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WELFARE EFFECTS OF SMALLHOLDER FARMERS' PARTICIPATION IN LIVESTOCK MARKETS IN ZAMBIA

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WELFARE EFFECTS OF SMALLHOLDER FARMERS' PARTICIPATION IN LIVESTOCK MARKETS IN ZAMBIA

Does participation in livestock markets improve the welfare levels of smallholder farmers in Zambia? Are there any biases in the distribution of benefits between poor and better off households? To address these questions, we employ propensity score matching and decomposition techniques on nationally representative household survey data collected from smallholder farmers in Zambia. Our findings suggest that, other factors constant, participation in cattle markets raises household income by over 50% on average among cattle selling households. However, decomposition results suggest that poor households derive relatively smaller benefits from participation than their non-poor counterparts due to discrimination which accounts for 80.3% of the inter-group income differential.

Key words: livestock market participation; smallholder farmers; income; propensity score matching; decomposition; Zambia

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The demand for livestock and its associated products in developing countries is increasingly rapidly. This trend is expected to continue rising for the next decade with production in the livestock sector growing faster than any other agricultural sub sector (Delgado et al, 1999). Growth in demand for livestock products is expected to stem primarily from human population growth, increasing urbanization and rising incomes. As a result of growing affluence among urban populations, an increasing share of the urban food basket is dedicated to the purchase of livestock products. Ideally, through effective urban-rural synergies, urban demand growth for livestock products can serve to create markets for smallholder livestock producers thereby contributing to rural poverty reduction and economic growth.

Several studies have reported on factors affecting smallholder farmers' participation in livestock markets and the contribution of livestock to household incomes (Davies et al., 2007; Maltsoglou and Rapsonimaniks, 2005). The extent to which livestock market participation contributes to household incomes depends on several factors including socio-economic characteristics of the household, such as age of household head, household size, distance to markets, and location of household. Available empirical evidence about who derives more income from livestock sales – better off households or poor households – is conflicting. For

example, evidence from Pakistan, Malawi, India, Asia, Latin America, and the Philippines shows that livestock sales contribute more to poorer households' incomes than to the incomes of better off households (Pica-Ciamarra et al., 2011). On the other hand, Wouterse and Taylor (2008) find that in Burkina Faso livestock sales contribute more to the better off households' incomes. While these studies present valuable information, none of them has employed econometric techniques to estimate the effects of livestock market participation on household incomes. Rather, the studies have based their finding on bivariate analysis, which fails to control for other factors that may affect incomes. Failure to control for other factors could potentially lead to biased estimates of the income effects of livestock market participation.

Using national representative household panel survey data collected from smallholder farm households, this article seeks to address the following questions. Does participation in livestock markets improve the income levels of smallholder farmers in Zambia? Are there any biases in the distribution of benefits between poor and better off households? The article focuses on cattle raising households in particular.

Rural poverty rates in Zambia have remained stubbornly high near 80% for more than a decade (CSO, 2009, 2011). This study provides useful empirical evidence on the potential for livestock market participation to contribute to raising incomes and reducing poverty among smallholder farmers in general and among poor households in particular.

The remainder of the article is organized as follows. The next section describes the data used in the study. This is followed by a description of the estimation methods employed, and then the results and discussion. Conclusions and policy implication are discussed in the last section.

Data

This study uses three waves of nationally representative survey data collected from smallholder farm households in Zambia in 2001, 2004, and 2008.[1] The three waves of the survey were implemented by the Zambia Central Statistical Office (CSO) and the Ministry of Agriculture and Cooperatives (MACO) in collaboration with Michigan State University's Food Security Research Project (FSRP). In the first wave (2001), 6,922 households were interviewed while in second wave (2004), 5,419 were interviewed. In the 2008 survey, a total of 8, 094 smallholder households were interviewed. We treat each survey wave as separate pooled cross sectional data. Of the 20,435 pooled households, only 4,261 (20.8%) households owned cattle.In each wave, data on the households' cropping patterns, crop and livestock production and marketing, asset ownership, income sources, and socio-demographic information on the household members were collected. For more details about survey design and sampling procedures, see Megill (2004; 2008).

