TRANSACTION COSTS AND CATTLE FARMERS' CHOICE OF MARKETING CHANNELS IN NORTH-CENTRAL NAMIBIA

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Abstract

About 70% of the Namibian population depends on agricultural activities for their livelihood. Moreover, agriculture remains an important sector to Namibia because its national economy is widely dependent on agricultural production. Cattle producers in the Northern Communal Areas (NCAs) have an option to market their cattle via the formal or informal markets. Efforts have been made to encourage producers to market their cattle through the formal market; however, limited improvement has been observed. In this study a number of factors have been analysed to determine its influences on cattle marketing decisions. Factors influencing the marketing decision of whether or not to sell through the formal market are analysed using the Probit model. Factors influencing the proportion of cattle sold through the formal market on condition that a producer uses the formal markets to sell cattle are analysed with the Truncated model. Testing the Tobit model against the alternative of a two-part model is done using Cragg's model. Empirical results revealed that problems with transport to MeatCo, improved productivity, accessibility to market-related information and access to new information technology, are some factors significantly affecting the decision of whether or not to sell through the formal market. Payment arrangements by MeatCo, animal handling, accessibility to new information technology, age of respondents and lack of access to marketing expertise, are some factors influencing the proportional number of cattle sold through the formal market. The results suggest that substantially more information is obtained by modelling cattle marketing behaviour as a two decision-making instead of a single decision-making framework.

Key words: Cattle marketing, decision-making, formal markets, transaction costs

1. Introduction

Strengthening agriculture is critical for facing the challenges of rural poverty, food insecurity, unemployment and sustainability of natural resources. World Bank (2007) points out that agriculture can work in conjunction with other sectors to produce faster growth, reduce poverty and sustain the environment. However, there is a need for promoting market participation to increasingly recognize the efforts of bringing about agricultural transformation in developing countries (Alene *et al,* 2007).

Currently, some 70% of Namibia's population derive their livelihoods from agriculture, either directly or indirectly (Horsthemke, 2009). The trend in the adoption of new technology in agricultural production and management has been termed the industrialization of agriculture (Cuthbert, 2008). Therefore, for Namibia to progress to a higher level of food security and indeed production for export, development of the sector is critical to accelerate the industrialization of agriculture.

As a semi-arid country well endowed with natural pastures, Namibia is suited for extensive livestock ranching (Ouseb, 2006). Historically, livestock from the commercial farming sector has dominated agricultural production in Namibia and this largely still holds true. Cattle, sheep and goats constituted about 80% of overall agricultural output in 2006 (Hosthemke, 2009).

The primary aim of this paper is to investigate the factors that influence the marketing behaviour of cattle producers in the NCAs to get an understanding of the factors restricting them to use formal marketing channels to market their cattle. In order to reach this primary objective, the following secondary objectives must be reached; firstly to determine the factors that influence producers' choice on whether or not to use the formal marketing channel; secondary to determine the factors that influence the proportion of cattle marketed through the formal markets **on condition that a producer has used the formal markets to sell his/her cattle;** lastly, to formally test whether it is sufficient to model marketing behaviour as a single decision as done by other researchers or should the marketing decision be separated into a two decision-making framework.

In the next section, the problem statement is given which is further supported by the literature review in section three. The fourth section provides more insight in the data used, as well as the methodology employed. The results are presented in the fifth section, while conclusions and recommendations are made in the final section.

2. Problem statement

Düvel (2001) states that, because of the Veterinary Cordon Fence (VCF), livestock producers in the NCAs are particularly disadvantaged as far as livestock marketing is concerned. Meat and livestock cannot pass freely through this VCF into the southern Foot-and- Mouth Disease (FMD) free zone. This complicates the marketing of livestock. To overcome this barrier, the government of Namibia established MeatCo in 1992 and built eleven quarantine facilities in the NCAs (FAO & NEPAD, 2005). MeatCo abattoirs in NCAs were established with the aim of creating marketing opportunities for communal producers in the NCAs to benefit from their livestock through the formal market.

Cattle owners in the NCAs of Namibia are able to sell their animals to the informal[4] or indigenous market, or they can sell to the government-owned parastatal, MeatCo (De Bruyn *et al*, 2001). For producers in the NCAs to market their cattle to the formal markets (MeatCo), it is a prerequisite that their cattle have to be kept in quarantine camps for inspection of any disease for at least 21 days before meat products enters the South of the Veterinary Cordon Fence (SVCF) or South African market. A problem associated with this is that transaction costs involved in the marketing of cattle is high in the formal markets because these cattle often lose condition (i.e. weight and grading in the quarantine camps due to insufficient feed causing low prices (Kirsten, 2002; FAO & NEPAD, 2005; Doss *et al,* 2005; NASSP, 2005) as well as due to long distances producers have to transport animals to quarantine camps (Sartorius von Bach, 1990; Arbik & Vigne, 2002; NOLIDEP, 2002).

Kruger and Lammerts-Imbuwa (2008) argue that the off-take rate of cattle through formal markets in NCAs, remain low at 2% compared to about an estimated 20% off-take for the rest of the country. Research has been done on this problem; however, most researchers consider marketing decision as a single decision. No one has considered that different factors may influence the decisions of cattle marketing, thus the two decisions need to be modelled separately: (i) the decision of whether or not to use the formal markets, (ii) the proportion of cattle sold through the formal markets given the condition that they have decided to use the formal markets to sell their cattle. An assumption of being a single decision while it actually may be two separate decisions, may cause the focus to fall on factors that are not really contributing to convince producers to market their cattle through formal markets.

3. Literature review

3.1 Livestock production and marketing in Namibia

Appendix **A** shows that 61% of all cattle population is found on the communal areas of which 44% is located in NCAs. Although only 10% of all sheep in the country are found in the

[4] This is the unregulated market where cattle producer may sell cattle to open market processors (meat sellers)

communal areas, just over 65% of all goats are found in communal areas (Kruger & Lammerts-Imbuwa**,** 2008).

Namibia is an ideal cattle ranching country and its beef products have long been taste-preferred favourites world-wide (Nevil, 2004). It is observed that per capita daily calorie intake from beef in Namibia is twice as much Kenya's, nine times as much as Nigeria's and almost equal to Canada's (Christian Science Monitor, 2008).

Cattle bought by MeatCo from NCAs regions of Kunene north, the Northern Central Regions and the Kavango Region are slaughtered at the Oshakati abattoir, while cattle from Caprivi region are slaughtered at the Katima Mulilo abattoir. MeatCo's Oshakati abattoir, which is being supplied with cattle by producers from North Central Regions (NCRs), with a slaughter capacity of 280 cattle per day, operates at only 40% capacity (FAO & NEPAD, 2005). Shown in Appendix **B** are the cattle marketing figures in NCAs, export abattoirs, butchers and South Africa.

