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# Factors Underlying Communal Beef Cattle Marketing Decisions in Botswana: *The Role of Public and Private Transfers*

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BOTSWANA INSTITUTE FOR DEVELOPMENT POLICY ANALYSIS

## BIDPA

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## Abstract

This article examines factors underlying communal beef cattle marketing at a household level in Botswana, with emphasis placed on the role of public and private transfers. Results show that public and private transfers (pensions, remittances, government food rations, and food supplies from friends and relatives) discourage cattle marketing. Thus, while they are important sources of household food security, cash and food transfers may adversely impact on beef export performance in Botswana. It is therefore fundamental that public transfer programmes are well targeted to needy and poor households, in order to minimize their adverse effects on the cattle industry. On the positive side, the paper argues that public transfer programmes may assist poor farmers rebuild their cattle and other livestock inventory, contributing to transition out of inter-generational poverty.

JEL Classification: Q12, Q13, Q18.

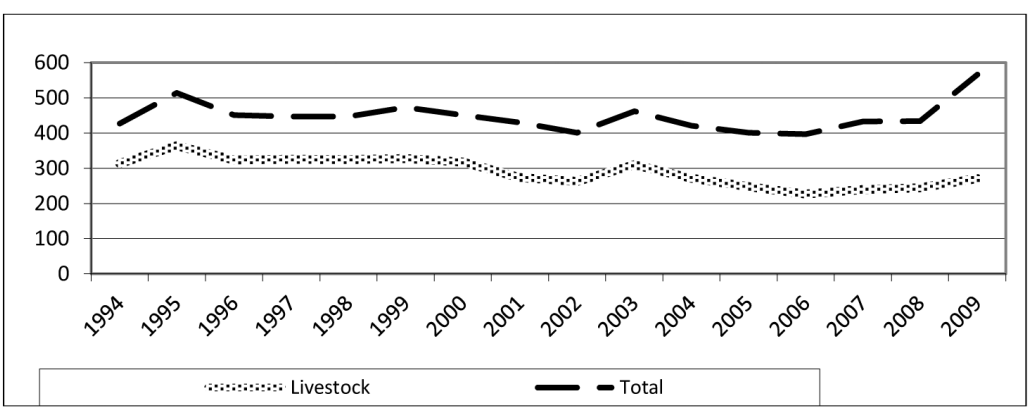
Keywords: Botswana, Cattle marketing, Poverty, Public and private transfers, Social safety nets.

# 1. Introduction

Cattle production in Botswana comprises two distinct production systems; communal and commercial. Communal farming is characterized by uncontrolled grazing due to open access to rangeland resources (BIDPA, 2006). Commercial farming, on the other hand, involves production in either freehold or leasehold ranches (Central Statistics Office, 2008a). The communal system accounts for a larger proportion of the cattle population; it consistently accounted for over 80 percent of the country`s cattle population during the period from 1979 to 2004 (TRANSTEC & BIDPA, 2010).

Cattle production is an important livelihood source in Botswana, particularly for the rural economy where income generation opportunities are limited. The industry is also an important source of non-mineral foreign exchange for Botswana. During the period from 1972 to 2009, beef and beef by-products contributed an average of 10 percent to total export earnings and were the most consistent and leading source of non-mineral exports (Central Statistics Office, online)[1]. The importance of the livestock sector is also seen in its real value added, which has been the main driver of agricultural GDP (Figure 1).

**Figure 1: Real Agricultural GDP in Millions of 1993/94 Pula; 1994-2009**



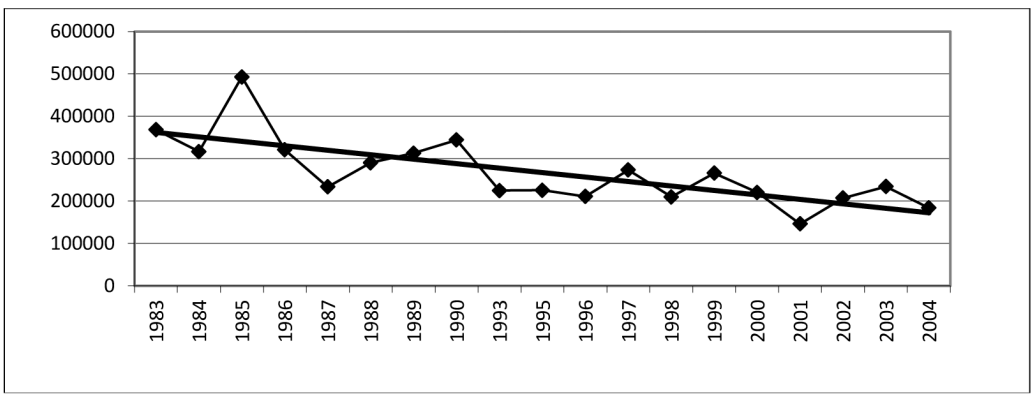

*Source: Central Statistics Office, National Accounts Statistics (Various)*

Notwithstanding the foregoing, the beef industry in Botswana is currently facing serious challenges. Both cattle sales for slaughter and beef exports have declined significantly since the 1990s, leading commentators to have doubts about the

[1] However, the share of beef and beef by-products export to total exports declined from 41.6 percent in 1972 to 3.4 percent in 2009. This is a serious concern since the decline was partly due to declining cattle sales for overall slaughter and export slaughter in particular. Notwithstanding this, most of the decline was caused by tremendous growth in mineral exports.