Welfare Effects indicator

There are several approaches for defining and measuring the welfare or well-being of a household. Traditionally, household income or expenditure is used as a measure of welfare. However, in many developing countries, expenditure is viewed as the preferred welfare indicator because income is often under reported (Meyer and Sullian, 2003; Ravallion, 1992). However, accurately estimated income aggregates can serve as an important indicator of household well-being and provide a wealth of information about income strategies and inequality (Covarrubias, de la O Campos, and Zezza, 2009). Moreover, collection of consumption data tends to be much more costly for any given sample size and datasets with consumption information are often much smaller.

[1] Smallholder households are farmers who cultivate less than 20 ha of land.

In this article we consider total smallholder household income as a measure of welfare. The household income includes gross value of crop production, gross value of vegetable and fruits production, gross income from livestock sales, value of animals slaughtered for home consumption, value of production of eggs, milk, broiler chicken and fish. We also include off-farm income from formal and informal business activities, salaries and wages, as well as cash and in-kind remittances received. Total household income for 2001 and 2004 were adjusted for inflation using the consumer price index. The base period for real income is 2008. To ensure intra-household comparisons, we adjust the household income by adult equivalent

Theoretical and Empirical Framework

In this article, we draw on the theoretical framework from Roy's self-selection model that was developed in the study of occupational choice and its consequences on the distribution of earnings (Roy, 1951). Similar to Roy's model, where individuals select an optimal choice between fishing and hunting based on their skills and abilities, our model assumes that an individual will choose to participate in livestock markets based on utility maximization. Thus, the objective of the decision marker is to maximize utility and an individual will always choose the alternative for which utility is maximal (Baltas and Doyle, 2001).

If we assume total utility as a function of household income (including livestock income), then the utility function can be expressed as;

$$U_{ji} = \alpha(Y_{ji}) + \varphi' z_{ji} + e_{ji} \qquad (1)$$

where Y_{ji} is the household income, z_i are observed factors that affect total utility, e_{ji} is a random component capturing the unobserved factors, i denotes an individual while j is an index (1, 0) representing the decision whether to participate or not respectively. Individuals

compare utilities associated with each decision, in this case participation and non-participation in livestock markets, before the choice is made. If we let V be the difference in the utilities of the participation and non-participation decisions,

$$V_i = U_{1i} - U_{0i} = \alpha(Y_{1i} - Y_{0i}) + \varphi' z_{ji} + e_{ji} \quad (2)$$

where Y_{0i} and Y_{1i} are household income associated with participation and non-participation in livestock markets, respectively. The difference in utilities is however not observed and only the decision that the individual takes is observed such that;

$$J_i \in j = \begin{cases} 1 \text{ if } V > 0 \\ 0 \text{ otherwise} \end{cases} \quad (3)$$

The individual is assumed to select the alternative that provides the greatest utility. The utility derived from participation will motivate the individual to participate in livestock markets only if it is greater than that derived from the other alternative, non-participation Therefore, the gain from participation can be expressed as follows;

$$ATE = E(Y_{1i} - Y_{0i}) \quad (4)$$

where Y_{1i} is the expected income level if household *i* participates in livestock markets and Y_{0i} is the expected income level of household *i* if it chooses not to participate, and w is dummy for participation (=1 if a household participates and 0 otherwise). Equation 4 estimates the expected value of the difference (impact) between the level of income attained by households participating in cattle markets and that which they would have attained had they not participated (Ravallion, 2001; Ravallion, 2006.). . The difference in incomes is referred to average treatment effect (ATE)

A well-recognized problem in impact evaluation in non-randomized settings is missing data. Outcomes are only observed in one state (participation or non-participation); the counterfactual is unobservable. In the absence of counterfactual income for participating households, the average income for non-participating households can be used to estimate the average treatment effect. However, a bias will arise if there are systematic differences between participants and non-participants that affect the household's decision of whether to participate or not (Dehejia and Webha, 2002). This bias (b) is given by:

$$b = E(Y_{0i} \mid w_i = 1) - E(Y_{0i} \mid w_i = 0) \qquad 5$$

In the impact evaluation literature, b is termed as selection bias. This bias could be corrected if $E(Y_{0i} \mid w_i = 1)$ were known. Unfortunately, the level of participants households income had they not participated cannot be observed. However, advanced econometric tools have been developed to minimize the bias in measuring the impact of the program such as the instrumental variables and propensity score approaches (see Ravallion, 2006). In this article, we employ propensity score matching techniques to evaluate the welfare effects of participating in livestock markets. The idea behind matching is that if non-participating households have the same probability of participation as the participants, the average income for non-participants approximates what the participating households would have attained had they not participated. The difference in the average incomes for the two groups (average treatment effect) would yield unbiased estimates of the impact of participating in livestock markets and this would be equivalent to Average Treatment Effect on the Treated (ATT).