3.2 Transaction costs economics and communal livestock production

Livestock and meat products have been among the fastest growing components of the global agriculture and food industry (Morgan & Tallard, 2006; SARD & Livestock, 2007). Moreover, livestock systems are characterized by long marketing chains featuring great distances, numerous phases of weight gain and feeding regimes, multiple levels of traders and transactions, a multitude of steps and stages of processing, and a variety of employment-creating services and inputs (Rich *et al*, 2009).

Pingali *et al* (2005) states that with small-scale farmers there are difficulties hindering them to commercialisation, these hindrances arise from lack of public goods that hamper market exchange as well as from a new set of transaction costs that emerged from dealing with the food system. Matungul *et al,* (2001) and Alene *et al* (2007) explains that smallholders in Africa often face high transaction costs in production and marketing of agricultural outputs owing to the nature of their products and the institutional environment in which they have to operate. In the African context, transportation infrastructures are a common bottleneck to increase intra-regional trade. Furthermore, inadequate market information flows and high illiteracy among market operators are hampering livestock marketing (Iimi, 2007). Transaction costs had different meanings to different groups of people thus all risks had to be understood within the larger social, cultural and economic context (Doss *et al*, 2005).

3.3 Definition of transaction costs

There is no standard definition of the term '**transaction costs'** with various references defining it differently. Singh (2004) explains that the term can be broadly interpreted to include costs associated with market exchange, including costs of searching for options, negotiating contracts and enforcing agreements. Hobbs (1997) and Matungul *et al* (2001) define 'transaction costs' as the costs involved in exchange or trade (e.g. marketing costs), costs of intangibles (e.g. search for exchange partners), contract monitoring and enforcement.

Walter and Boeckenstedt (2007) define transaction cost as logistic costs, including cash payments and amortized costs associated with post-production handling, packaging, storage, inventory carrying and transportation. Pingali *et al* (2005) and Alene *et al* (2007) define transaction cost as the embodiment of barriers to market participation by resource-poor smallholders and have been used as a definitional characteristic of smallholders and as factors responsible for significant market failures in developing countries.

3.4 Transaction cost theory

Chen *et al,* (2006) recommends that transaction cost is a viable theory to explain the acquisition decision in marketing channels. Musemwa *et al,* (2008) explains that transaction costs are considered as barriers to the efficient participation of producers in different markets. Thus, producers will not use a particular channel when value of using that channel is outweighed by the costs of using it (Musemwa *et al,* 2008). Transaction costs, which are distinct from physical marketing costs such as those for transport and storage, arise from the coordination of exchange among market actors (Eleni & Gabre-Madhin, 2001). De Bruyn *et al,* (2001) argue that market transactions do not occur in a frictionless environment. Transaction costs are economically equivalent to frictions in physical systems (MacInnis, 2004). Jabbar (2008) and Eleni and Gabre-Madhin (2001), explain that transaction costs are unique and specific to individual agents, therefore, each agent in the market conducts transactions on the basis of his/her own costs.

Hobbs (1996) argues that economic agents face costs in the search for information about products, prices, inputs and buyers or sellers. The costs of obtaining price information depend on the extent to which there is readily available information on market prices (Hobbs, 1997). Crase and Dollery (1999) argues that the limitations of human beings may be such that they lack the skills, knowledge or intelligence to process information on products even within a bounded rationality framework. Hence the more time and energy spent on searching for market information, the higher the information cost (Gong *et al*, 2007). Households living in places where roads are impassable may not have easy access to up-to-date information about the markets and market prices (Nkhori, 2004).

Negotiation costs arise from the physical act of the transaction and are influenced by the way in which the transaction is carried out. Hobbs (1996) gives an example that the opportunity cost of the time that procurement staff takes to locate supplies of cattle, is a negotiation cost. Acharya (2006) observe that the long travel distances involved to reach a market is a disincentive for most producers, with small surplus to sell. When the condition of the roads is poor, transporters increase fees to compensate for damages to their vehicles emanating from the use of such roads (Dovie & Shackleton, 2003).

It may be necessary to monitor the quality of goods from a supplier or to monitor the behaviour of a supplier (or buyer) to ensure that all pre-agreed terms of the transaction are complied with (Hobbs, 1996). Producers may accrue the monitoring costs in ensuring that the cattle are handled correctly during transportation to the quarantine camp and to the buyer premises. If there is a concern among buyers that the cattle are highly stressed or have been

bruised as a result of additional handling and transportation, they may discount the prices that they are prepared to pay for cattle.

Chen *et al* (2006) explains that human nature and the environment of exchange can cause market failure due to unacceptably high transaction costs in transaction processes; differences in the character of exchange level such as uncertainty, frequency and asset specificity can influence the transaction cost. Gong *et al* (2007) observes that, when selling live animals directly to processors, cattle producers may face great uncertainty, which is determined only after the animal has been slaughtered. It may be impossible for a farmer to distinguish whether the reason for the low price is due to random shocks to the supply or demand function and to know what to do differently next time (Grosh, 1994).

3.5 Reducing high transaction costs

The use of IT can dramatically increase the ability to share information, and this affects the economics of private and public provision of information goods and services. Singh (2004) argues that IT can significantly reduce the high transaction costs that poor consumers face as this can have a long-lasting positive impact on economic development. A study on transaction costs and market efficiency done by Gu (2001) observes that as transaction costs decline, individuals increase their use of the market, which results in an increase in overall degree of ignorance of the individuals that access the markets directly.

3.6 Related research

Gong *et al* (2007) used the model to examine key factors that affect cattle farmers' selection of marketing channels and draw implications for China's beef supply chain development. Hobbs (1997) measures the importance of transactions costs in cattle marketing in US by using a Tobit model whereas MacInnis (2003) measures transaction costs and organic marketing (Corn and Soybeans) in US by applying the same model. However, these researchers modelled decision with the Tobit model assuming it in a single-decision framework without considering that this model is very restrictive. Lin and Schmidt (1983) detect a problem with the Tobit as it links the shape of the distribution of the positive observations and the probability of a positive observation. They further state that the shape of the distribution of the positive observations would have to resemble the extreme upper tail of a normal, which would imply a continuous and faster than exponential decline in density as one moved away from zero. Conversely, when zero occurs less than half of the time, the Tobit model necessarily implies a non-zero mode for the non-zero observations (Lin and Schmidt, 1983). According to Zhang *et al* (2006), the Tobit model has been shown to be inadequate to characterize the two processes in market behaviour.

