

Evaluating the productivity gap between commercial and traditional beef production systems in Botswana

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Outline

- Background
- Research Problem
- Objectives
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Background

- Beef sector in the economy:
  - **main source of income for the rural population**
  - **contributes 80% to Agricultural GDP and only agricultural export.**

- Beef cattle production system is **dualistic** in structure **(80% traditional and 20% commercial production)**:
  - **Commercial production**
    - Under secure land tenure (private ranches) with own boreholes
    - employs modern animal husbandry e.g., feeding and breeding control
    - Raise their cattle in order to profit by their sales
    - high birth and off-take rates and low death rates
  - **Traditional production**
    - under communal grazing land system
    - employs primitive livestock management
    - sell under duress

Background

- The beef sector is currently facing serious challenges:
  - In recent years, both **cattle sales for slaughter** and **beef exports** have declined significantly.
  - **productivity has been declining.**

- The government has implemented various reforms to address this. In spite of this, productivity is continuing to decline, because of:
  - **low efficiency levels** and **many small scale farms**.
  - **slow adoption of improved breeds** and **feeding technologies**.
  - worsened by the **semi-arid production environment** in Botswana.
  - **frequent outbreaks of disease** such as foot and mouth (FMD).

Research Problem

- Prior research on Botswana beef sector has shown that:
  - **productivity is declining.**
  - **productivity tends to be related to herd size rather than land tenure.**
  - **production costs tend to decline with herd size, indicating economies of scale.**
  - **large herds tend to be more drought resilient than small herds.**
- However, studies have failed to account for heterogeneity amongst beef production systems and their analyses are now outdated.
- **The question that remains is, does the differences among the beef production systems in Botswana have an effect on efficiency and productivity?**
  - **so, how do we account for heterogeneity in production systems?**

Objectives

- To measure and compare the production technologies and productivity of traditional and commercial beef production systems in Botswana.
- To explore some of their performance drivers.
- To explore whether performance is related to land tenure system.

Data

- **Balanced panel data** (collected by Statistics Botswana)
  - 10 year period (2004 to 2013).
  - 26 traditional agricultural districts.
  - 15 commercial agricultural districts.

- **Production model**
  - **Outputs**: value of beef cattle
  - **Inputs**: labour, no of cows, other costs and dummies (time, region and tenure).

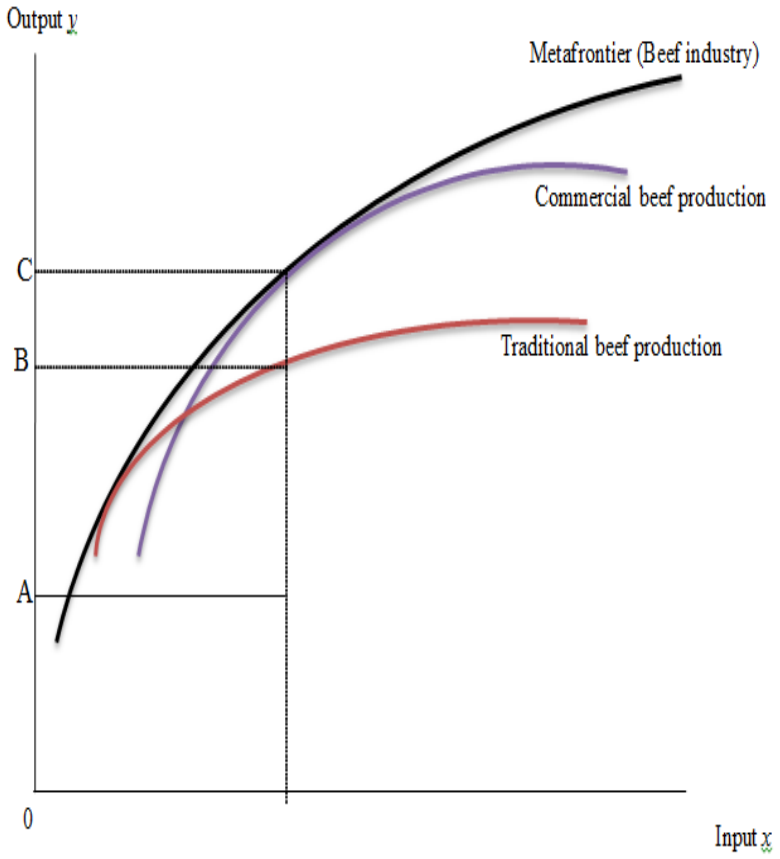
- **Inefficiency Model**
  - Herd size, off-take rates, birth rates, death rates, breed, market, land tenure system, regional dummies and time.

