Journal of Natural Sciences Research
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.14, 2016

The Impact of Alternative Livestock Market Choice, Constraints and Opportunities: A Case of Smallholder Farmers in the Southern Communal Area of Namibia.

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Acknowledgement
This research is commissioned by the National Namibian Farmers' Union. Gratitude is hereby expressed for their financial role. Special thanks are owed to the South African Confederation of Agricultural Unions (SACAU), the regional farmers' associations' representatives, communal farmers' associations, communal farmers, auctioneers, livestock transporters, abattoirs and red meat exporters for this contribution towards successful completion of this study.

Abstract
This paper used Regression Adjustment (RA), Inverse-Probability Weighted (IPW) and the Inverse-Probability Weighted (IPW) Regression Adjustment (IPWRA) estimators to estimate the treatment effects of marketing livestock at the informal market relative to other alternative market choices on the farmers' gross margin. Estimation is based on survey data obtained by interviewing livestock farmers in the Southern Communal Area of Namibia. Four treatment levels representing market channels are the informal market, the permit sale, auction market, and abattoir. The estimated Average Treatment Effects (ATE) of patronizing permit instead of the informal market is N$142,701.8. Moving from the informal market to the auction, the estimated ATE is N$224,547; also for a movement from the Informal market to the abattoir ATE is N$605,810.8. Results show that among the farmers who marketed at the alternative markets, there is an increase in their gross margin sales from the average of N$142,012.1 to N$145,343.4 for permit sales, N$236,677.8 for auction sales and N$578,671.3 for the abattoir sales. Quantile estimates of the potential outcome distribution were also calculated to determine whether the treatment affects those farmers at the lower end of the distribution differently from those at the middle or upper end. The result of the quantile estimate was found to be consistent with that of the conditional mean. Overall, the study found that upstream markets are more gross profit enhancing than the downstream markets *ceteris paribus*.
Keywords: treatment effects, average treatment effects, potential outcome framework, potential outcome mean, upstream market, quantile effects.

1. Introduction

There is concern that communal livestock farmers in Namibia do not actually benefit from livestock enterprise because the sector is dominated by oligopolistic market competition whereby the better-resourced merchants that are often vertically integrated foreclose resource poor communal farmers through unfair livestock marketing practices. An example of such practice is the prospecting of rural livestock farmers to buy livestock below average market price. In some instances, there is a chain of organized agents that speculate at the farm gate. This has resulted in years of unprofitable and unsustainable livestock farming enterprise by these communal farmers (National Namibian Farmers Union, 2006, 2015). Intuitively, cognisance is taken of the fact that farm gate marketing does not offer the farmers the opportunity to add as much value as the upstream markets (auction and abattoirs) do. As a result, farmers do not claim sufficient stake of the consumer dollar thus, profitability is limited especially among smallholder farmers.

Perhaps the problem is not limited to the type of market supply channels available to the farmers, other factors might have contributed. For instance, technical, socio-economic and institutional constraints such as transaction cost, poor market infrastructure, weak farmers' cooperative system and farmers' demographic characteristic play an important role however, these concerns are beyond the scope of this study. In an attempt to investigate market choice in this paper, the important question to be answered is which market channel adds the most value to livestock marketing among the smallholder farmers?

Therefore, the main objective of the study is to determine the impact of choosing one market outlet say, informal market sale, instead of choosing another alternative on the gross margin of livestock smallholder communal farmers. In other words, the aim is to establish the linkages amongst the market channels and determine the value adding capabilities with respect to the less likely preferred market option(s). Put differently, does marketing at the upstream market (such as the abattoir and auction) increase farmers' gross margin relative to marketing at the downstream market (such as informal and speculative markets). This investigation is important because normally, farmers would prefer upstream markets such as auction and abattoir where competitive prices are determined by the forces of demand and supply compared to the informal and speculative permit markets which they, because of limited choice, are obliged to patronize more. With improved knowledge about the market constraints and opportunities facing livestock farmers, policy makers are better equipped to design intervention strategies that will improve their relative market positions and thus, their profitability and sustainability. It is these reasons that motivate this study.

The rest of the paper is structured as follows: In section 2, the livestock market distribution is reviewed to highlight the structure and function of the distribution system. In section 3, the material and method used to evaluate treatment effects including the models, model specifications and application are highlighted. The results and discussions are presented in section 4. The outcome of the focus group discussions with farmers about the constraints and opportunities are presented in this section, followed by the results of the empirical analysis of the treatment effects models. Concluding remarks and recommendations are presented in section 5.

2. Sector overview

2.1. The livestock distribution system

The Namibian livestock distribution networks are the informal markets, the wholesalers, and the exporters. The informal market consists of livestock sales by farmers to neighbours and close relatives during marriage ceremonies, funerals, ancestral sacrifices etc. The wholesale distribution network comprises the bulk buyers who buy livestock for processors and the live export markets. The bulk buyers are market agents such as auctioneers, abattoirs, feedlots, permit buyers (speculators), butcheries and supermarket retailers who procure livestock from both commercial and smallholder communal farmers. Auctions, agents, and speculators supply feedlots and the local butchers. There are two categories of livestock agents, those that buy and supply directly to their principal (Auctioneers, abattoirs and feedlots) and those that act on behalf of other agents, in other words, there is a cartel of agents of livestock buyers. This type of relationship has a serious impact on livestock prices because the agents at the farm gate tend to bid too low to accommodate their own profit margin along the chain of agents. Feedlots also have agents that buy for them. They (feedlots) supply both local and export abattoirs that process meat for regional exporters, local markets, regional markets, retailers, and restaurants.

Live export flows from auctions, agents, speculators to the regional exporter and regional markets. Most of the live sales flow through auctions. Figure 1 depicts the distribution of auction kraals in SVCF areas. Most of the auction kraals are situated along major roads and the main settlement areas in the targeted regions. More communal auction kraals are found in large stock production strongholds such as Kunene South, Otjozondjupa and Omaheke regions compared to the sparse distribution in the Hardap and Karas regions with smaller stock than larger stock. The majority of these auctions are poorly equipped. Quality is not standardized while there is some level of quality assurance in some; others are completely negligent, resulting in facilities that have poor pre and post-sales record.