Bellemare and Barret (2005) presented an ordered Tobit estimator, a two-stage econometric model determining marketing behaviour, highlighting the implications of different assumptions about households' (discrete) participation and (continuous) volume decision: evidence from Kenya and Ethiopia. Ehui, *et al* (2009) applied a two-step procedure to provide an empirical basis for identifying options to increase participation and sales of

smallholder producers in livestock markets in Ethiopia. However, these researchers did not test whether it is sufficient to model the analysis as a double-hurdle model.

The contribution of this paper, apart from using a double-hurdle model to (i) determine the factors that influences producers' choice on whether or not to use the formal marketing channel and to (ii) determine the factors that influence the proportion of cattle marketed through the formal markets, a formal testing of whether it is sufficient to model the analysis as a single decision-making or as a two decision-making is done using Cragg's model. Hence, making it the first of its kind applied in the livestock marketing behaviour according to the knowledge of the researcher.

4. Data and methodology

A structured questionnaire was used to obtain primary data. Four regions (Omusati, Oshana, Ohangwena and Oshikoto) were sampled. The survey was conducted from June 2009 to August 2009 with 121 respondents from the four selected regions.

Table 1 summarizes the explanatory variables that are hypothesized to have an influence in the decision-making of whether or not to sell through the formal markets. A brief description of each variable and the expected direction of the influence on the hypothesized variable on the marketing behaviour of cattle are specified in Table 1 below. It is further hypothesized that the same variable is expected to have the same directional influence on both investigations, i.e. the decision whether or not to sell through the formal markets and the decision on the proportion of cattle sold through the formal markets **on condition that the producer has used the formal markets to sell his/her cattle.**

Table 1: Explanatory variables hypothesized to influence the marketing and the proportion decision of cattle in the NCRs

Variables description	Variable Name	Measurement value	Expected sign
Socio-economic characteristics			
Age of respondents	AGE	Age of the respondent (Number)	+/-
Marketing experience	EXPERIENCE	Number of years engaged in agricultural activities? (Number)	+
Information costs			
Lack of market experts	MRKEXP	How do you rate the accessibility of cattle marketing experts (1-5)[a]	+/-
Access to market related information	MRKINF	How easy/difficult to access market related information (1-5)[b]	-
Access to government related information	GOVINF	How easy/difficult to access government related information (1-5)[b]	-
Access to new technology information	NEWTECH	How easy/difficult to access new technology information (1-5)[b]	+/-
Market uncertainty	MRKUNCETY	Rank market access in order of importance as a constraint (1-5)[c]	+/-
Negotiation costs			
Transport problem to MeatCo	PTRNSPMEATC	Do you have a transport problem to MeatCo? (1-2)[d]	-
Transport cost	TRANSCOST	How much do you pay to transport a head of cattle to market? (N$)[e]	-
Buyer bargaining power	BUYERPOWER	Do you have bargaining power to influence selling price? (1-2)[d]	-
Payment arrangement	PAYMENT	Do you experience payment delay with MeatCo? (1-3)[f]	+
Monitoring costs			
Price uncertainty	PRCEUNCETY	Have you experienced problem with weight lost during transportation? (1-3)[f]	-
Animal handling	HANDLING	Have you experienced problem with carcass/hide damage during transportation? (1-3)[f]	+/-
Grading uncertainty	GRDEUNCETY	Rate age as a quality attributes buyers look at when buying cattle (1-3)[f]	-
Productivity uncertainty			
Improved productivity	IMPRODUCTY	Have you experience higher animal productivity over last 5 yrs? (1-2)[d]	-
Access to credit	CREDACCES	Rank in order of importance credit access as a constraint (1-5)[c]	+

[a] Possible answers were: 1= Very poor, 2= Poor, 3= Moderate, 4= Good, 5= Very good
[b] Possible answers were: 1= Very easy, 2= Easy, 3= Moderate, 4= Difficult, 5= Very difficult
[c] Possible answers were: 1 = Most important, 2= Important, 3= Moderate, 4= Not important, 5= Least important
[d] Possible answers were: 1= yes, 2 = No
[e] Possible answers were: In Namibian Dollar
[f] Possible answers were: 1= Never, 2= Sometimes, 3= Always

Following Magingxa *et al,* (2006) Principle Component Regression (PCR) is applied within maximum likelihood estimation framework. The correlation matrix C using both standardized and unstandardized variables were used to calculate the eigenvalues $\lambda_1, \lambda_2, ...\lambda_k$ and corresponding eigenvectors ν_i respectively in Equation 1 and 2:

$$|C-\lambda I| = 0, |C-\lambda_j I|V_j = 0 \quad \textbf{(1)}$$

The eigenvectors V_j were then arranged to give matrix V in Equation **2**

$$\boldsymbol{V} = \begin{bmatrix} \nu_{11} & \nu_{12} & . & . & . & \nu_{1k} \\ \nu_{21} & \nu_{22} & . & . & . & \nu_{2k} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ \nu_{k1} & \nu_{k2} & . & . & . & \nu_{kk} \end{bmatrix} \quad \textbf{(2)}$$

The matrix **V** is orthogonal as its columns satisfy the conditions $\nu_i'\nu_i = 1$ and $\nu_j'\nu_i = 0$ for $i \neq j$

$$Z = X^S V \quad \textbf{(3)}$$

Where X^S is n×k matrix of standardized variables; **V** is eigenvector matrix as defined in Equation **3.** There are **k** explanatory variables as there are **k** variables. The new sets of variables (explanatory variables) unlike the original variables are orthogonal i.e. they are uncorrelated.