$$ATT = E(Y_{1i} - Y_{0i} \mid w_i = 1), \qquad (6)$$

Estimation of the Propensity Scores

Ravallion (2006) characterizes various methods used to estimate impact under quasi-experimental conditions. Propensity score matching (PSM) presents a unique set of

techniques for reconstructing an experimental environment out of non-random, quasi-experimental conditions. The propensity score (PS) model is specified as:

$$Prob(w = 1) = \Phi\,(\alpha + \boldsymbol{\beta}'X + \varepsilon) \qquad (7)$$

where w is a dichotomous participation variable, X is a vector of household socio-economic attributes or covariates deemed to affect participation, Φ is a standard normal cumulative distribution function (CDF) , ε is the error term, and α and β are parameter and vector of parameters to be estimated, respectively. Equation (6) was estimated using maximum likelihood (ML).

PSM is a valid measure of the impact of participation if certain conditions are satisfied (Caliendo and Kopeinig 2008). The matching strategy requires that the covariates *X* that are included in the model satisfy the condition of independence between the outcome variable and the treatment conditional on the PS and that the covariates should at least be significantly correlated with the outcome variable (Brookhart *et al*., 2006). Thus, only variables that are significantly correlated ($p<0.10$) with the outcome are included in the model. The covariates should also be unaffected by participation (Brookhart *et al*., 2006; Caliendo and Kopeinig, 2008).

As robustness check on the results, we use four different matching estimators: nearest neighbor, radius, kernel and stratification matching. For more details about the different matching estimators, see Dehejia and Wahba (2002) and Becker and Ichino (2002).

Estimating the Income Gap between the poverty class

To estimate and analyze the income gap between household living below the poverty line and those living above the poverty line in more detail, we employ the Blinder-Oaxaca three-fold

decomposition technique developed by Blinder (1973) and Oaxaca (1973) and summarized by Jann (2008). More specifically, we compare household incomes for participating households between households living below the poverty line and those above the poverty line.[2] Thus the mean outcome difference (R) is expressed as:

$$R = E(Y^a) - E(Y^b) \tag{8}$$

where $E(Y)$ is the expected value of household income. The a and b index non-poor households and poor households respectively. We estimate $E(Y)$ separately for the sub groups defined by poverty class of the household as

$$Y^j = \bar{X}\hat{\boldsymbol{\varphi}}^j + \hat{e}^j \tag{9}$$

where $j = a\ or\ b$ and $\boldsymbol{\varphi}$ is a vector of parameter estimates

In participation studies, sample selection bias is potentially likely to occur especially when households do not create random sub-sample of the population. We thus employ the Heckman selection model to correct for any potential selection bias. This entails adding the inverse mills ratio to the income regression. The equation 9 becomes,

$$Y^j = \bar{X}\hat{\boldsymbol{\omega}}^j + \hat{\theta}^j\hat{\lambda}^j, \text{ where } \hat{\lambda}^j = \frac{\varphi(V\gamma)}{\phi(V\gamma)} \tag{10}$$

Where vector X includes all explanatory variables of the income equation, φ and ϕ signify standard normal density and distribution functions respectively, V represents the vector of explanatory variables of the participation equation that should differ from that included in the income equation and $\hat{q}^j$ is the parameter estimate on the inverse mills ratio $\hat{\lambda}^j$.

[2] The poverty line in this article is defined at USD1.25 per adult equivalent per day. For simplicity, we henceforth refer to households below the poverty line as "poor households" and households above the poverty line as "non-poor households". The Blinder-Oaxaca decomposition techniques are often used to analyze wage gap between sex or race.