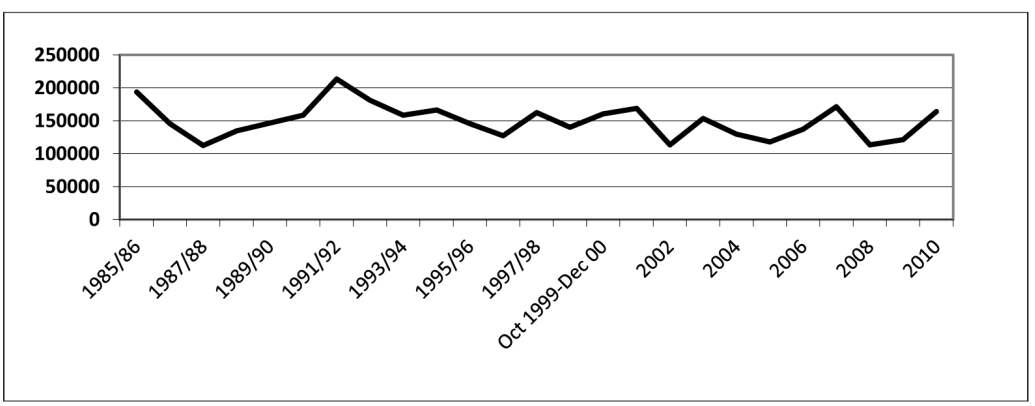
industry`s sustainability (BIDPA, 2006). Total cattle sales declined from 368 thousand heads in 1983 to 184 thousand heads in 2004, representing a two-fold decline (Figure 2). Most notably, cattle sales volume to the Botswana Meat Commission (BMC) has also declined, leading to a reduction in beef exports. BMC cattle throughput declined from 214 thousand cattle in 1991/92 to 164 thousand cattle in 2010, and was much lower at 113 thousand cattle in 2008 (Figure 3).

**Figure 2: Number of cattle sold to all outlets; 1983-2004**




*Source: Central Statistics Office, Agricultural Statistics (Various)*

**Figure 3: Number of Cattle sold to Botswana Meat Commission; 1985/86-2010**




*Source: BMC (Various)*

There is little empirical evidence on factors underlying beef cattle marketing in Botswana. Yet, market participation in agriculture is seen as among the most important contributory factors to poverty reduction in developing countries (Delgado, 1995; Ehui, Benin and Paulos, 2009). The limited research on cattle marketing in Botswana is surprising as the country's rural economy relies substantially on cattle farming as a source of livelihood. Moreover, outside mining, the cattle industry is a leading source of foreign exchange from commodity trade.

Jefferies (2007) reviewed three studies on cattle supply response in Botswana. Jefferies' review found that cattle producers in Botswana responded positively to cattle prices, although estimates varied greatly across studies. One of the studies reviewed found negative short-term and positive medium-term price elasticity estimates, while another study yielded a highly elastic short-term response and no long-term response. The third study, which used cross sectional data, yielded a positive inelastic supply response with respect to cattle prices. Only one study has so far modeled cattle marketing decisions in Botswana (Nkhori, 2004). The study found that, among other factors, herd-size and transaction costs (proxied by distance to market, market information, and speed of payment) affected cattle marketing decisions (choice of an outlet).

One other plausible determinant of cattle sales under communal settings in Botswana is the provision of public and private food and cash transfers, and employment in a Public Works Programme (PWP). Public food transfers are made through social safety net programmes outlined below. The Destitute Persons Programme (introduced in 1980) provides food packages to poor and needy households whose monthly income and livestock units fall below predetermined thresholds (Seleka et al., 2007). The Orphan Care Programme (launched in 1999) provides food rations and other needs to orphaned children aged below 18, to enable them to lead normal lives.

The Community Home Based Care Programme, introduced in 1995, initially provided food baskets to terminally ill individuals suffering from AIDS, but it now also covers individuals with other debilitating chronic illnesses such as diabetes, who cannot provide for themselves. The Vulnerable Group Feeding Programme has existed since independence in 1966 and provides food packages to selected (on medical grounds) pregnant and lactating mothers, TB and leprosy patients and children aged below 5 (Seleka et al., 2007).

Public cash transfers on the other hand are made through the Old Age Pension (OAP) programme and the World War II Veteran programme, which are also social safety net programmes. The OAP programme provides cash to all citizens aged at least 65, while the World War II Veteran programme benefits individuals who fought in the Second World War, their surviving spouses or children under the age of 21. In addition to providing food packages, the Destitute Persons Programme in Botswana also has a cash component to allow poor households to meet some of their non-food personal needs.

Cash benefits were also made to unemployed individuals, through a PWP, Labour Based Drought Relief Programme, during the period from 1982 to 2009, following the declaration of a drought by government. The current PWP, Ipelegeng, was introduced in 2009 to provide employment, on a permanent basis, with beneficiaries

rotated to widen participation and coverage of the unemployed (BIDPA, 2010). Private transfers include remittances and food supplies from relatives and friends, as will be seen from the agricultural census data used in this article.

Given the foregoing, this article uses the 2004 agricultural census data to analyze communal beef cattle marketing decisions in Botswana, with emphasis placed on the role of public and private (cash and food) transfers. Economic theory suggests that transfers (cash and food) can modify household behaviour, especially in cases where benefits are regular and consistent (Abdulai et al., 2005). The effect can be seen at household, community and national levels (Abdulai et al., 2005; RHVP, 2010).

At a household level, transfers may lead to changes in economic decisions such as cattle marketing, which we empirically explore in this article. This is important for policy as such transfers (particularly public programmes) could have contributed to declining cattle sales for slaughter and to poor beef export performance in Botswana. An understanding of factors underlying cattle sales is crucial as it may guide strategies for facilitating market participation in Botswana.

The rest of the paper is organized as follows. Section 2 reviews related empirical literature. In sections 3 and 4, we respectively specify the econometric model, and discuss data sources and descriptive statistics. Results and policy implications are presented in section 5, and section 6 concludes.

## 2. Review of related literature

Our review of the empirical literature is divided into four sections. The first section considers household characteristics included as independent variables in previous market participation studies. The second and third sections consider the influence of transaction costs and income (welfare) indicator variables (respectively) on livestock sales decisions, while the fourth section reviews the effects of herd dynamics on market participation.