Journal of Natural Sciences Research
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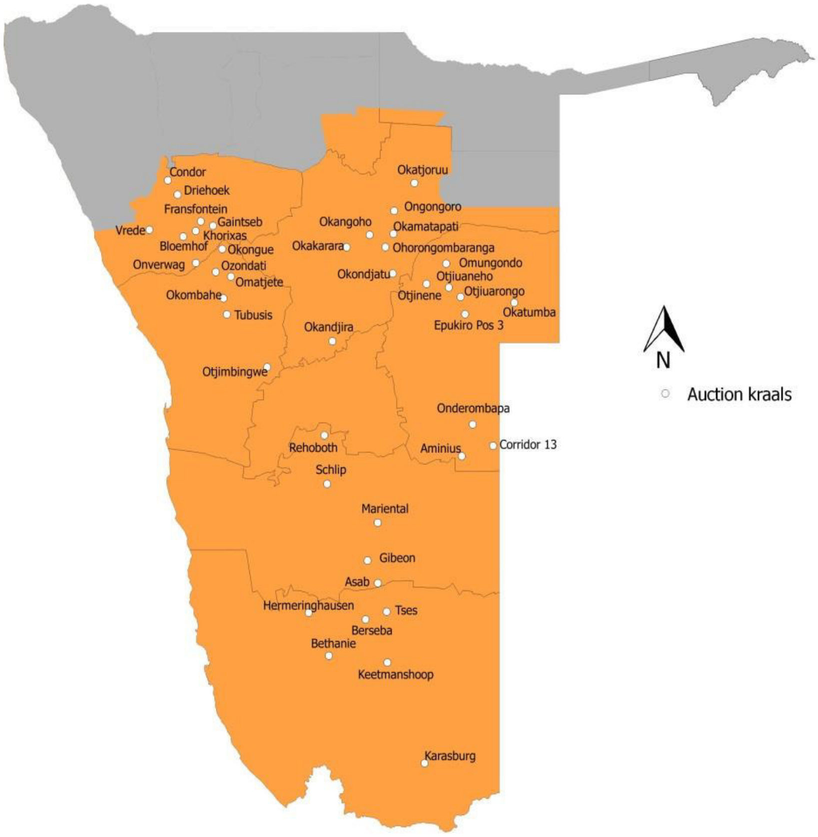

Figure 1: Mapping of auction kraals in the targeted regions
Sources: *Author's computation based on GPS data collected*

Export abattoirs are located in Kavango East, Oshana, Khomas, Omaheke, Zambesi, Hardap and Karas. Meatco is the biggest meat processor and exporter in Namibia with a total number of four abattoirs. The combined maximum cattle slaughter amounts to 215,000 per year and this figure includes the two abattoir facilities north of the Veterinary Cordon Fence (VCF). Most of the abattoirs are located in commercial farming areas except for the Oshakati and Kavango West abattoirs that are only Republic of South Africa (RSA) export approved. Slaughtering facilities in Namibia have an estimated capacity of 243,320 cattle compared to 1,049,600 for sheep per year. The total combined slaughtering capacity for cattle and sheep amounts to 1,296,920. In 2014, the Okahandja abattoir operated at 50.56% of its slaughtering capacity, compared to 96.90% of the Windhoek abattoir while Witvlei only operated at 42.31% of its maximum slaughtering capacity. In the same year, the Oshakati abattoir operated at 25.31% of its cattle slaughtering capacity compared to 53.51% of the Katima Mulilo abattoir. These records are indicative of the fact that the capacity utilization of the mostly rural livestock serving marketing outlets fluctuates more rapidly than the urban. Following their distribution along major routes as indicated previously, it is a major impairment to patronage by communal farmers who dwell in the rural hinterland.

3. Materials and methods

3.1 Sampling

The data for the study was collected through a survey conducted in six regions of the Southern Communal Area namely, Kunene South, Erongo, Omaheke, Otjozondjupa, Karas and Hardap. A consultative workshop was held with major stakeholder prior to the survey. During the workshop, an arrangement was made with traditional council leaders, farmer association representatives and village chiefs who notified farmers of the ongoing survey exercise. Respondents who own cattle, sheep or goat and who are willing to volunteer information were interviewed and the confidentiality of their information and anonymity thereof was guaranteed. Information was gathered by means of a semi-structured open-ended and closed questionnaire. In addition to personal interviews, a participatory focused group discussion (FGD) approach was utilized. During the FGD, farmers and stakeholders were asked to highlight major challenges and opportunities and to suggest the way forward. A total of three hundred and forty farmers, nine members of the farmer associations, three members of the livestock buyers and four auctioneers were interviewed.

3.2 Conceptual framework

The concerns about low profitability in the communal livestock sector are attributed to many factors amongst which is production, institutional and marketing constraints. Some of the challenges include land constraints, the farming system, transaction cost and market access. It is argued that land and production constraints compromise the quality of livestock produced. As a result, market conditions may not be favourable for the constrained farmers in the upstream markets (Auctions and abattoirs) because poor quality livestock cannot be purchased at a premium price. In addition to quality concerns, transaction cost and the other limiting factors also impair upstream marketing, increasing the probability of marketing livestock at the easily available and less competitive markets such as the permit (speculative) market albeit, the fact that sales may be below market price. Nevertheless, these market outlets are more often patronized, not because they are the optimal choice for the livestock farmer (decision maker) but because they are easily accessible, available and relatively cost saving. More often, permit sales are organised at the most financially vulnerable period of the year when the urge to sell livestock at all cost cannot be resisted. Auctions and abattoirs though not devoid of problems are the favourable options but are less likely to be chosen because of high transaction cost and the other alleged anticompetitive foreclosure practices.