Taking the difference of the income equations between the two different poverty classes, equations 11 identifies the contribution of group differences in the covariates to the overall outcome difference:

$$Y^a - Y^b = (\bar{X}^a - \bar{X}^b)\hat{\beta} + \bar{X}^b\left(\hat{\beta}^a + \hat{\beta}^b\right) + (\bar{X}^a - \bar{X}^b)\left(\hat{\beta}^a + \hat{\beta}^b\right) + \left(\hat{\theta}^a\hat{\lambda}^a - \hat{\theta}^b\hat{\lambda}^b\right) \quad (11)$$

Following Reimers (1983), we net out the last part to obtain the sample selection bias-corrected income differential estimates. This yields the three-fold decomposition (equation 12) which divides the outcome difference into three parts.

$$Y^a - Y^b = (\bar{X}^a - \bar{X}^b)\hat{\beta} + \bar{X}^b\left(\hat{\beta}^a + \hat{\beta}^b\right) + (\bar{X}^a - \bar{X}^b)\left(\hat{\beta}^a + \hat{\beta}^b\right) \quad (12)$$

The first part of the right hand side of equation 12 measures the proportion of income gap due to group differences in the discrimination. This is the expected change in the group of poor households mean income if they had endowments of non-poor households The second component measures the contribution of differences in the estimated parameters including the intercept. It measures the expected change in the group of poor households' mean income if they had coefficients non-poor households. The third component accounts for measures in the differences in endowments and coefficients simultaneously.

Results and Discussion

As a prelude to the econometric results, we first briefly discuss descriptive statistics that distinguish different groups and correlations for selected variables. Table 1 presents sample means for different groups based on market participation status (cattle market participants and non-participants), and the poverty status (poor and non-poor households).

Table 1. Summary Statistics

	Participation status in cattle markets			Poverty class among participants		
	non-participants	participants		Above poverty line (non-poor)	Below poverty line (poor)	
Demographics						
Male headed household (=1)	0.87	0.87		0.86	0.87	
Number of HH members	7.29	8.17	***	7.25	8.66	***
Adult equivalents	6.04	6.82	***	6.09	7.21	***
Age of household head (years)	50.18	51.86	***	51.38	52.12	
Years of schooling of HH head	5.95	6.73	***	8.10	6.00	***
Assets						
Number of cattle owned	7.66	20.81	***	32.83	14.39	***
Number of cattle sold				4	2	***
Number of pigs owned	1.39	1.36		1.67	1.19	*
Number of sheep owned	0.23	0.8	***	1.46	0.44	***
Number of goats owned	3.47	5.24	***	6.72	4.45	***
Landholding size (ha)	4.00	5.05	***	7.32	3.83	***
Welfare indicators						
Value of assets (ZWK)	5,632	15,322	***	27,966	8,558	***
Household income (ZWK)	1,616	2,548	***	5,712	856	***
Crop share of total income	70.63	44.71	***	41.82	46.25	***
Livestock share of total income	6.99	36.15	***	26.19	41.48	***
Off-farm share of total income	22.22	19.14	***	31.98	12.27	***
HCI (%)	31.66	30.71		43.66	23.79	***
Social capital						
HH related to village authorities (=1)	0.46	0.47		0.39	0.52	***
Number of years settled in the area	24.54	26.26	***	25.00	26.94	*
Accessibility						
Distance to nearest main road (km)	21.23	20.51		19.28	21.16	
Distance to nearest district town (km)	31.79	32.88	*	31.43	33.65	*
Number of observations	**3,161**	**1,099**		**383**	**716**	

Note: *p<0.10, **p<0.05, ***p<0.01; HCI=household crop commercialization index defined as (gross value of crop sales/gross value of crop production)*100; The 2008 Zambia Kwacha to US$ exchange rate was 3.829:
Source: CSO/MACO/FSRP Supplemental Survey.

The results in table 1 show statistically significant differences between participants and non-participants in most of the key variables such as demographic characteristics, assets and income. The results show that the two sub-samples are generally not well-balanced with respect to most attributes. Non-participating households have lower incomes and value of assets on average than their participating counterparts. There are also significant differences in the means for most attributes between the poor and non-poor among households who

participate in cattle markets. For example, poor households are less educated and have fewer animals on average compared to non-poor households. They also tend to sale less cattle compared to non-poor households. Interestingly, livestock accounts for an average of 41% of household income for poor households whereas their non-poor counterparts have an average of 26% of income coming from livestock..