## 2.1 Household characteristics

Household characteristics considered by past studies include household size, education, gender and age of farm owners. The effect of household size on market participation has been mixed. Studies in Kenya (Baldwin et al., 2008; Vincent et al., 2010) and South Africa (Montshwe, 2006) ascertained that household size related positively with cattle sales. This is because larger families have more needs to meet and hence may be more desperate for cash, leading to increased market participation. An inverse relationship between household size and market participation was also observed in South Africa (Uchezuba et al., 2009; Makhura, 2001). According to

Makhura, one of the causes of the negative response could be the need to negotiate or consult other household members when selling cattle. Household size also had no influence on market participation in Ethiopia and South Africa (Ehui et al., 2009; Musemwa et al., 2010).

Studies in Namibia (De Bruyn et al., 2001), Georgia (Kan et al., 2006) and the Philippines (Lapar et al., 2003) found the level of education to negatively relate with market participation. An increase in one`s skills increases his/her chances of non-farm employment, which further reduces livestock market participation (Lapar et al., 2003). Thus, education may raise the opportunity cost of labour, increasing one`s opportunity for paid employment, and hence reduce cattle marketing (Ehui et al., 2009).

Gender has been found to have mixed effects on market participation. Bellemare and Barrett (2006) found that female-headed households in Kenya and Ethiopia participated in the market less than male-headed households. However, Musemwa et al. (2010) found that, in South Africa, female-headed households had a higher probability of marketing cattle than male-headed households; this was due to the higher levels of unemployment and limited income sources among women.

Age of the farmer was found to positively relate with market participation in Namibia (De Bruyn et al., 2001) and Botswana (Nkhori, 2004). This may be because older farmers are relatively more experienced and, therefore, are more likely to have contacts with various marketing outlets (Matungul et al., 2001).

## 2.2 Transaction costs

Transaction costs are broadly classified into information costs, negotiation costs and monitoring or enforcement costs (Hobbs, 1997).[2] If information becomes readily available, information costs decline and the probability of market participation increases. Access to information increased market participation in Botswana (Nkhori, 2004), Kenya (Vincent et al., 2010), Namibia (De Bruyn et al., 2001) and South Africa (Musemwa et al., 2010; Bahta and Bauer, 2007).

Negotiation costs include transport cost (proxied by distance to the market), payment delays and bargaining power (Hobbs, 1997; Gong et al., 2006).[3] Studies conducted in Botswana (Nkhori, 2004), Kenya (Vincent et al., 2010) and South Africa (Uchezuba et al., 2009; Bahta and Bauer, 2007) found that distance to the market reduced market participation.

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[2] We do not discuss monitoring or enforcement costs here as they are mainly relevant for analyzing the choice of a marketing channel, which is beyond the scope of this article.

[3] We do not discuss payment delays and bargaining power here as they are usually considered in studies analyzing the choice of a marketing channel, which is outside the scope of this article.

## 2.3 Non-farm income

Non-farm income variables have not been commonly included as explanatory variables in livestock market participation studies. However, non-farm income, both wage and fixed income, can influence household behavior and hence, cattle marketing decisions. This includes both earned (from employment) and received (remittances and pensions) income. We review the few studies that have considered off-farm income variables.

Ehui et al. (2009) found that non-farm income increased participation in marketing of live animals in Ethiopia. Montshwe (2006) found that remittances increased the probability of market participation for small-scale cattle farmers in South Africa. According to Alene et al. (2008), a positive influence of non-farm income on market participation is seen in cases where non-farm income is used to finance farm productivity.

Other studies have however found non-farm income to negatively influence livestock marketing. Baldwin et al. (2008) found wages to reduce cattle offtake rates in Kenya. Vincent et al. (2010) ascertained that remittances lowered the probability of market participation in Kenya. Pension earners in South Africa had a lower probability of participating in the market compared to non-pension earners (Makhura, 2001). According to Kan et al. (2006), non-farm income had a negative effect on market participation in Georgia. A negative association suggests that households use off-farm income to meet their consumption needs, which could otherwise be met through receipts from livestock sales (Baldwin et al., 2008).

## 2.4 Herd size and dynamics

Drought and cattle diseases influence cattle herd-size and dynamics, further affecting market participation. BIDPA (2006) found that drought increased cattle marketing during the year it occurs. However, the lagged effects were negative as farmers rebuilt their cattle inventory in subsequent years. The impact of drought was also observed by Barrett et al. (2004), where households sold their livestock during worst droughts as a risk coping strategy in Kenya and Ethiopia. The BIDPA study also ascertained that cattle disease outbreaks reduced cattle supply to the BMC.

Cattle herd-size was found to positively influence market participation in Botswana (Nkhori, 2004), Kenya (Vincent et al., 2010), Namibia (De Bruyn et al., 2001) and South Africa (Montshwe, 2006). Cattle deaths increased market participation in Kenya (Vincent et al., 2010) and South Africa (Montshwe, 2006). The decision to sell more cattle in response to increasing mortalities is a risk aversion strategy to guard against further mortalities (Vincent et al., 2010; BIDPA, 2006). Cattle births were found to increase cattle marketing in Ethiopia and Kenya (Bellemare and

Barrett, 2006) and South Africa (Bahta and Bauer, 2007). As increasing births imply an expansion in the future breeding stock, it might stimulate market participation now to meet immediate cash needs.