Estimation Procedure

Stochastic Metafrontier

- Individual group frontier (SFA)
- Metafrontier production function to estimate TE and meta-technological ratios.
- Hypothesis Testing

Figure A1: Technical efficiency (TE) and metatechnology ratios (MTRs) of beef production systems in Botswana



Results: Production Model

- **first order coefficients positive** and **significant**.
- **LU** and **labour** are the most important inputs, **costs** also plays a significant role in commercial.
- **secure land tenure rights contribute positively to production**.
- commercial farms are **slightly more efficient** than traditional farms.
- **increasing returns to scale**.
- **decreasing technical change** for commercial
- **increasing technical change** for commercial.

	Commercial	Traditional	Botswana
LU	**0.456*** **	**0.825*** **	**0.900*** **
Labour	**0.403** **	**0.263*** **	**0.201*** **
Costs	**0.151** **	-0.017	**-0.006*** **
Tenure	**0.340*** **	-	**0.278*** **
TC	-0.044	0.006	**0.046*** **
TE	0.81	0.79	0.80
RTS	1.01	1.07	1.10

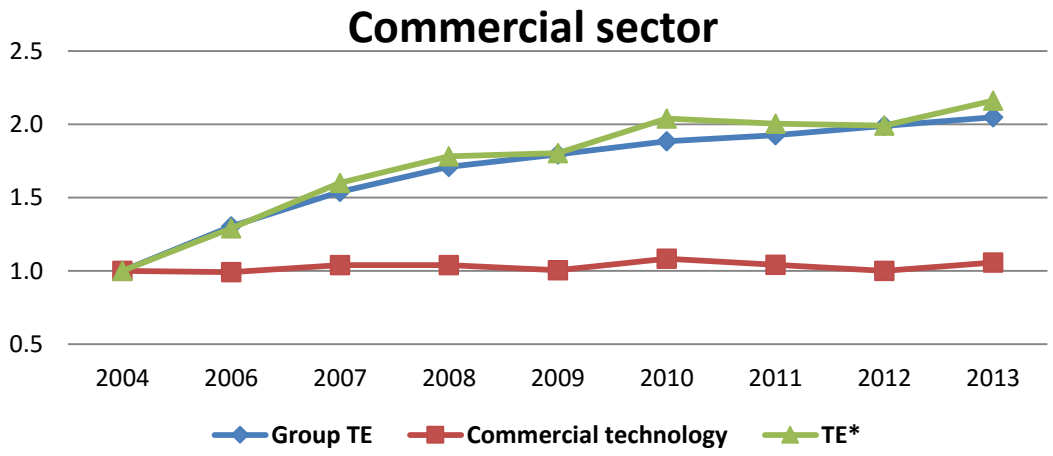
Results: Inefficiency Model

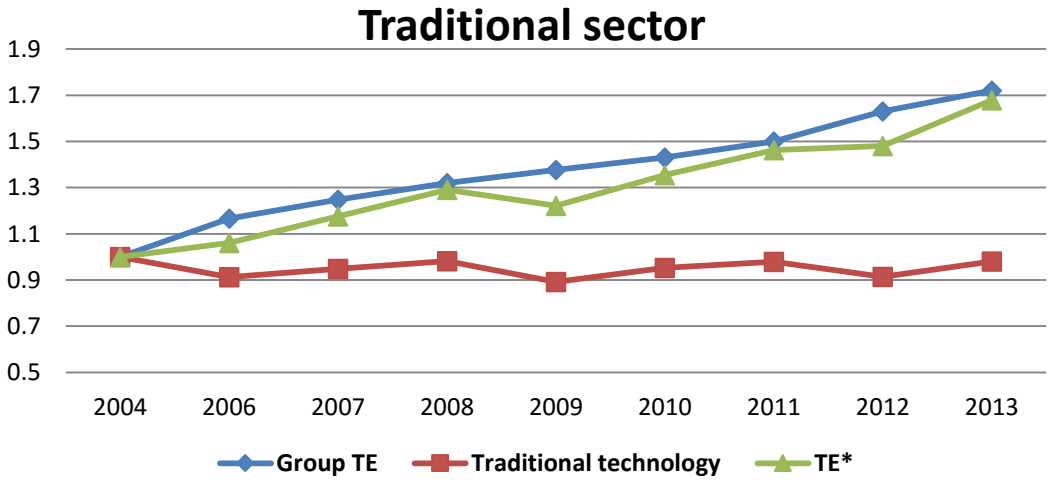
- Commercial beef production:
  - **herd size** is associated with **higher productive efficiency.**
  - **use of exotic and cross breeds has a positive relationship with efficiency.**
  - **off-take rates and selling to export markets has a positive effect on efficiency.**
- Traditional beef production:
  - **herd size has a negative effect on efficiency.**
  - **off-take rates are positive and significant.**