Propensity Scores Estimation

Participation in livestock markets is influenced by various factors (see for example, Musemwa et al. 2010; Ehui, Benin, and Paulos 2003; Lapar, Holloway, and Ehui 2003). To ensure consistency of PSM, only covariates that exhibited significant bivariate correlation with the outcome variable (log of household per capita income) were included in the estimation of PS. Table 2 presents the bivariate correlation coefficients that were used to make the choice of covariates.

Table 2. Covariates Bivariate Correlation Coefficients of Selected Variables

Covariates	Treatment variable Selling cattle	Outcome variable Log of household income
Male headed household (=1)	0.0036	0.1051***
Number of household members	0.0974***	-0.0629***
Age of household head (years)	0.0486**	-0.0752***
Years of schooling of HH head	0.0896***	0.3015***
Number of pigs owned	-0.0033	0.0795***
Number of sheep owned	0.0596***	0.0719***
Number of goats owned	0.1003***	0.1752***
Landholding size (ha)	0.0987***	0.3712***
HH reporting non-farm income (=1)	0.0677***	0.2397***
Household Commercialization Index	-0.0137	0.4155***
Household related to village authorities (=1)	0.0096	-0.0860***
Number of years settled in the area	0.0450**	-0.0745***
Distance to nearest district town (km)	0.0260*	-0.0410**
Central province (=1)	-0.0129	0.1411***
Copperbelt province (=1)	0.0067	0.0846***
Eastern province (=1)	-0.1195*	-0.0690***
Luapula province (=1)	0.0008	0.0112

Covariates	Treatment variable Selling cattle	Outcome variable Log of household income
Lusaka province (=1)	0.0196	0.0853***
Northern province (=1)	0.0420*	-0.0364*
North western province (=1)	-0.0349*	-0.0542***
Southern province (=1)	0.1055*	0.0417**
Western province (=1)	0.0055	-0.1251***

Note: treatment variable=households selling cattle; significance level *p<0.10, **p<0.05, ***p<0.01.

Propensity Score Balancing Tests

The propensity score balancing test results presented in table 3 confirm the existence of strong bias for most covariates as indicated by significant differences between the participants and non-participants before matching. However, propensity score balancing successfully eliminated this bias as evidenced by the insignificant *t*-test after matching. This was further reinforced by a likelihood ratio test (Ho: all covariates jointly equal to zero), which was significant (198.11, p-value=0.000) prior to matching and insignificant (10.56, p-value=0.957) after matching. The estimated propensity score was also inspected for common support requirement. This was satisfied within [0.08191682, 0.92294961] (i.e. $0. < PS < 1$).

Table 3. Balancing Properties of Covariates in Treated and Control Groups

Covariates	Sample	Mean treated units	Mean control units	% bias between treated and controls	% reduction in bias	H0: Mean(treated) = Mean(control) t	p>|t|
Male headed household (=1)	Unmatched	0.869	0.866	0.8		0.23	0.817
	Matched	0.869	0.886	-5.1	-529.2	-1.24	0.216
Number of HH members	Unmatched	8.168	7.290	21.3		6.39	0.000
	Matched	8.168	8.297	-3.1	85.3	-0.64	0.523
Age of household head	Unmatched	51.864	50.163	11.3		3.20	0.001
	Matched	51.864	51.906	-0.3	97.5	-0.07	0.946
Years of schooling of HH head	Unmatched	6.731	5.949	20.1		5.87	0.000
	Matched	6.731	6.795	-1.7	91.7	-0.39	0.695
Number of pigs owned	Unmatched	1.356	1.388	-0.8		-0.22	0.830
	Matched	1.356	1.428	-1.7	-120.6	-0.31	0.757
Number of sheep owned	Unmatched	0.796	0.234	11.7		3.90	0.000
	Matched	0.796	0.661	2.8	75.9	0.43	0.670
Number of goats owned	Unmatched	5.245	3.470	20.7		6.58	0.000