## 3. Model specification

To investigate the determinants of cattle sales decisions, we specified two models. Firstly, we examined factors affecting the probability of selling cattle using a binary Logit model, which is one of the extensively used models if the dependent variable is dichotomous (Greene, 2008). The choice of this analytical technique was informed by the following; (i) that it is best suited for modeling non-linear distribution, unlike the ordinary least squares (OLS) method, and (ii) that it can be used to analyze a relationship between categorical responses and a set of both categorical and continuous variables (Uchezuba et al., 2009). The estimated model is specified as in Equation 1.

$$\ln\left(\frac{P_i}{1-P_i}\right) = \alpha_0 + \sum_{j=1}^{n} \alpha_j X_{ij} + \nu_i \qquad (1)$$

In this specification, the dependent variable carries 1 if the farmer sold cattle and 0 otherwise, $\alpha_0$ is the constant term, $\nu_i$ is the error term, $\alpha_j$ is the coefficient for the *jth* explanatory variable $X_j$, $P_i$ is the probability of household i participating in cattle marketing. $X_j$s include household characteristics, sources of income dummies, cattle water sources dummies, ownership of water source dummies, hired labour input dummy, and district dummies (Table 1).

Secondly, we estimated an equation for analyzing factors that influence the level of cattle sales. As cattle sales were only observed for the households that sold cattle, the number of cattle sold is censored at 0. Estimating this equation through the OLS method, ignoring the censoring of the dependent variable, would yield biased coefficients (Hobbs, 1997). To address the problem of selection bias and the bias arising from censoring of data, we specified the Tobit model, also known as censored regression model (Sigelman and Zeng, 1999; Makhura, 2001). The model is specified as follows:

$$S_i^{*} = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ij} + \varepsilon_i \qquad (2)$$

$$S_i = \begin{cases} S_i^* & if \quad S_i^* > 0 \\ 0 & if \quad S_i^* \leq 0 \end{cases} \tag{3}$$

In this specification, $S_i^*$ denotes the number of cattle sold by the *ith* household and is the latent or unobserved variable, S is the observed level of cattle sales, $\beta_0$ is the constant term, $\varepsilon_i$ is the error term, and $\beta_j$ is the coefficient for the *jth* explanatory variable $X_j$. The number of cattle sold is only observed if a farmer sold cattle, i.e if the number of cattle sold is greater than 0 (Equation 3).

Coefficients for the Tobit model are interpreted in the same way as for OLS coefficients, but this is made difficult by the presence of censoring (Hobbs, 1997). Thus, the Tobit model produces a single coefficient for each explanatory variable despite having two types of dependent variables; censored and uncensored (LeCLERE, 1994). This coefficient measures how the unobserved variable changes with respect to changes in the regressors. However, since our aim is to investigate the variation in uncensored observations, we computed the marginal effect on the conditional expected value of cattle sales. The marginal effect describes how the observed cattle sales change with respect to changes in the regressors (STATA Corp, 2009).

## 4. Data and descriptive statistics

The paper used data from the 2004 Botswana Agricultural Census for communal cattle farmers. Since this article is about cattle marketing, we extracted cattle farmers from the entire sample, resulting in a sample of 13,218 households.[4] Table 1 defines the variables used in the model and Table 2 presents descriptive statistics. The explanatory variables, for both Logit and Tobit models, include household characteristics, income sources, cattle herd dynamics, water sources, water source ownership, and hired labour. We also included district dummies to capture fixed regional effects, including transaction costs such as distance to market and other unobserved fixed regional effects.

About 42 percent of the sampled farmers sold cattle during 2004. This is comparable to the 46 percent found by BIDPA (2006). Average household size stood at 4 individuals, which is consistent with an earlier study (Central Statistics Office, 2008b). The average age of the head of the household is 58 years, signifying predominance of the elderly. About 75 percent of the households were male-headed, implying predominance of males in cattle farming. About 59 percent of the household heads were married.

[4] A few observations were left out due to missing entries for some of the explanatory variables.

**Table 1: Variable Definition**

| Variable | Description |
|---|---|
| Participation | Whether farmer sold cattle:1=Yes and 0 otherwise |
| **Household Characteristics** | |
| *HHSS* | Household Size (Total Number of people in the household) |
| *AGEH* | Age of the head of household |
| *Gender* | Gender of the Household head:1=Male and 0 otherwise |
| *Full time* | Whether the household head is full time farmer or not: 1= fulltime |
| *Married* | Whether the household head is married or not: 1=married |
| *Education* | Number of years of schooling for the household head |
| **Sources of Income** | |
| *Paid Employment* | Whether income was sourced from Paid Employment: 1=Yes |
| *Other business* | Whether income was sourced from Other Business:1=Yes |
| *Remittances* | Whether income was sourced from Remittances:1=Yes |
| *Pension* | Whether income was sourced from Pension: 1=Yes |
| **Sources of Food** | |
| *Own Production* | Whether the household sourced food from own production: 1=Yes |
| *Government Rations* | Whether the household sourced food from government: 1=Yes |
| *Relative and friends* | Whether the household sourced food from relatives and friends: 1=Yes |
| **Cattle Water Source** | |
| *Borehole* | Whether main water source is borehole: 1=Yes |
| *Well* | Whether main water source is well: 1=Yes |
| *Dam* | Whether main water source is Dam: 1=Yes |
| *River* | Whether main water source is River: 1=Yes |
| *Pan* | Whether main water source is Pan: 1=Yes |
| *Pond* | Whether main water source is Pond: 1=Yes |
| **Ownership of water source** | |
| *Self* | Whether the water source is owned by an individual: 1=Yes |
| *Family* | Whether the water source is owned by family: 1= Yes |
| *Syndicate* | Whether the water source is owned by a syndicate: 1 = Yes |
| *Community* | Whether water source is owned by the community: 1 =Yes |
| *Government* | Whether the water source is owned by government: 1 = Yes |
| **Herd Dynamics** | |
| *Herd- size* | Total number of cattle owned |
| *Deaths* | Total number of animals that died during the season |
| **Labour Input** | |
| *Hired Farm Labour* | Presence of hired farm labour: 1=Yes |