To investigate the impact of choosing informal and permit market (as opposed to upstream markets) on the farmers' gross margin, the study adopts a statistical modelling technique known as the treatment effects model. One of the first analysts to apply this model was Rubin in 1974 since then; there is a wide application of the concept in the literature. A treatment effects model evaluates causal relationship between treatment level(s) and outcomes. A treatment effect is a change in an outcome caused by a subject, often an individual getting one treatment instead of another. This type of model is widely used in many areas of science and social science research. For example, it has been used to evaluate the efficiency of a drug in a drug regimen medical research in which a measure of causal impact is the average difference in the outcomes of the treated and the untreated groups (Cameron and Trivedi, 2005). Other examples include the effects of smoking during pregnancy on birthweight**,** the impact of a job-training program in which the earnings of those who participated in the programme and those who did not participate are compared (Ashenfelter, 1978 and Heckman & Robb, 1985) and the impact of class size on students learning etc. Notably, each of these examples depicts a cause and effect relationship whereby the causal variable in some instances constitute individual decision to participate or a designed treatment programme where individual or subjects are selected (Cameron and Trivedi, 2005:32). Treatment could be measured using observational or experimental data. Using observational data, the effects of treatment on a subject or individual can be observed as Y. When a subject is treated, it is denoted as Y_1 and Y_0 when untreated. The gain from treatment or treatment impacts can be obtained by averaging the differences between Y_1 and Y_0 across all the subjects in the dataset. This may be possible if both observations Y_1 and Y_0 are made under identical conditions so that the only difference is the presence or absence of treatment. However, there is a limit to the use of an observational data when the same subject is to be observed as having received treatment and not. This is because only one possible potential outcome can be observed for each individual - a situation referred to as the fundamental problem of causal inference (Holland, 1986). In such instance, a randomized designed experiment is appropriate. However, it is not possible to randomize causal relationship using observational data, as a result, the outcome and treatment are not independent except appropriate conditioning covariates and model estimators are introduced (Holland, 1986 and Stata, 2014). The choice of estimators and the modelling framework for this type of model underpin the type of impact that can be consistently estimated. These are discussed fully in the sections that follow.

3.3 The potential outcome framework (POF)

More insight on the treatment effect estimation can be drawn from the concept of potential outcome framework (POF) (See Rubin, 1974; Holland, 1986; Heckman, 1996; Cameron and Trivedi, 2005; Imbens and Woodridge, 2009; Imbens and Angrist, 1994). The POF assumes that every targeted member of the sample population (subject) is potentially exposed to the treatment and therefore, is capable of being treated or not treated with a potential outcome Y_1 for those that received treatment and Y_0 for those subjects who did not receive treatment. The POF or counterfactual for the treated Y_1 is the outcome Y_0 that would have been observed had they not received treatment, for Y_0, the counterfactual is the observed outcome Y_1 had they received treatment. The problem of observing a counterfactual outcome or missing data is accounted for by using a treatment-effects method. A binary treatment effect can be evaluated by considering the treatment levels $(Y_{1i}, Y_{0i}, w_i), i = 1,.2......N$. Where Y_{1i} and Y_{0i} are the observed and unobserved treatments for the individual i respectively. The w_i is a categorical treatment variable that takes the value of 1 if an individual is treated, otherwise zero for the untreated. Therefore, the POF can be represented as

$$Y_i = \begin{cases} Y_{1i} \text{ if } w_i = 1 \\ Y_{0i} \text{ if } w_i = 0 \end{cases} \quad (1)$$

Similarly,

$$Y_i = (1 - w_i)Y_{0i} + w_i Y_{1i} = Y_{0i} + w_i(Y_{1i} - Y_{0i}) \quad (2)$$

Since it is not possible to observe the full set of potential outcomes given the POF in (1), treatment effects cannot be evaluated at the individual level, because Y_{1i} and Y_{0i} and their difference $(Y_{1i} - Y_{0i})$ are random variables that potentially vary across individuals in the sample population. Therefore, average causal effects are estimated when evaluating the effects of treatment on outcomes. The treatment parameters that are usually estimated are: (a) the Potential outcome Means (POM), that is, the average potential outcome for the treatment level is the means of Y_{1i} and Y_{0i} in the sample population, (b) the average treatment effects (ATE) – the means of the difference $(Y_{1i} - Y_{0i})$, (c) the Average Treatment Effect on the Treated (ATET) – the mean of the difference $(Y_{1i} - Y_{0i})$ among the subjects that actually received treatment.

According to Cameron and Trivedi (2005:33), the effect of the treatment w on the outcome of an individual i is measured by $(Y_{1i} - Y_{0i})$, whereas, the average causal effects of $w_i = 1$, relative to $w_i = 0$, is measured by the ATE:

$$ATE = E[Y_{1i} \mid w = 1] - E[Y_{0i} \mid w = 0] \quad (3)$$

The ATET is measured as:

$$E[Y_{1i} - Y_{0i} \mid w_i = 1] = E[Y_{1i} \mid w = 1] - E[Y_{0i} \mid w_i = 1] \quad (4)$$

The POM is measured as:

$$POM = E(Y_1) \quad (5)$$

In contrast to the binary treatment effects model given in equations (1) and (2), multiple treatment models are specified where the treatment levels are multiple or multivalued. Cattaneo (2010), argue that though a binary treatment effect has a wider application in the literature; it amounts to a considerable loss of information when used to evaluate programmes of multivalued-nature. When additional information is available, binary treatment cannot capture non-linearities and differential effects across treatment levels, which, with multivalued treatment results in efficiency gain. Following Cattaneo, Drukker, and Hollard (2013), multivalued treatment model can be specified as follows. Consider a sample n with treatment $J+1$ assigned to individuals where $j = 0, 1, \ldots J$. For each individual $i = 1, 2, \ldots n$, assume random observed vector,

$$z_i = (y_i, t_i, x_i')' \quad (6)$$

where y_i is the observed outcome variable, t_i is the treatment level, x_i is a vector of covariates. The covariate may affect the outcome or the treatment levels or there may be some elements of the covariate that affect both. As specified above, consider a categorical variable $w_i(j) = 1(t_i = j)$, where w_i is as indicated. The observed outcome can be represented as

$$y_i = w_{0i}y_{0i} + w_{1i}y_{1i} + \ldots w_{Ji}y_{Ji} \quad (7)$$

where $\{y_{0i}, y_{1i}, \ldots, y_{Ji}\}$, is assumed an independently and identically distributed $(i.i.d)$ draws for each individual $i = 1, 2, \ldots n$. The $i.i.d$ assumption implies that the potential outcomes and treatment status of each individual are unrelated to the potential outcome and treatment statuses of all other individuals in the population (Drukker, 2014). The distribution of the outcome variable $y(j)$ will be observed if individuals receive treatment level j.