After the explanatory variables are calculated and explanatory variables with the smallest eigenvalues are eliminated Equation **4** was fitted to determine explanatory variables having significant impact on the probability of decision-making of whether or not to sell through the formal markets and the proportion of cattle sold through the formal markets:

$$\boldsymbol{P = F(}\alpha_0^s + X^s VV'\varphi^s + \varepsilon\boldsymbol{)} \quad \textbf{(4)}$$

After insignificant explanatory variables from Equation **5** are identified and eliminated, Equation **5** is obtained in terms of the retained hypothesized variables.

$$\boldsymbol{P= F}\left(\alpha_0^s + Z\gamma + \varepsilon^\circ\right) \quad \textbf{(5)}$$

where $Z = X^s V$ and $\gamma = V'\varphi^s$. Z is an $n \times \ell$ matrix of retained explanatory variables, ***V*** is a $k \times \ell$

matrix of the eigenvectors corresponding to the ℓ retained components, γ is $\ell \times \ell$ vector of coefficients associated with the ℓ variables. Standard errors of the estimated coefficients γ are represented by an $\ell \times 1$ vector.

$$Var(\hat{\gamma}) = \hat{\delta}^2 (\mathrm{Z}'\mathrm{Z})^{-1} = \hat{\delta}^2 \, diag\left(\lambda_1^{-1}, \lambda_2^{-1}, ... \lambda_l^{-1}\right) \quad \textbf{(6)}$$

where $\hat{\delta}^2$ is variance of residuals from Equation **4**. Therefore standard error of γ may be given by

$$k^s = \left(s.e.\hat{\gamma}_1 s.e.\hat{\gamma}_2 ... s.e.\hat{\gamma}_\ell\right) \quad \textbf{(7)}$$

Results obtained using Equation **5** may be transformed back to the explanatory variable estimators of standardized variables as follows:

$$\begin{bmatrix} \alpha^s_{1,EV} \\ \alpha^s_{2,EV} \\ . \\ . \\ . \\ \alpha^s_{k,EV} \end{bmatrix} = \begin{bmatrix} V_{11} & V_{12} & . & . & . & V_{1l} \\ V_{21} & . & . & . & . & V_{2l} \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ V_{k1} & . & . & . & . & V_{kl} \end{bmatrix} \times \begin{bmatrix} \hat{\gamma}_1 \\ \hat{\gamma}_2 \\ . \\ . \\ . \\ \hat{\gamma}_l \end{bmatrix} \quad \textbf{(8)}$$

where $\hat{\gamma}_i$ is estimator of γ_i in Equation **6**. The constant $\alpha^s_{\circ,EV} = \bar{y}$.

The standardized coefficients evaluate the relative importance of the explanatory variables in determining the marketing decision-making of cattle producers. Variance of the explanatory variables estimators in standardized variables is given by:

$$Var(\alpha^s_{EV}) = \Psi^s_\ell \mathrm{K}^S \quad \textbf{(9)}$$

where Ψ^s_ℓ contains the squares of the elements of V^s_l in Equation **2** and K^S contains the squares of the elements of the matrix of standard errors of the coefficient matrix of γ in Equation **5**. The corresponding standard errors for the estimators of explanatory variables of standardized variables are given by:

$$s.e\left(\alpha^s_{EV}\right) = \left[\mathrm{var}\left(\alpha^s_{EV}\right)\right]^{1/2} \quad \textbf{(10)}$$

The transformed standardized coefficients $\alpha^s_{j,EV}$ of standardized variables X^x_j back to $\alpha_{j,EV}$ unstandardized coefficients $\alpha_{j,EV}$ of X_j

$$\alpha_{j,EV} = \frac{\alpha^s_{j,EV}}{S_{xj}}, j = 1,2,...,k \quad \textbf{(11)}$$

and

$$\alpha_{\circ,EV} = \alpha^s_{\circ,EV} - \frac{\alpha^s_{1,EV}\bar{x}_1}{S_{x1}} - \frac{\alpha^s_{2,EV}\bar{x}_2}{S_{x2}} - ... - \frac{\alpha^s_{k,EV}\bar{x}_k}{S_{xk}} \quad \textbf{(12)}$$

where S_{xj} is the standard deviation of the j^{th} original variable Xj & $\alpha^{s}_{0,EV}, \alpha^{s}_{1,EV}, \alpha^{s}_{2,EV}, \alpha^{s}_{k,EV}$ are coefficients of the standardized variables.

Partial effect of the continuous explanatory variables on marketing decision may be computed by the expression

$$\frac{\partial p_i}{\partial x_{ij}} = \beta_j \phi(Z_i) \qquad \textbf{(13)}$$

where $Z_i = \beta_\circ + \sum_{i=1}^{k} \beta_i x_{ij}$

The "partial" effects of the discrete variables are calculated by taking the difference of the probabilities estimated when value of the variable is set to 1 and 0 $(x_i = 0, x_i = 1)$, respectively.

The regressand in this objective is a binary variable that take only two values (1, 0), say, if a cattle producer has at least sold through the formal markets and 0 if never sold through the formal markets. Probit model was used to determine the factors that influence the decision of whether or not to sell through the formal markets (**secondary objective 1**). Estimates for the Probit model are developed by the method of maximum likelihood and it capitalizes on the assumed normality of the error term (Aldrich & Cnudde, 1975; Bertschek & Lechner, 1998). Following (Maddala, 2001) the following Probit model is estimated:

We assume that we have a regression model

$$\mathrm{Y}_i^* = \beta_\circ + \sum_{j=1}^{k} \beta_j x_{ij} + \mu_i \qquad \textbf{(18)}$$

where Y_i^* is not observed. It is commonly called a latent variable. What we observe is a dummy variable y_i defined by:

$$y_i = \begin{cases} 1 \text{ if } Y_i^* > 0 \\ 0 \text{ otherwise} \end{cases} \qquad \textbf{(19)}$$

If we multiply Y_i^* in Equation **19** by any positive constant, does not change y_i. Hence if we observe y_i, we can estimate the β's in Equation **18** only up to a positive multiple. It is customary to assume var(u_i) = 1. From the relationship Equation **18** and **19** we get:

$$\boldsymbol{P_i} = \text{Prop}\,(y_i - 1) = \text{Prop}\,[u_i > -(\beta_\circ + \sum_{j=1}^{k} \beta_j x_{ij})] \qquad \textbf{(20)}$$

$$= 1\text{-}F\left[-\left(\beta_\circ + \sum_{j=1}^{k} \beta_j x_{ij}\right)\right]$$

where F is the cumulative distribution function of u. if the distribution of u is symmetric, since
1-F(-Z) = F(Z). The observed y_i are just realizations of a binomial process, probabilities is given by:

$$\boldsymbol{P_i = F}\left(\beta_{\circ} + \sum_{j=1}^{k} \beta_j x_{ij}\right) \quad \textbf{(21)}$$

Varying from trial to trial (depending on x_{ij}), we can write the likelihood function as

$$L = \prod_{y_i=1} P_i \prod_{y_i=0} (1 - P_i) \quad \textbf{(22)}$$

We can write Equation **(21)** differently as given by (Katchova & Miranda, 2004).

$$P(c_i = 1) = \Phi(\gamma' \mathbf{z}_i) \quad \textbf{(23)}$$

Where c_i is the formal marketing-decision, Φ is the standard normal cumulative density function, $\mathbf{z}_i$ is an $R \times 1$ vector of personal and farm characteristics for farmer i, and γ' is a vector of coefficients. It is assumed that the density of c_i, conditional on being a non-limit (positive) observation, is that of $N(X_i\beta_2, \sigma^2)$.