**Table 2: Descriptive Statistics**

| Variable | Mean | Std Deviation | Min | Max |
|---|---|---|---|---|
| Participation | .4206385 | 0.4936803 | 0 | 1 |
| **Household Characteristics** | | | | |
| *HHSS* | 4.00365 | 3.008922 | 1 | 30 |
| *AGEH* | 58.26033 | 14.98365 | 12 | 99 |
| *Gender* | .7498109 | .4331382 | 0 | 1 |
| *Full time* | .7363444 | .4406314 | 0 | 1 |
| *Married* | .5924497 | .493973 | 0 | 1 |
| *Education* | 3.226661 | 3.984259 | 0 | 19 |
| **Sources of Income** | | | | |
| *Paid Employment* | .3937056 | .4885893 | 0 | 1 |
| *Other business* | .1519897 | .3590245 | 0 | 1 |
| *Remittances* | .3113936 | .4630808 | 0 | 1 |
| *Pension* | .304736 | .4659142 | 0 | 1 |
| **Sources of Food** | | | | |
| *Own Production* | .3185051 | .4659192 | 0 | 1 |
| *Government Rations* | .0635497 | .2439583 | 0 | 1 |
| *Relative and friends* | .0309427 | .1731689 | 0 | 1 |
| **Livestock Water Source** | | | | |
| *Borehole* | .4315654 | .4953133 | 0 | 1 |
| *Well* | .2746255 | .4463423 | 0 | 1 |
| *Dam* | .1364806 | .3433111 | 0 | 1 |
| *River* | .1350431 | .3417826 | 0 | 1 |
| *Pan* | .0045393 | .672235 | 0 | 1 |
| *Pond* | .01445 | .119341 | 0 | 1 |
| **Ownership of water source** | | | | |
| *Self* | .1827811 | .3865015 | 0 | 1 |
| *Family* | .1201392 | .3251365 | 0 | 1 |
| *Syndicate* | .2422454 | .4284582 | 0 | 1 |
| *Community* | .1344379 | .3411351 | 0 | 1 |
| *Government* | .0566652 | .2312104 | 0 | 1 |
| **Herd Dynamics** | | | | |
| *Herd- size* | 42.18233 | 82.30366 | 1 | 1789 |
| *Deaths* | 3.9711 | 9.627004 | 0 | 350 |
| **Labour Input** | | | | |
| *Hired Farm Labour* | .3137388 | .4640292 | 0 | 1 |

Min: minimum, Max: maximum

Those who practiced cattle farming on a full time basis accounted for 74 percent of cattle producers. Average years of schooling are estimated at about 3, signifying low educational attainments. Similar observations were made by BIDPA (2006), which found that about 43 percent of communal farmers had attended primary school and that 24 percent were illiterate.

A majority of cattle farmers (39 percent) sourced cash income from *paid employment,* followed by *remittances* and *pensions,* with 31 and 30 percent, respectively. *Other business* was a source of income for 15 percent of the households. A significant proportion (32 percent) of the households sourced food from *own production*. Other food sources were *government ration* (6 percent of the households) and *supply from relatives and friends* (3 percent of the households).

Boreholes were the most common source of water for cattle, having been cited by 43 percent of the households. This is followed by wells (27 percent) and dams and rivers (with 14 percent each). Pans and ponds were cited by negligible proportions of households as water sources. Thus, underground water sources (boreholes and wells) are the most common water source for cattle. A majority of water sources belonged to syndicates[5] (24 percent), followed by individual households (18 percent), community (13 percent) and family (12 percent). Government owned water sources were used by only 6 percent of the households.

Average cattle herd-size is estimated at 42 animals, implying the predominance of smallholders. The average number of cattle deaths is about 4 animals. About 32 percent of the households used hired farm labor.

## 5. Results and policy implications

Table 3 presents the Logit regression results on cattle marketing decisions. The table reports coefficients, odds ratios and associated p-values. The coefficients give the change in the log of odds of the outcome (cattle sales) for a one unit change in the predictor variable while odds ratios give the odds of selling cattle (Gujarati, 1995). An odds ratio of more than 1 implies that there is more likelihood to sell cattle while a ratio of less than 1 suggests a less likelihood. The table also reports the marginal (or partial) effects, which represent a change in the probability of selling cattle due to a change in regressors. We also present Probit results for comparison purposes, but we do not interpret or discuss them.

The results of the Tobit regression, which models the number of cattle sold, are presented in Table 4. The marginal effects of the model, presented in column 4, represent how the observed variable (i.e number of cattle sold) changes with respect to changes in the regressors.

[5] A syndicate is a group of farmers who share a water point such as borehole, including operational and maintenance costs.