The specifications in equations (7) can be used to evaluate treatment effect in both experimental and observational data save for one major problem. There is no random assignment of treatment for the observational data. In this instance, the treatment and the outcome are not independent. This problem is resolved by conditioning treatment on covariates as shown in equation (6). The conditioning independence assumption (CI) also known as the selection on observable assumption, states that conditional on x, the outcomes are independent of treatment, as long as participation in the treatment does not correlate with the outcome (Cameron and Trivedi, 2005; Drukker, 2014, Cattaneo et al 2013; Stata, 2014). This is a type of random treatment assignment for each treatment level conditional on observable similar characteristic among individuals. This assumption rules out the presence of observed characteristics (interaction) among the individuals that could affect both the treatment and the outcome (Drukker, 2014, Cattaneo et al 2013; Stata, 2014). Introducing the conditional independence assumption into the specification in the model, the ATE and ATET equations become:

$$ATE = E[Y_{1i} \mid x, w=1] - E[Y_{0i} \mid x, w_i = 0] \qquad (8)$$

And

$$ATET = E[Y_{1i} - Y_{0i} \mid x, w_i = 1] = E[Y_{1i} \mid x, w=1] - E[Y_{0i} \mid x, w_i = 1] \qquad (9)$$

3.4 Statistical techniques for estimating treatment effects

3.4.1 The conditional mean effects

Because of the problem of missing data, treatment effects evaluation is based on the estimation of auxiliary models whereby the parameter of an auxiliary model is used to condition on the covariate in order to correct for the correlation between treatment and outcome. The conditioning largely depends on the functional form of the outcome variable and the treatment process. Treatment effect estimators use different functional forms to estimate the conditional mean, the probability of treatment or both conditional on sets of assumptions that permit identification of causal effects such as the conditional independence (CI) assumption, the independently and identically distributed $(i.i.d)$ assumptions that were described previously, and the overlap assumptions. The overlap assumption is assumed so that any individual could receive any treatment level.

The commonly used estimation estimators used in this study for the multivalued treatment effect models are the Regression Adjustment (RA) estimators, the Inverse-Probability Weighted (IPW) estimators, the Augmented IPW estimators (AIPW), and the Inverse-Probability weighted Regression-Adjusted (IPWRA) estimators.

The CI assumption imply that there are two estimable models $E(Y_1 \mid x, w=1)$ and $E(Y_0 \mid x, w=0)$. The RA estimators run a separate regression for each treatment level and then use the means of the predicted outcomes for each treatment to estimate each POM, thus calculating the ATE and ATETs as the differences in the estimated POMs. The ATEs are the differences in the estimated POMs, whereas, the ATETs are the averages of the predicted outcomes over the treated observations.

The IPW estimators use the weighted averages of the observed outcome variable by the inverse of the probability that it is observed, to estimate the means of the potential outcomes thus, accounting for the missing data inherent in the POF described previously. During the IPW estimation process, observations that are not likely to contain missing data get a weight close to one; otherwise, they get a weight larger than one or even more than one (Drukker, 2014 and Stata, 2014). Assume the outcome variable Y, treatment variable $w \in \{0, 1\}$, and potential outcomes Y_1 and Y_0. To estimate the POM for $E(Y_1 \mid x, w=1) = E(Y_1)$ using observed data, $Y_i w_i$ is Y_{1i} when $w=1$, hence it is unobserved if $w_i = 0$. The IPW estimator for $E(Y_1)$ is

$$E(Y_1) = \frac{1}{N}\sum_{i=1}^{N} Y_i w_i / p(x_i) \qquad (10)$$

Where $p(x_i)$ is the probability that $w_i = 1$ which is a function of x_i. If Y_{1i} is observed the weights will be equal to 1. More information about RA and IPW estimation can be found in Woodridge (2002, 2010), Hirano Imbens and Ridder (2003), Cameron and Trivedi (2005), Imbens (2000), Curtis, Hammill, Eisenstein, Kramer, Anstrom (2007), Firpo (2007).

The AIPW is the IPW estimator that includes an augmentation term that corrects for model misspecification. Its estimation combines the features of RA and IPW methods to estimate POM and the ATEs. It can be used to estimates both the outcome mean and the treatment probability. An advantage of the AIPW is that it has double robust features and is more efficient than RA and IPW estimator especially when either outcome or treatment model is not correctly specified. It emerges from a general technique of creating efficient estimators such as the efficient-influence function (EIF) estimator. The IPWRA is a combination of IPW and RA features. Estimated inverse-probability weights are used to fit weighted-regression models of the outcome to obtain treatment-specific predicted outcomes and their means which are averaged to calculate the ATEs and the ATETs.

3.4.2 The quantile effects

The treatment effects estimation procedures described above are implemented in Stata using *teffects* command. In addition to *teffects* command, other user-written commands can be used to estimate causal effects. Cattaneo *et* *al.,* (2013), used *poparms*[1] commands to estimate the conditional means and quantiles of the potential outcome distribution. For comparison, both *teffects* and *poparms* commands are adopted and both conditional mean and the quantile treatment effects were estimated in this study. The aim of estimating quantile effects is to determine the effects of treatment on the dispersion of an outcome or the effects on the different quantile (lower or upper tail) of the outcome distribution (Firpo, 2007). Quantile estimation is justified because of the heterogeneity that exists among outcome variables. To account for the heterogeneity, differences in the quantile estimates of the outcome distribution at individual levels are compared to determine if individual rank in the distribution are maintained irrespective of treatment status. In other words, it is expected that the rank of an individual relative to another should remain the same irrespective of the treatment level received. This assumption is referred to as the rank preservation assumption (Heckman, Smith and Clement, 1997; Firpo, 2007 and Cattaneo *et al.,* 2013). Using this assumption, overall quantile treatment effects is estimated as the measure of the horizontal distance between two cumulative outcome distribution function that is, the distribution of the outcome for the treated and the non-treated individuals (Imbens, 2004; Hirano, Imbens, and Ridder, 2003 and Firpo, 2007). The parameter for the quantile treatment effects can be specified as follows:

Consider the treatment variable w, for an individual i , if $w_i = 1,\ Y_{1i}$ is observed otherwise Y_{0i} is observed. Let the observed outcome be $Y_i = Y_{1i} w_i + Y_{10}(1 - w)$, and the covariates x_i is represented as $X \subset \Re^r$. Let τ be a real number in (0,1), the parameter can be expressed as[2]:

$$\Delta_\tau = q_{1,\tau} - q_{0,\tau} \text{ where } q_{j,\tau} \equiv \inf_q \Pr[Y_j \le q] \ge \tau,\ j = 0, 1 \quad (11)$$

3.5 Model Application

The treatment effect concept was applied on the communal livestock data collected during the survey period described previously. The potential outcome framework was adopted to analyse the data using Stata 13. In the context of this study, a treatment is regarded as the sale of livestock by farmers to a particular market outlet; the outcome is the gross margin. Therefore, the treatment evaluation involves the inference of a causal connection between market patronage and the gross margin, that is, the impact of the choice of selling to the informal market relative to the foregone alternative upstream market on the farmers' gross margin. Four treatment levels representing market channels were chosen. These are the informal market, permit sale, auction market and abattoir. An important question to be resolved with the models is how the outcome of an average untreated individual farmer would change if such a person were to receive an alternative treatment. Untreated farmers are farmers who traded their livestock mainly at the downstream informal market. Farmers are said to be in the treated category if they traded at the upstream market.