Factors affecting decisions on proportion of cattle marketed through the formal markets on condition that a producer has used the formal markets to sell his/her cattle

This specification relies on the potentially strong assumption that the discrete cattle producer choice to participate in the formal market is made simultaneously with the continuous choice as to the number of animals to sell conditional on having chosen to go through the formal market. The Truncated model on this analysis captures the characteristics that influence producer's decisions on the proportion of cattle to sell through the formal markets (**secondary objective 2**). Following Katchova and Miranda, (2004), the Tobit model assumes that a latent variable α_i^* is generated by:

$$\alpha_i^* = \beta_\alpha' X_i + \varepsilon_{\alpha i} \quad \textbf{(24)}$$

Where X_i is an $S \times 1$ vector of personal and farm characteristics for farm i, β_α is a vector of coefficients, and $\varepsilon_{\alpha i}$ are independently and normally distributed with mean zero and variance σ^2. If α_i^* is negative, the variable that is actually observed, the proportion of cattle sold through formal markets, α_i, is zero. When α_i^* is positive, $\alpha_i = \alpha_i^*$. In the Tobit model, the probability that the proportion of cattle sold through formal markets is zero is calculated by Equation **25**:

$$P(\alpha_i = 0) = \Phi\left(-\frac{\beta_\alpha' X_i}{\sigma}\right) \quad \textbf{(25)}$$

and the density for the positive values of α_i is

$$f(\alpha_i \mid \alpha_i > 0) = \frac{f(\alpha_i)}{P(\alpha_i > 0)} = \frac{\frac{1}{\alpha}\phi\left(\frac{\alpha_i - \beta'_\alpha X_i}{\sigma}\right)}{\Phi\left(\frac{\beta'_\alpha X_i}{\sigma}\right)} \quad \textbf{(26)}$$

where $\phi(\bullet)$ is the standard normal probability density function. Equation **25** represents the adoption decision, and is a valid Probit model if considered separately from Equation **26.** Equation **26** represents a Truncated regression for the positive values of the continuous decision of how much cattle to sell through the formal markets $(\alpha_i > 0)$ as indicated by Peracchi (1987). The Tobit model arises when the decision-making, represented by the Probit model in Equation **26**, and the decision of what proportion of cattle sold through the formal markets, represented by the Truncated regression model in Equation **26** have the same variables X_i and the same parameter vector β_α. In the Tobit model, a variable that increases probability of decision-making of whether or not to sell through the formal markets will also increase the mean number of cattle marketed through the formal markets (Katchova & Miranda, 2004).

Using Equation **26,** a Truncated regression is used to determine the proportion of cattle sold through the formal markets **on condition that producer has used the formal markets to sell his/her cattle**. The data used for this analysis were obtained from the matrix V in Equation **2**; the same procedures were followed as specified from Equation **5** to Equation **12.** Only cattle producer that indicated to have used the formal markets were included in this analysis. The use of a two-step model allows different variables to influence the decisions on whether or not to use formal markets, and the proportion of cattle sold through the formal markets. A variable can also influence these decisions in the same or opposite direction (Katchova & Miranda, 2004).

Within a single decision-making framework the log-likelihood for the Tobit model consists of the probabilities of some farmers who did not sell any cattle through the formal market and a classical regression for the positive values of α_i

$$\ln L = \sum_{\alpha_i=0} \ln \Phi\left(-\frac{\beta'_\alpha X_i}{\sigma}\right) + \sum_{\alpha_i>0} \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta'_\alpha X_i}{\sigma}\right)\right] \quad \textbf{(27)}$$

Katchova and Miranda (2004) reveal that Cragg relaxed the assumption that the same variables and the same parameter vector affect both the decision-making of whether or not to sell through the formal market and the decision of what proportion of cattle to be sold through the formal markets. Following Katchova and Miranda, (2004) a hurdle model was used in which a farmer makes a two-step decision:

$$P(c_i = 1) = \Phi(\gamma' \mathbf{z}_i) \quad \textbf{(28)}$$

If the "impediment" is crossed, that is, the farmer has decided to sell through the formal market (c_i=1), a Truncated regression (Equation **26)** describes his choice of how much cattle production to sell through the formal markets ($\alpha_i > 0$). The log-likelihood in Cragg's model is a sum of the log-likelihood of the Probit model (the first two terms) and the log-likelihood of the Truncated regression model (the second two terms),

$$\ln L = \sum_{c_i=0} \ln \Phi\left(-\gamma' \mathrm{Z}_i\right) + \sum_{\alpha_i>0} \left\{ \ln \Phi\left(\gamma' \mathrm{Z}_i\right) + \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta_\alpha' \mathrm{X}_i}{\sigma}\right)\right] - \ln \Phi\left(\frac{\beta_\alpha' \mathrm{X}_i}{\sigma}\right)\right\} \qquad \textbf{(29)}$$

Testing the more restrictive Tobit model against the more general Cragg model, first and second conditions are stated as:

H_0: Tobit, with a log-likehood function given in Equation **27**

H_1: Cragg's model (Probit and Truncated regression estimated separately), with a log-likelihood function given in Equation **29**

Cragg's model reduces to a Tobit model if $\mathbf{Z}_i = \mathbf{X}_i$ and $\gamma = \beta_\alpha / \sigma$. Given the first condition, the second condition is a testable restriction. Therefore, the Tobit model can be tested against Cragg's model (**Secondary objective 3)** by estimating a Probit, a Truncated regression, and a Tobit model with the same variable (X_i) and computing the following likelihood ratio statistic:

$$\lambda = 2(\ln L_{\text{Probit}} + \ln L_{\text{Truncated regression}} - \ln L_{\text{Tobit}}) \qquad \textbf{(30)}$$

where λ is a chi-square distribution with R degrees of freedom (R is the number of independent variables including a constant). The Tobit model will be rejected in favour of Cragg's model if λ exceeds the appropriate chi-square critical value.

5. Results and discussion

The interpretation of the Probit coefficients differs from typical linear regressions (Bahta & Bauer, 2007). Thus requires more manipulation in order to calculate the impact of the independent variables on the probability to decide whether or not to sell through the formal markets (Bahta & Bauer, 2007). For the purpose of this study coefficients are only interpreted according to the direction of their influences on the marketing behaviour of cattle. The partial effects of individual variables thus are not calculated.

