivity by 0.074. The justification can be that educated farmers are more likely to adapt to new farming methods and techniques which can increase productivity compared to less educated farmers. This then points to the simple fact that continued support from government to the resettled farmers can be a waste of resources to other farmers whilst beneficial to others if the education aspect is not addressed first.

4. Discussion

The limiting factors in the context of Zimbabwe have been the late disbursement of inputs usually on the presidential input schemes which smallholder farmers usually receive at the middle of the next agricultural season hence the utilisation of such input schemes by the smallholder farmers will not be sustained by the rains in the last segment of the summer season which will be almost dry. Also due to moral hazard and adverse selection, government support might have been directed to lazy and uneducated farmers hence no tangible results can be yielded. Continued dependence on the government by smallholder resettled farmers may also be a result of the way the inputs are distributed by the relevant authorities which may and usually be corrupt and on partisan basis hence the issues of moral hazards and adverse selection will be at play. Also in general, financial support through the availing of credit at concessionary rates failed due to abuse of funds through diversion to other unproductive uses increasing the rising cases of non-performing loans.

Generally smallholder resettled farmers are not motivated to produce beyond consumption due to the nature of pricing of agricultural produce in Zimbabwe under which farmers are just but price takers and in many cases the profits will be very minimal and demotivates farmers to be hazard farmers and continue to be survivor farmers. Inefficient and unreliable financial markets in Zimbabwe also play a significant role in letting down the potential of smallholder farmers due to lack of financially inclusive credit and savings products for the smallholder farmers. This is also exacerbated by the government land policy which does not give title deeds to the A1 resettled farmers leading to no access to the formal financial system for financial assistance meaning the A1 smallholder farmers are generally financially excluded. On another note, land size also contributes immensely towards the productivity of smallholder resettled farmers where they have been allocated land of not more than 10ha per household which makes it also complex for the farmers to be surplus producers given also the fact that the household sizes are big enough to consume all that is produced per season and even to demand more than produced. Also on the part of the government, the pricing of agriculture commodities must be reviewed upwards at the same subsidising with public goods to reduce production costs. Infrastructure development should be prioritised to allow easy connection of the markets and smallholder farmers thereby acting as an incentive for increased farm produce. There are also issues emanating from the liquidity and financial crises which demotivates the smallholder farmers especially on the disbursement of proceeds of the surplus marketed where farmers are having to struggle more in order to access their proceeds as evidenced on tobacco and cotton farmers where others are even regretting on producing in excess against the low prices and late receipt of proceeds. The findings then lead to recommendations that the government should design ways and strategies for educating the resettled farmers since it failed to educate them prior resettlement if and only if the objective of the resettlement exercise was/is to increase productivity and government expenditure through social protection. This can however be done now through the increase in the agriculture extension workers, promotion of field schools and more farmers training workshops through the government and Non-Governmental Organisations. Farmers also continue to be survivors due to their vulnerability to natural disasters such as droughts and floods and often exposed to food insecurity meaning less than enough for consumption will be produced. The government is however supposed to effectively provide infrastructure such as roads for easy accessibility of markets by smallholder farmers if there is need for transforming the smallholder farmers from being survivor farmers to hazard farmers.

Further studies can be carried out which may combine the factors in a translog manner because some factors may not be that significant enough until joined to another variable. Also the addition of some more deterministic variables such as experience, access to credit, household sizes, land tenure systems, gender of household head, prices of agriculture commodities (main motive for commercialisation), land size, crops grown and also translogging the variables to check on joint significance of the variables.

5. Conclusions

In line with the findings of this study, educating farmers will enhance the graduation of farmers from being survivor farmers (subsistence) to hazard farmers (surplus/commercial). Given that educated farmers are able to quickly produce in surplus, meaning they do not need considerable time to be productive, it calls upon the government to consider the levels of education of the farmers from the allocation of land to the landless and also when targeting agriculture support to farmers so that availed funds will yield tangible results to the interventions or any form of treatment. Government support to smallholder resettled farmers proved to be insignificant and this can be attributed to the abuse of support by the receivers be it in cash or kind like inputs (seeds, fertilisers, pesticides).

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