The model framework used in this study is the multivalued treatment in which each subject could receive one of the several different treatments (i.e., they can sell to one or several outlets) or else not sell at all. The data consist of both continuous and binary observational data. The outcome variable is the farmers' gross margin sales measured in Namibian dollars while the conditioning covariates are the farmer's age, farm experience, non-farm income, input costs, farm credit and a categorical variable indicating whether the farmer is a member of a cooperative or not (Memcop). These sets of covariates are assumed to affect both outcome and the treatment assignment of the individual farmers but are not correlated across individuals. The variables such as, age, farm experience, and non-farm income, are assumed to affect treatment level. This is because the older and experienced farmers may make a better market decision than younger and inexperienced once. In the same manner, farmers that engaged in off-farm activities may likely be less financially constrained than their peers who, due to cash constraints may be obliged to patronize market outlet that is not optimal. Other variables such as farm input cost, farm credit and membership of a cooperative were included as covariates because a marginal increase in farm cost might affect the choice of market outlet whereby, the less optimal, easily available market outlet might be chosen.

4. The results and discussion

4.1 Marketing constrains

4.1.1 Farm-level Focussed Group Discussions (FGD)

Two approaches were followed to analyse the constraints at the farm level. The approaches are (a) A Focused Group Discussion (FGD) and (b) a face-to-face interview with the farmers. An FGD approach is a type of participatory approach to the problem, whereby, groups of farmers interactively discuss and analyse the constraints and opportunities they encounter in their day-to-day livestock production and marketing activities. The FGD sessions also received questions about clarity, suggestions, and the way forward.

[1] For more information on *poparms* see Cattaneo *et al.,* (2013).
[2] For details on the technical specification of the quantile effects see Firpo, (2007), and Cattaneo *et al.,* (2013)

Factors militating against livestock marketing in the communal areas were the key issues discussed. The discussions centred on livestock marketing channels such as auction pens, abattoirs and the private livestock buyers (speculators). There was a strong concern about the impact of livestock price signal from neighbouring country South Africa which is a major export destination of the Namibian livestock. Price changes in South African livestock market tend to have a spill-over effect on the Namibian market leading to uncertainty in farmers' expectations. When input prices in South Africa increase, the cost of raising livestock at the feedlots increase, thus the demand for export in Namibia decreases as feedlots in South African are constrained to expand their operation. As a result, livestock buyers in Namibia (mainly speculators) exploit the situation and buy livestock at reduced prices which the resell at a later stage for at a higher margin. Another constraint identified was the issue of transaction cost. Farmers claim that the cost of transacting at the auctions is too high. Their transaction costs include (a) transportation cost; (b) cost of obtaining and returning permits, (c) auction commission, and (d) the cost of cashing the auction cheques at the bank. According to the farmers, auction commission is 6% which is high and the average cost of transporting livestock is: cattle- N$300 per Large Stock Unit (LSU), sheep and goat – N$200 per Small Stock Unit (SSU). The cost of taking and returning permits is location specific, in some areas, permits are returned by agents. Service charge at the bank is N$58-N$60 per cheque excluding monthly charges on the account. Because of these transaction costs, farmers have no choice than to sell livestock at give-away prices at the expense of profitability instead of returning home with them.

Human factor was strongly identified by farmers for not getting good value for their livestock at the auction market. These include amongst others; discriminatory auction bidding, collusion and the absence of weighing scale at most auctions in the communal areas. According to the farmers, auctioneers give preferential treatment to commercial farmers by reserving and allocating auction kraals solely to them. There is a gross misconduct by bidders during bidding by way of winking, gesticulating and prospecting for a higher bid for certain farmers in order to bias price in their favour while they bid too low for the unfavoured ones. In some instances, collusion and price fixing between the bidders and the buyers have been observed, whereby a pre-arranged price ceiling was never exceeded. Farmers also expressed their dissatisfaction about how livestock is handled prior to auction at the auction pen. Ill-treatment of animals often results in bruises, animal stress and in some occasion death. Bruises reduce the market value of the livestock resulting in loss of profit. No compensation of any sort is given to farmers in cases where there is a loss of revenue due to the ill-treatment of the animal.

The constraints encountered by farmers who marketed in abattoirs were also noted. Communal farmers would prefer to sell their livestock as the need arises, but they cannot do so if they want to market at the abattoirs. This is because abattoirs subject their livestock to two weeks quarantine. This is a precautionary measure that ensures sick animals do not enter the food chain, but with regards to the communal farmers, it is an entry barrier. Other entry barriers to marketing in abattoirs include; (a) stringent supply quota system, (b) stringent minimum requirement on livestock weight, (c) registration fees, (d) high slaughter fees and (e) the issuing of crossed cheques. Abattoir takes a few number of livestock supply per day. If the number is exceeded, no livestock will be accepted. This is a capacity constraint applicable to most abattoir especially the low throughput ones. The requirement on livestock weight is an entry barrier to communal farmers who seldom produce high-quality livestock. As a result, communal farmers do not usually market their livestock at the abattoirs. Abattoirs require registration and slaughter fee, which together with transport and other costs contributes to increased transaction cost. Crossed cheques are issued by abattoirs, which imply that farmers cannot cash them over the counter. Clearing of cheques takes a minimum of four working days, whereas farmers have immediate needs to cater for. The farmers recognize the need to market at abattoirs, but strongly stressed the need for more abattoirs in the communal areas that will be specifically tailored to their needs.