Appendix **C** shows six variables that are significant at 5%, 10% and 15%[5] level of significance. Interestingly two of the significant variables (transport cost and price uncertainty) have opposite sign. Although **transport cost (p<0.10)** sign does not make

[5] Significance of variables at 15% was opted because the intention is just to identify significant factors that influence the decision-making of whether or not to sell to formal markets.

economic sense, it may indicate that cattle producers make decisions to market to the formal market irrespective of whether transport cost is high or not. They may take such decision as they are obliged to sell when a need of money arise. P**rice uncertainty (*p* < 0.15)** indicates a positive influence, making it blurred to justify the influence of **Price uncertainty** on the marketing behaviour of cattle in NCRs**.** Nonetheless, this may be an indication that cattle producers are not sensitive to the weight difference[6] of their cattle because the marketing patterns are driven more by income needs than by price movements.

According to the magnitude of standard coefficients **problem to transport cattle to MeatCo (*p*<0.10**) has the biggest impact on the decision of whether or not to sell cattle through the formal markets. The study found that some producers in Omusati and North West of Oshikoto have to transport their animals over distances of more than 330 km. As a result livestock often loses weight during transportation. The situation is worsened by the poor road network from livestock production area as some places cannot be accessed by trucks. Trucks often get stranded while on the way, particularly during the rainy seasons. Most cattle posts are situated deep in the forests, with dense vegetation along single, narrow roads, fit for small vehicles only. In most cases trucks get stuck in hanging branches of trees along the road, causing massive damage to vehicles. Consequently, transportation costs is blatantly transferred on to the cattle producers.

Improved productivity (*p*< 0.10) can influence negatively the decision-making of whether or not to sell through the formal market. Lack of improved productivity among animals in the NCRs is believed to discourage producers to market through the formal market. Possible reason could be that producers have high expectation to receive good returns when taking their cattle to the formal market without considering the productivity values of their cattle. After the cattle have been slaughtered and graded producers feel deceived, thus get demoralized to continue supplying cattle to MeatCo. Lack of production and **marketing-related information (*p*<0.05)** has been revealed to be a major constraint that needs immediate attention in the marketing behaviour of cattle farmers in the NCRs because it results in producers being unable to make mainstream market-related decisions[7]. Unlike the above three factors, **accessibility to new information technology (*p*<0.15)** has a positive influence on the decision of whether or not to sell through the formal markets. Through the adoption of new livestock production technologies, producers use medicines to combat diseases and use improved management practices, which lead to reduced mortality rate and increased weight gain.

The results of Truncated specification[8] are presented in Appendix **D**. Based on the results[9] shown in Appendix **D**, six factors (**age**, **accessibility to new information technology**,

[6] This may be attributed to the limited access of resources as producers typically do not have scales to weigh their animals before market. The differences in weight (weight of cattle at the production area and the weight of cattle after delivered at the slaughtering plant) thus will not influence the decision because the initial weight is unknown.

[7] Lack of information results in producers being unable to receive information for the purpose of adopting new and relevant technologies at the right time.

[8] To attain the second **secondary-objective** of identifying factors influencing the proportion of cattle sold

payment arrangement by MeatCo, **experience**, **lack of market experts** and **animal handling**) have significantly influenced the proportion of cattle sold through the formal markets.

It is doubtful having **marketing experience (p<0.15)** with opposite signs. The satisfaction of selling to the formal markets determines how an individual will be interested in that particular marketing channel. The lesser satisfaction, the fewer cattle a producer is willing to sell through that market channel. The way cattle producers view their farming businesses depends on their personal aspirations, objectives and goals. Thus producers' decision-making regarding marketing is influenced by the relative importance they attach to their selling and producing roles.

Given the standardized coefficients of the significant factors, **payment arrangement by MeatCo (p<0.10)** is having a significant influence in encouraging cattle producer to sell a large proportion of their cattle through the formal markets. Because of the quick payment process[10], producers are encouraged to increase the proportion of cattle as they are assured that they will get a lump sum of income shortly after their cattle are slaughtered. Influencing the proportion of cattle sold through the formal markets relates to **animal handling (p<0.15)**; poor animal handling do not worry producers in taking their cattle to the formal markets. Instead, it encourages them to sell more animals; this may be attributed to a number of reasons[11]. The influence of **accessibility of new information technology (p<0.05)** is negative which implies that although new technology can increase the number of animals as a herd, it does not necessarily increase cattle with the same qualities. Thus, producers only choose the best quality cattle to sell through the formal markets and discard the rest for home consumption or to the informal markets[12]. Another possible reason could be that producers do not receive necessary technologies that improve qualities demanded by the market or they may not have enough information on the type of qualities that the market demand. **Lack of market experts (p<0.15)** has a negative influence, implies that lack of market experts may have a lethal effect on the functionality of the whole marketing system if the stakeholders in the system are un-informed. The inaccessibility of market experts indicates that cattle producers are locked out of relevant information and they are likely to make decision according to the only out-dated available information or little marketing experience they have. There is a relationship between the **age (p<0.01)** of the cattle producer and the herd size as the older cattle producers are likely to sell a large quantity of cattle at a time. In most

through the formal markets conditional to the producer having used the formal markets Truncated model is used.

[9] Similar to the Probit regression, the marginal effect of the independent variables is not calculated, the coefficients will be interpreted only based on the direction of their influence on the dependent variable.

[10] MeatCo settle payment the following day after the slaughtering date.

[11] Firstly, hides has no benefits to producers as MeatCo does not grade, neither compensate, producers for hides and offal. Secondly, producers are likely to get rid-off of bad-looking cattle first, should a cattle show bruises or symptoms of sickness it becomes the first target to be sold out.

[12] Informal markets has no specified quality requirements or grading

cases, good breed (hybrid) are found in their herds and this encourage them to sell through the formal markets as they are assured that their cattle meets the quality attributes that buyers consider when buying their cattle.

The estimation results of the Probit, Truncated and Tobit specification are presented in Appendix **E**[13]. The inconsistence in the significance of factors across alternative specifications prompted us to consider testing the more restrictive Tobit model against the more general Cragg model. The three models are estimated with same variables and the log-likelihood of the Tobit model is compared to the sum of those in the Probit and the Truncated regression models. The highly significant (***p*<0.000012**) log-likelihood test ratio of 60.21 strongly reject the Tobit model specification in favour of the more general Cragg model specification. This implies that the same personal and farm characteristics do not influence both the decision of whether or not to sell to the formal markets and the decision-making of the proportion of cattle sold through the formal markets in the same way through the restricted coefficients in the Tobit models.