	Commercial	Traditional
Herd size	-0.001	0.002
Offtake rate	**-0.153*** **	**-0.853*** **
Birth rates	0.009	-0.004
Death rates	-0.190	-0.001
Market	**-0.021***	-0.009
Exotic breed	**-0.100** **	0.034
Cross breeds	**-0.085*** **	0.028
time	-0.034	-0.091

Results: Productivity and technological measures

- TFP (TE*) has been gradually increasing in both systems:
  - **the main contributor was TE in both systems.**
  - **positive production technology slightly contributed to the growth in commercial production.**
- **Commercial farms** are more efficient within and as compared to traditional farms.





Conclusion

- Significant Differences in production technology between traditional and commercial beef farming.
  - **Farms under secure (freehold) land tenure performed better.**

- The performance of beef producers are influenced by **market based**, **biological** and **genetic characteristics**.

- Farmers use available technology sub-optimally and produce far less than their potential output:
  - **average technology is 0.92 and TE is 0.74 for commercial production.**
  - **average technology is 0.89 and TE is 0.71 for traditional production.**

Conclusion

- **The implications of the results are that, in order to improve agricultural performance in Botswana:**
  - **support programs and technologies should be made relevant to and should target high potential areas and sub-sectors.**
  - **Access to appropriate knowledge on cattle feeding methods and alternative feeds may help.**
  - **Provision of relatively better technology (e.g., locally adaptable and affordable cattle breeds).**

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Thank you

Further Research

- **More empirical research** needs to be done to investigate the productivity and technological differences between the two beef production systems using **farm level data** from the **same agro-ecological region**.

- Also, with more data within the commercial production system, there is potential to separate farmers according to the land tenure (i.e., **TGLP ranches versus freehold ranches**), thus allowing investigation of the relationship between **farm size**, **land tenure** and **productivity** on which the **empirical evidence remains mixed**.

Summary statistics

Variables	Traditional production	Commercial production
No. of observations	234	135
Beef Output (000's BWP)	5614.61 (4110.34)	3455.76 (6526.18)
Labour (000's BWP)	3986.29 (2805.95)	74.54 (90.48)
No. of cows (000's LU)	50.86 (35.26)	11.38 (14.68)
Other costs (BWP)	19.24 (13.74)	2324.83 (7729.41)
Herd size (LU/farm household)	19.84 (11.18)	305.31 (480.34)
Offtake rate rates (%)	7.55 (3.38)	13.09 (14.57)
Birth rates (%)	55.33 (9.59)	38.51 (17.76)
Death rates (%)	9.75 (8.73)	4.39 (2.39)
Export market access (%)	35.11 (23.45)	50.84 (28.96)
Local breed (%)	55.03 (19.63)	8.08 (11.95)
Exotic breed (%	4.44 (7.07)	34.83 (23.18)
Crossbreed (%)	40.53 (19.73)	57.08 (25.91)
Land tenure dummy		0.40 (0.49)