The sale of livestock to permit private buyers (Speculators) also has its own problems. As mentioned previously, permit (speculative) buying creates more problem than solutions. They are usually agents of an agent who buys specifically for export (South African) market. The chain of representation in most cases can be alarming. This is because speculators are agents of an agent; they buy at a price that ensures a stake for themselves and their employer. Therefore, speculative prices are usually low and may be correlated with the length of the speculative chain. The shorter the chain, the more they will be willing to pay for livestock bought on the communal farms. Because of the permit system, speculators are permitted to possess livestock even at the farm gate. This reduces the transport cost of travelling to auctions and abattoir but denies the farmers the opportunity of adding value down the value chain. Although they need a permit, farmers' report that some speculators do not operate with permits and often operate till it is dark in the evening. This encourages theft and the sale of stolen livestock to them.

4.1.2 Constraints to livestock marketing in the communal areas

In the previous section, the outcome of the farmer's focused group discussions was analysed, in this section, a summary of the overall challenges stressed by farmers during the face-to-face interviews are discussed. The identified challenges in the two sessions are overarching, therefore, further insight is laid to the identified challenges especially those not discussed at length in the previous section. The constraints are broadly classified into market-price related problems discussed above, production bottlenecks, poor marketing infrastructure, lack of adequate institutional support and logistics. Overall, everything cascades into the problem of low profitability and lack of sustainability in the communal livestock farming enterprise.

4.2.3 Production related constraints

Apart from marketing constraints discussed in the previous sections, factors related to livestock production are important because they also contribute to low profitability in the sector. The identified production related challenges include; (a) high cost of production, (b) lack of adequate land holding capacity, (c) limited rainfall/ periodic drought, (d) open land grazing system and (e) Land tax – grazing fee. High input costs such as feed, licks, medicines, contribute to increases in production cost. The communal farmers lack the financial resources to procure inputs regularly as a result; they do not produce according to market requirements. Consequently, they cannot competitively exploit the end market. Another major production constraint is the lack of adequate land holding capacity by individual farmers. The capacity of the communal land is not enough for a large number of farmers resulting in overcrowding and overgrazing. In addition, there is no reserved land for fattening livestock before marketing. In some areas such as Rehoboth, farmers pay land tax in the form of a grazing fee, (cattle-N$5 and sheep/goat- N$2 per livestock per month) which amounts to additional transaction cost. Other production related challenges are the use of open grazing land system – no fences. The magnitude of the problems related to open land grazing such as theft, predation and diseases are alarming.

4.1.4 Marketing infrastructural constraints

Access roads to most areas in the regions are not easily navigable especially during the rainy seasons. The roads are bumpy and dusty with gravel and potholes. The more remote the roads are the more difficult and inconveniencing it is to access market. Also, information dissemination becomes problematic in the rural areas because efficient and effective means of communication such as radios, newspapers, internets, cell phone services, and Short Message Services (SMS) are limited in the rural areas. However, farmers identify radio as the most accessible means of communication.

4.1.5 Institutional support constraints

Institutional support such as credit and training are important factors influencing the success of agribusiness enterprises. The study investigated the magnitude of institutional support by asking farmers whether they have ever received financial assistance from any institution. The report shows that only 15% of the interviewed farmers have received farm loans for the purchase of livestock. This is an indication that there is no sufficient financial support at the communal level. Also, there is a need to train farmers on essential farm management practices such as animal health, breeding, and disease management. Good management practices will ensure that farmers know the quality requirement of the market.

4.2 Empirical result of the multi-valued causal effect models

This section presents the results for the treatment effect conditional mean and quantile estimates implemented with *teffects* and *poparms* in Stata. The mean of the farmers' gross income summed over the four treatment levels namely: informal market, permit sales, auction market and abattoirs were first estimated as shown in Table 1. The results show that the average mean of the gross income for the farmers who marketed in the informal markets during the one year calendar month was N$116,796.3. The estimated mean for the other outlets are; N$287,355.5 for permit sales, N$356,099.9 for auction market and N$425,578 for the abattoir. The results show that the mean sale increases as the treatment level go from the informal market, the permit sales, to the abattoir. There is an indication that the sale of livestock on the selected market channels had a positive and statistically significant impact on the farmers' gross margin (Table 1).

Table 1 Estimated mean of the farmers' gross margin sales

Market channel	Mean	Stand error	Confidence Interval	
Informal market	N$116,796.30	37089.83	N$43,841.16	N$189,751.50
Permit sales	N$287,355.50	51387.61	N$186,276.80	N$388,434.20
Auction	N$356,099.90	67716.29	N$222,902.90	N$489,297.00
Abattoir	N$425,578.00	159259.50	N$112,316.60	N$738,839.30
Observation	340			

Applying the concept of POF, the study explores the effects the treatment levels would have on the farmers' gross margin after controlling for the characteristics of each individual in the sample population. The estimated means of the potential distribution of the outcome variable is shown in Table 2. The estimates were obtained with *teffects* using RA estimators and *poparms* using IPW and EIF. The informal market was used as a reference level in the model, therefore; the results are interpreted by comparing the reference level with the others. It can be seen from Table 2 that the POM of the control reference (informal market) is N$130,826.8. This is the average annual gross margin for a farmer who marketed in the informal market. The estimated ATE of patronizing permit market instead of the informal market that is, moving from selling at the informal market to the permit sale is N$142,701.8. Moving from the informal market to the auction, the estimated ATE is N$224,547, also for a movement from the Informal market to the abattoir ATE is N$605,810.8. The results are all statistically significant. The estimated result shows that average treatment effects increase with treatment levels. The percentage changes in the gross margin of the farmers from the reference market (informal market) to the permit market, auction, and the abattoir are 9%, 72%, and 363% respectively. This implies marketing at the permit market instead of the informal market does not increase gross margin as much as moving from informal market to auction and abattoir. In other words, permit sales do not add much value to the farmers compared to auction and abattoir sales. This is because the transaction cost saved by the farmer marketing in a nearby village where permit speculative market holds is offset by the loss of revenue due to lower bargain on livestock prices. In comparison, results obtained with *poparms* models are larger than *teffects* model. The results of both models are statistically significant.