6. Conclusion and recommendation

The study concluded that the provision of IT[14] is positively influencing the decision of whether or not to sell through the formal market. The development of feasible technical options that address producers' priorities and a participatory extension system responsive to producers' needs are critical to enhance the knowledge of producers and win their trust so that they may try new technologies introduced.

The different factors identified by the Truncated and Probit analysis indicates that different factors must be considered when opting to influence marketing behaviour, i.e. when you advise producers to market their cattle through the formal markets and when you advise producers on the proportion of cattle to sell through the formal markets.

Considering the results of this study and the conclusions drawn above, the following recommendations are made. It is assumed that improving on some factors will remove or reduce the identified transaction costs and hence stimulate the choice of the formal market in the NCRs.

[13] Appendix **E** is not interpreted, rather the results of the three specified models are compared to each other to determine the feasibility of testing whether it is sufficient to model the analysis as a single decision-making or as a two decision-making.

[14] This indicates that effective introduction of livestock technologies must be clearly understood by producers to improve feeding and management practices needed to uplift livestock production and marketing to another level.

- Transportation of cattle to the abattoir

Transportation costs can be cut if producers from one production area are well organised by making use of the same transport to markets. By transporting in bulk they stand a better chance of getting good basic consent of economies of scale compared to transporting as individuals and in small quantities.

- Strengthening producers' bargaining power

Efforts are needed to increase cattle producers' bargaining power and specialisation in cattle farming. As producers become more specialised in beef cattle production, producers bargaining power will increase when dealing with buyers (Gong, 2007). Therefore producers are recommended to work collectively in the procurement of production inputs, managing all shared grazing land and infrastructure, obtaining all required production and marketing-related information and collectively marketing their livestock.

- Accessibility of IT and market-related information

A gradual approach to disseminate new technologies with substantial capacity building support at the field level for their successful adoption, marketing development and information support, and development of private service providers in essential areas of livestock production and marketing for sustainable and effective livestock development are of prime importance. The development of training programmes for producers to assist them in improving their farm management skills, farming efficiency as well as correct usage and management of livestock veterinary technologies are hereby recommended. Educating cattle producers on the grading system will reduce transaction costs of some of the producers who feel cheated because they do not know how the grading system works.

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APPENDIX A

Livestock numbers for different sectors in Namibia, for the 2006 calendar year

	Cattle numbers	Cattle %	Sheep numbers	Sheep %	Goats numbers	Goats %
NCAs	1,039,309	44	25,895	1	774,195	38
SCA	394,475	17	226,963	9	566,734	27
TOTAL CA	1,433,784	61	252,858	10	1,340,929	65
COMMERCIAL AREA	950,176	39	2,407,394	90	720,474	35
TOTAL	**2,383,960**	**100**	**2,660,252**	**100**	**2,061,403**	**100**

NCAs= Northern Communal Areas, SCAs = Southern Communal Areas, CAs= Communal Area

Source: MAWF (2008)

APPENDIX B

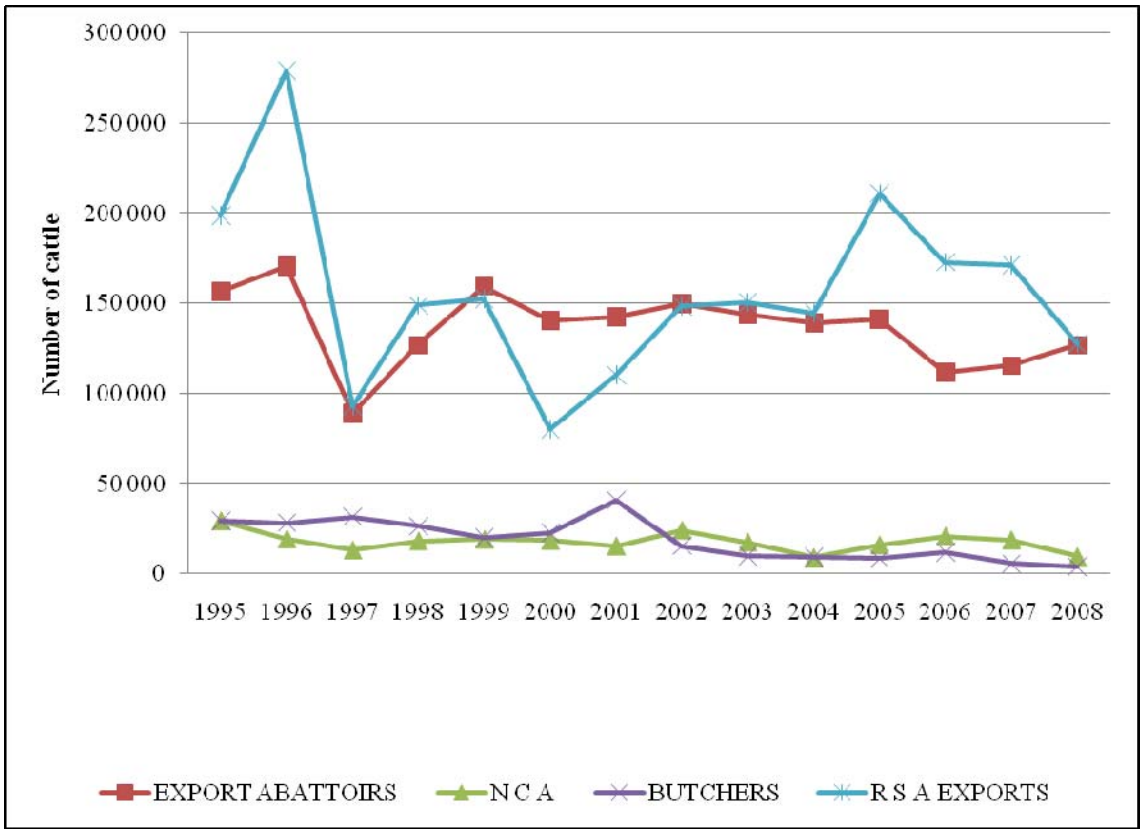

Figure 4: Marketing of total production of cattle - Numbers

Source: Meat Board of Namibia (2008)

APPENDIX C

Regression results of Probit model of factors influencing probability to use formal market