Specifications Tests

	Test statistic	Critical Value	Decision
Model 1 (Traditional)			
CD vs.TL	19.70	15.51(8)	Reject H0 at 5% level
No Technical Change	16.43	5.99(2)	Reject H0 at 5% level
Time varying vs time invariant model	11.74	7.81(3)	Reject H0 at 5% level
Technical inefficiency	214.53	22.36(13)	Reject H0 at 1% level
Constant returns to scale	1.07	3,84(1)	Accept H0 at 1% level
Model 2 (Commercial)			
CD vs.TL	43.94	16.92(9)	Accept H0 at 1% level
No Technical Change	248.08	5.99(2)	Reject H0 at 5% level
Time varying vs time invariant model	19.28	7.81(3)	reject H0 at 5% level
Technical inefficiency = 0	61.51	16.92(9)	Reject H0 at 1% level
Constant returns to scale	1.01	3,84(1)	Accept H0 at 1% level
Pooled vs. Group Frontiers	148.30	76.15(50)	Reject H0 at 1% level

Results: Production model

	Commercial beef production		Traditional beef production		Metafrontier	
Beef output	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Labour	**0.403****	0.188	**0.263*****	0.090	**0.201*****	0.00490
Livestock units (LU)	**0.456*****	0.123	**0.825*****	0.089	**0.900*****	-0.00185
Costs	**0.151****	0.071	-0.017	0.048	**-0.006*****	-0.00155
Time	-0.044	0.030	0.006	0.012	**0.046*****	-0.00070
Labour^2	-0.054	0.359	0.183	0.152	**-0.120*****	-0.00157
LU^2	0.164	0.248	0.162	0.196	**0.262*****	0.00161
Other Costs^2	**0.174*****	0.045	0.026	0.033	**0.168*****	-0.00087
Labour × LU	0.332	0.479	-0.475	0.349	**0.036*****	-0.00060
Labour × Costs	-0.146	0.197	-0.012	0.123	**-0.002*****	0.00621
LU×Costs	**-0.364*****	0.119	-0.077	0.136	-0.444	-0.00155
Labour × Time	-0.048	0.034	**-0.041*****	0.013	**-0.036*****	0.00028
LU × Time	**0.035****	0.018	0.012	0.012	**-0.014*****	-0.00055
Costs× Time	-0.003	0.011	0.011	0.007	**0.021*****	0.00237
Time^2	0.003	0.003	-0.001	0.001	**-0.012*****	0.00000
Gaborone	**-0.317*****	0.111	**0.050***	0.027	**-0.065*****	0.00048
Central	**-0.287*****	0.087	**0.048***	0.030	**-0.070*****	0.00265
Francistown	**-0.347*****	0.074	0.015	0.036	**-0.105*****	-0.00150
Maun	**-0.292****	0.125	-0.016	0.041	**-0.134*****	0.00006
Western	**-0.229****	0.094	**0.061***	0.033	**-0.053*****	0.00043
Tenure	**0.340*****	0.068	-	-	**0.278*****	0.00337
Constant	**0.394*****	0.125	**0.107*****	0.038	**0.192*****	0.02090
Log-likelihood function	38.82		238.91			
Returns to scale	1.01		1.07		1.096	

Results: Efficiency Model

Commercial beef production			Traditional beef production		
Beef output	**Coefficient**	**Standard error**	**Beef output**	**Coefficient**	**Standard error**
Tenure	**2.062***	1.249	**Tenure**	-	-
Herd size	-0.001	0.001	**Herd size**	0.002	0.022
Offtake rate	**-0.153*****	0.048	**Offtake rate**	**-0.853*****	0.110
Birth rate	0.009	0.011	**Birth rate**	-0.004	0.017
Death rate	-0.190	0.129	**Death rate**	-0.001	0.031
Market	**-0.021***	0.012	**Market**	-0.009	0.016
Exotic breed	**-0.100****	0.035	**Local breed**	0.034	0.029
Cross breeds	**-0.085*****	0.024	**Crossbreed**	0.028	0.028
Gaborone	-6.613	11.345	**Gaborone**	0.167	0.751
Central	-0.446	0.690	**Central**	**1.666****	0.817
Francistown	-1.800	1.398	**Francistown**	0.690	0.803
Maun	-1.331	1.512	**Maun**	-0.378	0.740
Western	-0.596	0.836	**Western**	**2.887*****	1.068
time	-0.034	0.104	**time**	-0.091	0.083
Constant	**9.435*****	2.989	**Constant**	180.606	166.223

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