Table 2 The estimated means of the potential distribution of the outcome variable

Treatment effects	Market channel	*Teffects* coefficients	*Poparms* coefficients
ATE	Permit vs Informal	N$142,701.8** (0.0260)	N$280,409.70*** (0.000)
	Auction vs Informal	N$224,547*** (0.0030)	N$345,175.50*** (0.0000)
	Abattoir vs Informal	N$605,810.8** (0.0360)	N$660,860.80*** (0.0050)
POM	Informal market	N$130,826.8*** (0.0020)	N$153,249.20*** (0.0030)
Observation		340	340

Note: Note: *, **, *** indicates statistical significance at the 10%, 5% and 1% statistical significance. The figures in Parenthesis are the p-values.

The models under *teffects* and *poparms* were also used to compare adjacent treatment effects. The aim is to determine effects of moving from one adjacent treatment level to another. The result in Table 3 indicate that moving from informal market to abattoir and moving from permit sales to abattoir have much larger effects on the gross margin than moving from informal market to the permit sale and moving from informal market to auction. The result highlights the problems discussed in the preceding sections that sale of livestock in the downstream markets offer the farmers little opportunity for profit compared to the sales at the upstream markets. Though the farmers face transaction cost at the upper market, the trade-off is offset by the higher premium obtained *ceteris paribus*. Auction sales are more problematic in terms of the numerous constraints and anticompetitive behaviours highlighted in the previous sections, therefore, abattoir sales are expected to have much more impact on the gross margin than auction sales. Similar but larger effects are observed with *poparms* models. However, the Wald test of joint significance coefficient rejects the null hypothesis of zero effects in both models. Therefore the two models fit the data.

Table 3 Comparing adjacent treatment effects

Treatment effects	Market channels	Teffects coefficients	Poparms coefficients
POM	Permit vs Informal	N$139,043.50 (2.001)	N$127,160.40 (1.7671)
	Abattoir vs Informal	N$9,396,969.00 (0.7578)	N$507,611.50 (2.1163)
	Auction vs Informal	N$213,291.60 (2.6680)	N$191,926.20 (2.2925)
	Abattoir vs Permit	N$9,257,925 (0.7466)	N$380,451.1 (1.5885)
	Auction vs Abattoir	-N$9,183,677 (-0.7406)	-N$315,685.3 (-1.2973)
Wald test of joint sign			
Df		3	3
chi2		8.52	9
P>chi2		0.0364	0.0293
Observation		340	340

Figures in parenthesis are the z-statistics.

The POMs for the treatment model is given in Table 4. This is the expected average gross margin of farmers in one calendar year who did not market their livestock elsewhere except in their reference market. The result also shows that those whose reference market is abattoir have higher gross margin sales (N$4,736,637.6) than others. Again, there is an increasing order of influence from the informal market (N$130,826.8) to the abattoir (N$4,736,637.6), and all but three of the results are statistically significant. Two of the insignificant results compared to one were obtained with teffects an indication that *poparms* models is more consist and fit the data better than *teffects* models. Next, the distribution of the average treatment for those farmers who marketed at the alternative market is compared with their average treatment effects had they not marketed there. The result for the average treatment effects on the treated is shown in Table 5. According to the result, among the farmers who marketed at the alternative markets, there is an increase in their gross margin sales from the average of N$142,012.1 to N$145,343.4 for permit sales, N$236,677.8 for auction sales and N$578,671.3 for abattoir sales. The result shows that communal livestock farmers in the Grootfontein district would increase their profitability if they market more at the upstream markets than downstream markets.

Table 4 Potential treatment effects

Treatment effects	Market	Coefficients.	Robust Standard error	Z-stat	P-value|
POM	Informal	N$130,826.8	42523.88	3.08	0.0020
	Permit	N$273,528.6	48645.92	5.62	0.0000
	Auction	N$355,373.8	62077.23	5.72	0.0000
	Abattoir	N4,736,637.6	285889.9	2.58	0.0100

Table 5 Average treatment effect on the treated[1]

Treatment effects	Market	Coefficients	Robust Standard error	Z-stat	P-value|
ATET	Permit vs Informal	N$145,343.4	69444.58	2.1	0.0360
	Abattoir vs Informal	N$578,671.3	288830.8	2.0	0.0450
	Auction vs Informal	N$236,677.8	80629.99	2.9	0.0030
POM	Informal	142,012.1	48603.01	2.92	0.003

4.2.1 Quantile effects

The result for the quantile regression estimate is presented in Table 6 and 7. The output in Table 6 shows that the estimated 0.25 quantiles of the potential-outcome distribution corresponding to the four treatment levels (market alternatives) such as informal, permit, auction and abattoir are N$7181, N$8944, N$9868 and N$47625 respectively. The output for the 0.75 quantiles for the four treatment levels are N$106162, N$227213, N$255335 and N$407663. The result shows that outcome distribution increases as the treatment level moves from informal market to abattoir for the farmers in the lower and upper end of the outcome distribution. It should be recalled that dataset for the study includes cross section of the population samples of farmers from Hardap with 51 farmers, karas (34), Kunene South - Erongo (50), Omaheke (96) and Otjzondjupa (109), therefore the lower end of the distribution (Q25) comprise farmers from Hardap and Karas, the median (Q50) comprise the Kunene Sout - Erongo and Omaheke whereas the upper end (Q75) comprise farmers from the Otjzondjupa regions. It is interesting to estimate quantile effect in order to determine whether treatment affects those farmers at the lower end of the distribution differently than it affects those in the middle or at the upper end.

Given the quantile estimates in Table 6, the differences of a given quantile across the potential-outcome distributions are calculated. This amounts to pairwise comparisons of adjacent predictions of the outcome variables in the different quantiles to derive the estimates in Table 7. For example under 0.25 quantile, the potential outcome distribution at treatment one (informal market) is compared with that of treatment two (permit sale) by taking their differences. The smaller the difference, the more the rank preservation assumption is achieved. The result in Table 7 shows that the estimated difference between 0.25 quantile of the population potential-outcome when everyone markets his livestock at the permit sales and when everyone markets at the informal market is [N$8944-N$7181 = N$1763]. The estimated difference between the 0.25 quantile of the population potential-outcome distribution when everyone markets at the abattoir and when everyone markets at the informal market is [N$47625–N$7181 = N$40444]. Following the same procedure, the coefficients for other quantiles at different treatment levels are computed as shown in Table 7. It can be seen that the result of the conditional mean effects reported in Table 3 is consistent with the results obtained with the quantile effects in Table 7. The conditional mean result indicates that the potential outcome (gross margin) increases as farmers' move from marketing at the informal market to the permit sale, auction and to the abattoir. A similar result was obtained with the quantile effects however, the differences in the quantile estimate is larger as the quantile increases from the lower to the upper end. This is an indication that treatment affects farmers differently depending on the quantile or the side of the outcome distribution they are situated. It can be seen that farmers at the upper end of the distribution have larger gross margins compared to other parts of the distribution. The rank

[1] Estimated with *teffects* command in Stata

preservation assumption can be said to be marginally achieved because though the quantile differences are large, they are on overall smaller than the estimate obtained with the conditional mean result in Table 3.