Variables	Coefficient	Standard error	T-value	Probabilities
Constant	1.3488	0.2326	5.7982***	0.0000
Age	0.0147	0.0144	1.0226	0.3099
Experience	-0.0042	0.0166	-0.2519	0.8016
Lack of market experts	0.0974	0.1229	0.7929	0.4297
Market related information	-0.3120	0.1339	-2.3298**	0.0218
Government related info	-0.0302	0.0909	-0.3322	0.7404
New tech. information	0.1873	0.1188	1.5766S	0.1181
Market uncertainty	-0.0099	0.1652	-0.0599	0.9524
Prob transport to MeatCo	-0.7808	0.4393	-1.7774*	0.0785
Transport cost	0.0017	0.0010	1.6609*	0.0999
Bargaining power by buyer	-0.0490	0.6599	-0.0742	0.9409
Payment arrangements	-0.0230	0.2735	-0.0839	0.9333
Price uncertainty	0.7545	0.5192	1.4533S	0.1493
Animals handling	-0.2697	0.3096	-0.8709	0.3859
Grading uncertainty	-0.2670	0.2218	-1.2038	0.2315
Improved productivity	-0.72353	0.429611	-1.6842*	0.0953
Credit access	0.0456	0.1243	0.3670	0.7144
Model summary				
No. of observations				121
% of correct predictions				84%
McFadden R^{2a}				0.2790
Model chi-square[b]				32.017
Model significance				0.031
N sellers				99
N Non sellers				22

***, **, and * = 1%, 5%, and 10% significance level respectively

S = Significant at 15% level

[a] = McFadden R^2 is given by one minus the ration of the unrestricted to restricted log likelihood function value

[b] = The chi-square test evaluates the null hypothesis that all coefficients (not including the constant) are jointly zero

APPENDIX D

Regression results of Truncated model on the proportion of cattle market through the formal markets on condition that the producer used the formal markets to sell his/her cattle.

	Truncated estimators			
Variables	**Coefficient**	**Standard error**	**T-value**	**Prob**
Constant	0.3752	0.0170	22.0470***	0.0000
Age	0.0041	0.0014	2.9559***	0.0039
Experience	-0.0022	0.0014	-1.5597S	0.1219
Lack of market experts	-0.0199	0.0122	-1.6419S	0.1037
Market related information	-0.0063	0.0144	-0.43517	0.6644
Government related info	-0.0078	0.0097	-0.80718	0.4216
New tech. information	-0.0259	0.0114	-2.2889**	0.0242
Market uncertainty	-0.0128	0.0154	-0.8271	0.4101
Prob transport to MeatCo	-0.0257	0.0391	-0.6566	0.5129
Transport cost	0.0001	0.0001	0.9866	0.3262
Bargaining power by buyer	-0.0336	0.5973	-0.5628	0.5749
Payment arrangements	0.0456	0.0261	1.7434*	0.0843
Price uncertainty	0.0053	0.0327	0.1632	0.8707
Animals handling	0.0451	0.0285	1.5823S	0.1167
Grading uncertainty	0.0049	0.0239	0.2022	0.8402
Improved productivity	-0.0507	0.0424	-1.1955	0.2347
Credit access	0.0047	0.0132	0.3584	0.7208
Model summary				
No. of observations				121
Sigma[a]				12.421*** (0.0126)
Log likelihood				51.5469

***, **, and * = 1%, 5% , and 10% significance level respectively and Numbers in parentheses are standard errors

S = 15% significant level

[a] = It represents the percent of variation in the dependent variable explained by the independent variables in the model

APPENDIX E

Regression results for alternative model specifications when modelling cattle marketing behaviour

	Single Decision	**Choice Decision**	**Quantity Decision**
	Tobit	**Probit**	**Truncated**
Dependent variable	Proportion of cattle sold to formal markets	Dummy = 1if used formal market	Proportion of cattle sold to formal markets
Variables	**Coefficient**	**Coefficient**	**Coefficient**
Constant	0.3894*** (0.0223)	1.3488*** (0.2326)	0.3755*** (0.0170)
Age	0.0056*** (0.0018)	0.0147 (0.0144)	0.0041*** (0.0014)
Marketing experience	0.0011 (0.0018)	-0.0042 (0.0166)	-0.0022S (0.0014)
Lack of market experts	0.0034 (0.0153)	0.0974 (0.1229)	-0.0199S (0.0122)
Market related information	-0.0428** (0.0180)	-0.3119** (0.1339)	-0.0063 (0.0144)
Government related info	0.0114 (0.0125)	-0.0302 (0.9091)	-0.0078 (0.0097)
New tech. information	0.0005 (0.0143)	0.1873S (0.1188)	-0.0259** (0.0114)
Market uncertainty	-0.0239 (0.0200)	-0.0099 (0.1652)	-0.0128 (0.0154)
Prob transport to MeatCo	-0.0084 (0.0497)	-0.7808* (0.4393)	-0.0257 (0.0391)
Transport cost	0.0001 (0.0001)	0.0017* (0.0010)	0.0001 (0.0001)
Bargaining power by buyer	0.0153 (0.0753)	-0.0489 (0.6599)	-0.0336 (0.5973)
Payment arrangements	0.0078 (0.0345)	-0.0229 (0.2735)	0.0456* (0.0261)
Price uncertainty	-0.0006 (0.0418)	0.7545S (0.5192)	0.0053 (0.0327)
Animals handling	0.0878** (0.0373)	-0.2697 (0.3096)	0.0451S (0.0285)
Grading uncertainty	0.0382 (0.0303)	-0.2670 (0.2218)	0.0049 (0.0239)
Improved productivity	-0.2108*** (0.0548)	-0.26701* (0.2218)	-0.0507 (0.0424)
Credit access	0.0062 (0.0169)	0.0456 (0.1243)	0.0047 (0.0132)
Model summary			
No. of observations	121	121	121

Sigma[a]	13.728*** (0.0175)		12.421*** (0.0126)
Log likelihood	-19.913	-41.356	51.546
McFadden R^{2b}		0.2790	
Model Chi-square[c]		32.017	
Model significant level		0.031	
LR test for Tobit vs Truncated regression			60.2075[d] (0.0000)[e]

***, **, and * = 1%, 5%, and 10% significance level respectively and Numbers in parentheses are standard errors

[s] = 15% significant level

[a] = It represents the percent of variation in the dependent variable explained by the independent variables in the model

[b] = McFadden R^2 is given by one minus the ration of the unrestricted to restricted log likelihood function value

[c]= The chi-square test evaluates the null hypothesis that all coefficients (not including the constant) are jointly zero

[d] = The likelihood ration test is given by $\lambda = 2(\ln L_{Probit} + \ln L_{Truncated\ regression} - \ln L_{Tobit})$

[e] = Number in parentheses are associated with chi-square probabilities