**Table 3: Regression Results for the Likelihood to Sell (Logit and Probit Models)**

| | Logit Regression | | | | Probit Regression | | |
|---|---|---|---|---|---|---|---|
| **Variables** | **Coeff.** | **P>Z** | **O. Ratio** | **Mag.Eff** | **Coeff.** | **P>Z** | **Mar. Prob** |
| **Household Characteristics** | | | | | | | |
| *HHSS* | -.0035159 | 0.603 | .9964903 | -.008614 | -.0026497 | 0.517 | -.0010371 |
| *AGEH* | .0065968 | 0.000*** | 1.006619 | .0016162 | .0044052 | 0.000*** | .001568 |
| *Gender* | -.0004011 | 0.994 | .999599 | -.0000983 | .0037676 | 0.910 | .0014744 |
| *Full time* | .1187806 | 0.031** | 1.126123 | .0289717 | .0706904 | 0.032** | .0275702 |
| *Married* | .2703796 | 0.000*** | 1.310462 | .0659041 | .1729254 | 0.000*** | .0673866 |
| *Education* | .0233387 | 0.000*** | 1.023613 | .0057179 | .014369 | 0.000*** | .0056243 |
| **Income Sources** | | | | | | | |
| *Paid Employment* | -.4991791 | 0.000*** | .6070288 | -.120724 | -.3034489 | 0.000*** | -.1175412 |
| *Other business* | -.2132662 | 0.000*** | .807941 | -.0515894 | -.1224078 | 0.000*** | -.047445 |
| *Remittances* | -.3501335 | 0.000*** | .704594 | -.0846956 | -.2156552 | 0.000*** | -.0835221 |
| *Pension* | -.1926576 | 0.000*** | .8247643 | -.0468996 | -.106754 | 0.001*** | -.041588 |
| **Sources of Food** | | | | | | | |
| *Own Production* | .2767003 | 0.000*** | 1.318771 | .0681269 | .164591 | 0.000*** | .0647007 |
| *Government Rations* | -.4305817 | 0.000*** | .6501308 | -.101517 | -.2700771 | 0.000*** | -.1023136 |
| *Relative and Friends* | -.28053 | 0.016** | .7553833 | -.0670806 | -.1665679 | 0.018** | -.0639473 |
| **Water Source** | | | | | | | |
| *Well* | -.1117913 | 0.036** | .8942309 | -.0272799 | -.0791226 | 0.014** | -.0308499 |
| *Dam* | -.0716323 | 0.370 | .9308731 | -.0174803 | -.057401 | 0.235 | -.0223687 |
| *River* | -.1899253 | 0.006*** | .8270209 | -.045991 | -.1363433 | 0.001*** | -.0527479 |
| *Pan* | .0230276 | 0.935 | 1.023295 | .0056505 | .0081166 | 0.962 | .0031795 |
| *Pond* | -.1317444 | 0.427 | .876565 | -.0319453 | -.1019888 | 0.309 | -.0394719 |
| **Water source ownership** | | | | | | | |
| *Family* | .100511 | 0.115 | 1.05736 | .0247742 | .056484 | 0.145 | .0221937 |
| *Syndicate* | .0398529 | 0.475 | 1.040658 | .0097774 | .0165485 | 0.624 | .0064827 |
| *Community* | -.1103038 | 0.147 | .895562 | -.026853 | .0723913 | 0.116 | -.0281737 |
| *Government* | -.2402011 | 0.011** | .7864697 | -.0577461 | -.1631409 | 0.004*** | -.0627325 |
| **Herd Dynamics** | | | | | | | |
| *Herd size* | .0103106 | 0.000*** | 1.010364 | .002526 | .0048176 | 0.000*** | .0018857 |
| *Deaths* | .0120254 | 0.000*** | 1.012098 | .0029462 | .0056635 | 0.000*** | .0022168 |
| **Labor Input** | | | | | | | |
| *Hired Labor* | .1578534 | 0.000*** | 1.170995 | .038807 | .1302553 | 0.000*** | .0511761 |
| Constant | -1.323198 | 0.000*** | | | -.7770833 | 0.000*** | |
| No. of observations | 13,218 | | | | 13,218 | | |
| LR chi2 (49) | 2044.04 | | | | 1955.24 | | |
| Prob>chi2 | 0.0000 | | | | 0.0000 | | |
| Pseudo $R^2$ | 0.1136 | | | | 0.1087 | | |

* **Significant at 1 percent, ** Significant at 5 percent, * Significant at 10 percent

**Table 4: Regression Results for the Number of Cattle Sold (Tobit Model)**

| Variables | Coefficient | P>t | Marginal Effects |
|---|---|---|---|
| **Household Characteristics** | | | |
| *HHSS* | -.0670305 | 0.170 | -.0194175 |
| *AGEH* | .0419314 | 0.000*** | .0121468 |
| *Gender* | .4589441 | 0.256 | .1322505 |
| *Full time* | .7239659 | 0.065* | .2080842 |
| *Married* | 1.739332 | 0.000*** | .5002727 |
| *Education* | .1771533 | 0.000*** | .0513181 |
| **Income Sources** | | | |
| *Paid Employment* | -3.504081 | 0.000*** | -.9989154 |
| *Other business* | -.5217099 | 0.194 | -.1498757 |
| *Remittances* | -2.132373 | 0.000*** | -.6066275 |
| *Pension* | -1.126226 | 0.002*** | -.322998 |
| **Sources of Food** | | | |
| *Own Production* | 1.26717 | 0.000*** | .3710372 |
| *Government Rations* | -3.048584 | 0.000*** | -.3710372 |
| *Relatives and friends* | -2.192249 | 0.011** | -.6059686 |
| **Water Source** | | | |
| *Well* | -1.452125 | 0.000*** | -.4144433 |
| *Dam* | -1.011615 | 0.092* | -.2881542 |
| *River* | -1.848188 | 0.000*** | -.519181 |
| *Pan* | .9765087 | 0.639 | .2892738 |
| *Pond* | -1.980267 | 0.099* | -.5490131 |
| **Water source ownership** | | | |
| *Family* | -.1259605 | 0.782 | -.036569 |
| *Syndicate* | -.4244704 | 0.286 | -.1223457 |
| *Community* | -1.120115 | 0.048** | -.3184542 |
| *Government* | -2.154207 | 0.002*** | -.5974535 |
| **Herd Dynamics** | | | |
| *Herd size* | .0815259 | 0.000*** | .0236166 |
| *Deaths* | .11005779 | 0.000*** | .0320324 |
| **Labour Input** | | | |
| *Hired farm Labour* | 2.590314 | 0.000*** | .7676784 |
| | | | |
| Constant | -12.28254 | 0.000*** | |
| Sigma | 13.18375 | | |
| | | | |
| No. of observations | 13,218 | | |
| LR chi2 (49) | 4451.55 | | |
| Prob>chi2 | 0.0000 | | |
| Pseudo $R^2$ | 0.0793 | | |
| | | | |

* **Significant at 1 percent, ** Significant at 5 percent, * Significant at 10 percent

## 5.1 Overall model results

Even though the Pseudo R-squares for the models appear to be low, this was expected for cross-sectional data (Kennedy, 2003). The Likelihood ratio chi-square of 2044.04 with p-value of 0.0000 indicates that the specified Logit model as a whole fits significantly better than an empty model (i.e a model with no predictors). This means that the considered variables significantly explain farmer participation in cattle marketing. Similarly, the Likelihood ratio chi-square of 4451.55 (with a p-value of 0.0000) shows that the Tobit model, as a whole, fits better than an empty model. Sigma is the "estimated standard error of the regression" (STATA Corp, 2009; p.120). Therefore, a value of 13.18375 is comparable to the mean squared root error obtained in the OLS method, which is an absolute measure of fit.