Table 6 Estimates of the quantile treatment effects

Treatment	Markets	Coefficient.	Bootstrapped Standard Error	z-stat	P-value
Mean	Informal	N$153249	55012	2.7900	0.0050
	Permit	N$280410	51582	5.4400	0.0000
	Abattoir	N$660861	385000	1.7200	0.0860
	Auction	N$345176	67034	5.1500	0.0000
Q25	Informal	N$7181	2486	2.8900	0.0040
	Permit	N$8944	2946	3.0400	0.0020
	Abattoir	N$47625	81949	0.5800	0.5610
	Auction	N$9868	2101	4.7000	0.0000
Q50	Informal	N$21565	14098	1.5300	0.1260
	Permit	N$40393	17484	2.3100	0.0210
	Abattoir	N$169725	163606	1.0400	0.3000
	Auction	N$27347	6408	4.2700	0.0000
Q75	Informal	N$106162	63395	1.6700	0.0940
	Permit	N$227213	114498	1.9800	0.0470
	Abattoir	N$407663	387312	1.0500	0.2930
	Auction	N$255335	92410	2.7600	0.0060

Note: Note: *, **, *** indicates statistical significance at the 10%, 5% and 1% statistical significance.

Table 7 The estimated difference between quantiles for the different treatment levels

Market	Coefficient (Lower end)	Coefficient (Median)	Coefficient (Upper end)
Permit vs Informal	N$1763	N$18828	N$121051
Auction vs Informal	N$2687	N$5782	N$149173
Abattoir vs Informal	N$40444	N$148160	N$301501
Abattoir vs Permit	N$38681	N$129332	N$180450
Auction vs Permit	N$924	-N$13046	N$28122
Auction vs Abattoir	-N$37757	-N$142378	-N$152328

5. Concluding remarks and recommendations

Because of transaction cost, poor marketing infrastructure and anti-competitive behaviour at the upstream markets, the communal livestock farmers in the Grootfontein district of Namibia tend to sell their livestock to the easily accessible informal or permit market. These informal markets are patronised not because they offer better profit opportunities but because most communal livestock farmers cannot easily access upstream markets. There is a concern that the livestock market is dominated by oligopolies that use their market power to outcompete the less resourced peasant farmers. Using a survey data administered through a semi-structured questionnaire in the study area, this study investigated the gain or loss in the gross margin of selling livestock in one market channel relative to the alternative market.

This is a type of cause-and-effect relationship, therefore; a treatment (casual) effects model was used to determine whether farmers who marketed in the downstream market when they ought to have marketed at the upstream markets gained or lost in gross margin terms. The potential outcome framework was used to model treatment effects models. Four treatment levels representing market channels were chosen. The market channels are: the informal market, the permit sales, abattoir and auction market. The major aim of the study was to determine how the gross margin of an untreated individual farmer would change if such a person were to receive an alternative treatment. Untreated farmers are farmers who market their livestock solely at the informal markets organized a few distance from their homestead instead of the upstream market that requires skill and resources to exploit. The farmers in the treated category are those that market their livestock at the upstream markets such as the abattoir and auction. The potential outcome framework (POF) and the multivalued treatment effects model were applied to evaluate the causal effect. The POF enabled the estimation of conditional means and quantile of the outcome distribution given different treatment levels. The treatment effects were implemented in Stata using *teffects* and *poparms* commands. For comparison, the conditional mean effects were calculated with the two Stata commands.

The results show that the potential outcome means for the informal (reference) market is N$130,826.8. This is the average annual gross margin for a farmer who marketed in the informal market. The average treatment effects of marketing in other market channels instead of the informal market were also calculated. The estimated average treatment effect (ATE) of selling at the permit market instead of the informal market was N$142,701.8. Moving from informal market to auction, the ATE was N$224, 547. Market at abattoir instead of the informal market, the gross margin was the highest N$ 605,810.8 compared to other alternatives. The estimated result shows that the average treatment effect increases with treatment levels. A comparison of adjacent treatment effects shows that moving from informal market to abattoir and moving from permit sales to abattoir have much larger effects than moving from informal market to the permit sale and moving from informal market to auction. The result obtained with the quantile effect models compliments the conditional mean results. The quantile effects result shows that outcome distribution also increases as the treatment level moves from informal market to abattoir for the farmers in the lower and upper end of the outcome distribution.

The findings in this study strongly imply that transaction costs and other constraints such as production bottlenecks, lack of adequate market infrastructure and lack of institutional support polarize the livestock markets and underpin market exchange, therefore, should be accounted for in designing strategic intervention policy for the livestock sector. However, in spite of the numerous challenges discussed in this study that militates against communal livestock marketing, it is worth mentioning that there are opportunities that can cumulatively position the farmers to explore the profitable upstream market for improved profitability and sustainability. There are opportunities for farmers to join farmer's unions, farmer associations, and livestock cooperatives. These organisations bargain on behalf of the farmers for a better price. Farmer organisations are lobby group that lobby for policy changes that affects farmers. For example, the phasing out of bank cheques as a means of payment in Namibia will alleviate the problem of issuing of cheques to communal farmers who have to pay bank charges per cheque and undergo a waiting period for the clearing of cheques. Other opportunities include (a) opportunity for increased livestock export due to the endorsement by Namibia of the European Preferential Agreement (EPA), (b) preferential access of export abattoirs to EU/RSA market, (c) the fast-growing domestic market economy which is expanding demand and stimulating growth, (d) opportunity for greater participation in the value-adding process and (e) the opportunity for the development of a niche market – organic market. One of the major challenges faced by communal farmers is the anticompetitive behaviour of auction organisers. Development of appropriate livestock marketing policy would ensure fair practice at the permit, abattoirs, and auction markets. A compulsory corporate social responsibility implemented with a levy will ensure that excess profits by corporate entities are ploughed back into the society to the benefit of the poor especially the smallholder farmers.

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