## 5.2 Household characteristics

Household size is statistically insignificant in influencing both the probability of selling cattle and the volume of cattle sold. While this is contrary to the study by Uchezuba et al. (2009) and Vincent et al. (2010), it is consistent with those of Ehui et al. (2009) and Musemwa et al. (2010).

Education of the head of household is highly significant in influencing both the probability of selling cattle and the number of cattle sold. An increase in years of schooling by one year would increase the probability of selling cattle by 0.6 percent and the number of cattle sold by 0.1 heads. This was expected as education improves farmers' access to market information as well as its utilization. Even though some argue that increased level of education may result in lower probability of cattle sales, arising from the opportunity costs of education (Kan et al., 2006; Ehui et al., 2009), such argument is not supported by the current findings for Botswana.

An increase in the household head`s age by one year would increase the probability of selling cattle by 0.2 percent and the number of cattle sold by 0.01 heads. This confirms results for Namibia (De Bruyn et al., 2001). Since older farmers are relatively more experienced, they are more likely to have established contacts with buyers, increasing the probability of market participation. Having a married household head increases the probability of selling cattle by 6.6 percent and the number of cattle sold by 0.5 heads. This may result from increased cash needs associated with marital responsibilities (Nnadi and Akwiwu, 2008).

Full time farming increases the probability of selling cattle by 2.9 percent and the volume of cattle sold by 0.2 heads. This might partly be because full time farmers depend more on cattle farming as a source of income, increasing the need to sell

and the number of cattle sold to finance household consumption and investment in cattle production. The less likelihood to sell by part-time farmers could be due to the possibility of them having alternative income sources to meet consumption needs and to finance cattle farming operations.

## 5.3 Sources of income

The different sources of cash income considered here are *paid employment*, *other business income*, *remittances* and *pension*. These are all binary variables. We expected these variables to have negative effects on both the probability of selling cattle and the number of cattle sold. Results are consistent with *a priori* expectation. Paid employment reduces the probability of selling cattle by 12.1 percent and the number of cattle sold by 1 animal. This is because the availability of an alternative income source yields reduced pressure on farmers to sell cattle. The results confirm the findings obtained in Kenya (Baldwin et al., 2008; Vincent et al., 2010).

Income sourced from *other business* has a significant effect on the probability of selling cattle but has no influence on the number of cattle sold. Sourcing income from *other business* reduces the probability of selling cattle by 5.2 percent. *Remittance* reduces the probability of selling cattle by 8.5 percent and the volume of cattle sold by 0.6 heads. *Pension* reduces the probability of selling cattle by 4.7 percent and the number of cattle sold by 0.3 heads; the results are consistent with the findings in South Africa (Makhura, 2001). In sum, and consistent with findings elsewhere (Makhura, 2001; Baldwin et al., 2008; Uchezuba et al., 2009; Ehui et al., 2009), alternative income sources reduce participation in cattle marketing.

Contrary to our expectation, *own production* increases the probability of selling cattle (by 6.8 percent) and the number of cattle sold (by 0.4 heads). It is not clear why this might be the case. However, as subsistence crop production is mainly in the purview of poorer smallholder farmers and due to low productivity in the sector (TRANSTEC and BIDPA, 2010), those participating might be having limited livelihood opportunities and undiversified income portfolios, implying that those of them owning cattle (though few) may be more compelled to participate in the market to meet immediate cash needs. Notwithstanding such possibility, the positive influence cannot, in the main, be logically explained.

*Government food rations* reduce the probability of selling cattle by 10.2 percent and the number of cattle sold by 0.4 heads. Thus, while government food rations are an important source of household food security, they negatively impact on cattle sales. *Food from relatives and friends* reduces the probability of selling cattle by 6.7 percent and the volume of cattle sold by 0.6 heads.

Overall, the results imply that publicly provided cash and food transfers discourage cattle sales. Therefore, if not well targeted to the poor or if they are associated with high leakages to the non-poor, such programmes would have far-reaching implications on the performance of the beef industry as they would stimulate the accumulation of cattle inventory and discourage sales.[6] Thus, they may further contribute to poor beef export performance. Cattle inventory accumulation may also exacerbate environmental degradation in communal areas, due to overstocking and, hence, overgrazing.

On the positive side, however, the provision of cash and food transfers, if well targeted, would allow poor cattle owners to accumulate inventory and to improve their welfare outcomes. Such stock accumulation may possibly allow the poor to escape intergenerational poverty. This, however, can only happen if such programmes are provided regularly and consistently over a number of years to allow the poor to achieve optimum herd-sizes that can sustain their families (see Abdulai et al., 2005; RHVP, 2010; and Grosh et al., 2008 for similar conclusions)

## 5.4 Main water sources for livestock

These are also binary variables and we chose *borehole* as a reference category. Results show that watering livestock from wells and rivers respectively reduces the probability of selling cattle by 2.7 and 4.6 percent, and the number of cattle sold by 0.4 and 0.5 heads. Sourcing water from *dams* has no significant effect on the probability to sell cattle but reduces the number of cattle sold by 0.3 heads. Sourcing water from a pond reduces the number of cattle sold by 0.5 heads but has no effect on the probability to sell cattle.

Arguably, the above sources of water for cattle are less likely to have higher user fees than boreholes; they are associated with lower production costs than boreholes. A farmer who owns a borehole (base variable) is expected to sell more cattle to finance the costs associated with running and maintaining it. In cases where a farmer does not own a borehole but uses one to water cattle, we expect him/her to contribute user fees to the owner. Hence, all borehole users (both owners and non-owners) should have a higher probability to sell cattle, as well as higher cattle sales volumes, than users of other water sources. Moreover, the use of boreholes, rather than rivers or dams, reduces the chances of cattle straying, leading to an increased likelihood of selling and number of cattle sold.

[6] Seleka et al. (2007) revealed that government transfer programmes in Botswana have a low coverage of the poor; they highly leak to the non-poor. This implies that targeting of these programmes to the poor would likely reduce their adverse impact on cattle marketing.

## 5.5 Water source ownership

Compared with individual (self) ownership (the base variable), family ownership of the main water source has no effect on both the probability of selling cattle and the number of cattle sold. This is expected as individual ownership and family ownership imply that the household has a stake in the water source. Water source ownership by a syndicate also has no effect on both the probability of selling cattle and the volume of cattle sold, also because a member of a syndicate has a stake in the water source.

Community ownership of a water source has no effect on the likelihood to sell cattle, but reduces the number of cattle sold by 0.3 heads. The use of a *government-owned* water source reduces the probability of selling cattle by 5.8 percent and the number of cattle sold by 0.6 heads. In sum, the negative coefficients are attributed to the lower costs of utilizing (running and maintaining) a community or government-owned water source, compared to individual ownership of the water source; lower costs reduce the need to market cattle.

## 5.6 Herd dynamics

Cattle herd-size increases the probability of cattle sales and the number of cattle sold. An increase in herd-size by one animal increases the probability of selling cattle by 0.3 percent and the volume of cattle sold by 0.2 heads. Cattle deaths also have a positive influence on sales decisions as well as on the number of cattle sold. An increase in the number of deaths by one animal would increase the probability of selling cattle by 0.3 percent and the number of cattle sold by 0.03 heads. This may imply that farmers sell more cattle as a risk aversion strategy, to guard against the likelihood of the occurrence of further deaths. Montshwe (2006) also observed a similar pattern in South Africa.

## 5.7 Hired labour input

Having hired farm labour increases the likelihood to sell cattle, as this is a form of cost that needs financing. This increases the probability of selling cattle by 3.9 percent. Moreover, the presence of hired farm labor increases the number of cattle sold by 0.8 heads, due to the need to pay wages.

## 6. Summary and conclusions

This paper examined factors underlying communal beef cattle marketing decisions in Botswana. Results show that cattle market participation is significantly influenced by household characteristics such as age, marital status, and education of the head of household. Age of the household head has a positive impact on the probability of selling cattle and the number of cattle sold. Households with married heads are more likely to sell cattle than those headed by unmarried individuals. This might be due to marital responsibilities.

Household size does not have a significant effect on both the probability of selling cattle and the volume of cattle sold. Education level of the head of household positively influences both the probability of selling cattle and the volume of cattle sold. This suggests that education is used as an input in utilizing market information, which enhances market participation.

Full-time farmers are more likely to sell cattle than part-time farmers. This might be due to the limited availability of alternative income sources to finance consumption and cattle farming operations. Put differently, part-time farmers are more likely to finance consumption and farming operations from income earned elsewhere, while full-time farmers are forced to sell cattle to finance consumption and farming operations.

When measured against using boreholes, sourcing water from wells and rivers reduces both the likelihood of selling cattle and the number of cattle sold, while sourcing water from dams and ponds only reduces cattle sales. This is because boreholes have higher operation and maintenance costs than these other water sources, which may need financing through cattle sales. When measured against self ownership, ownership of main water source by a community only reduces cattle sales, whereas government ownership reduces both the probability of selling cattle and the number of cattle sold. This is attributed to the fact that operating a self-owned water source may be more costly than using community- or government-owned water sources, and would require selling cattle to finance operation and maintenance costs.

The key finding of this study is that off-farm income sources (*pensions*, *remittances*, *paid employment*, *other business*, *government food rations*, and *food supplies from relatives and friends*) reduce both the probability of selling cattle and the volume of cattle sold. These results were expected for an extensive communal production system where the general motive is to accumulate cattle inventory as a store of wealth (BIDPA, 2006). In this production system, cows and bulls are the current breeding stock while heifers and female calves are the future breeding stock.

Oxen are usually the candidates for marketing, while tollies will be marketed in the near future after reaching full maturity. Cows and bulls are marketed only for culling purposes or when there are emergency cash needs that need financing and there are not enough oxen to sell. Similarly, tollies and heifers may be sold for the same reason. Under the production system, having alternative sources of income reduces emergency cash and food needs, leading to cattle inventory accumulation (to store wealth) and reduced market participation.

The question is whether the results present a policy dilemma as alternative income (cash and food) sources include government support programmes meant to reduce poverty. Thus, while these programmes increase household food security, they also discourage farmers from marketing cattle and hence may contribute to poor beef export performance, and lower foreign exchange. Cattle inventory accumulation may also lead to environment degradation from overstocking and overgrazing. There is need, therefore, to ensure that such programmes are targeted to the poor to minimize their adverse impact on the beef industry. The results also imply that public cash and food transfers may allow poor households to rebuild their livestock inventory and to possibly get uplifted out of intergenerational poverty traps. Therefore, if well targeted and provided consistently and regularly to the poor, over a long period of time, some of these programmes would likely bring about positive welfare outcomes for the poor. Hence, the poor would escape intergenerational poverty, through rebuilding of productive assets (such as livestock).

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