	Matched	5.245	5.012	2.7	86.9	0.57	0.567
Landholding size (ha)	Unmatched	5.047	3.995	20.6		6.48	0.000
	Matched	5.047	5.154	-2.1	89.9	-0.43	0.669
HH reporting non-farm income (=1)	Unmatched	0.666	0.591	15.6		4.42	0.000
	Matched	0.666	0.680	-2.8	81.9	-0.68	0.495
HCI	Unmatched	30.715	31.661	-3.2		-0.90	0.370
	Matched	30.715	32.207	-5.0	-57.6	-1.16	0.248
HH related to village authorities (=1)	Unmatched	0.474	0.463	2.2		0.63	0.526
	Matched	0.474	0.479	-0.9	58.9	-0.21	0.831
Distance to nearest district town (km)	Unmatched	27.364	26.014	6.5		1.86	0.063
	Matched	27.364	27.429	-0.3	95.2	-0.07	0.942
Central province (=1)	Unmatched	0.112	0.121	-3.0		-0.84	0.401
	Matched	0.112	0.114	-0.6	80.9	-0.13	0.893
Copperbelt province (=1)	Unmatched	0.019	0.017	1.5		0.44	0.659
	Matched	0.019	0.017	1.4	10.4	0.32	0.750
Eastern province (=1)	Unmatched	0.220	0.347	-28.5		-7.87	0.000
	Matched	0.220	0.220	0.0	100.0	0.00	1.000
Lusaka province (=1)	Unmatched	0.034	0.026	4.4		1.28	0.200
	Matched	0.034	0.031	1.6	63.2	0.36	0.718
Northern province (=1)	Unmatched	0.091	0.066	9.3		2.74	0.006
	Matched	0.091	0.096	-2.0	78.1	-0.44	0.661
North-western province (=1)	Unmatched	0.015	0.028	-8.5		-2.28	0.023
	Matched	0.015	0.019	-2.5	70.6	-0.65	0.513
Southern province (=1)	Unmatched	0.379	0.269	23.7		6.93	0.000
	Matched	0.379	0.370	2.0	91.8	0.44	0.660
Western province (=1)	Unmatched	0.125	0.120	1.3		0.36	0.716
	Matched	0.125	0.125	0.0	100.0	0.00	1.000

Note: matching reduced Pseudo R2 from 0.044 to 0.007 and the overall likelihood ratio chi-square for the probit model from 198.11 (p-value= 0.000) to 10.56 (p-value=0.957). The overall mean and median bias reduced from 10.7 and 8.9 before matching to 2.5 and 1.8 after matching respectively. The treatment group includes households that sold cattle while the control group includes households that did not sell cattle

Welfare Estimation

The descriptive statistics above indicate that households that participate in cattle markets have higher per capita incomes, on average, than non-participating households. However, we cannot conclude that cattle market participation has a positive causal effect on per capita household income from the descriptive statistics because they do not account for other factors affecting household income. To draw such conclusions, we turn to the PSM estimates of the average treatment effects, which are summarized in table 4.

Table 4. Estimates of Average Treatment Effect of Cattle Market Participation on log of Per Capita Household Income

Matching technique	Number of households. Participating group	control group	ATE	Bootstrapped Standard error	t-stat
Nearest neighbor	1,099	806	0.524	0.062	8.516
Stratification	1,096	3,160	0.549	0.038	14.373
Kernel	1,099	3,137	0.574	0.029	19.865
Radius	1,099	3,157	0.640	0.036	17.540

The results indicate large positive and significant effects of participation in cattle markets on per capita household incomes. More specifically, participation in cattle markets raises per capita household income by about 52-64% on average.

Income decomposition of Non-poor and poor households

Table 5 presents results from decomposition of household income between non-poor versus poor households who participate in cattle markets.

Table 5. Results of Linear Decomposition of Log of Household Income: poor vs. non-poor households

Panel A: mean predications	Bias unadjusted			Bias adjusted		
	Mean	Robust standard error		Mean	Robust standard error	
Non-poor households	8.302	0.037	***	8.307	0.039	***
Poor households	6.614	0.021	***	6.616	0.022	***
non-poor-poor differential	1.688	0.043		1.691	0.045	***
Panel B: Simultaneous change in endowment and coefficient						
Three-fold endowment	0.455	0.042	***	0.453	0.042	***
Coefficients	1.356	0.053	***	1.360	0.057	***
Interaction	-0.123	0.057	**	-0.123	0.058	**

Note: the difference is between the predicated log of household income of the non-poor and poor households among the participating households only. Significance level *p<0.10, **p<0.05, ***p<0.01.

Form panel A, both estimates for the natural log of household income for non-poor and poor households who participate in cattle market are highly significant. the difference in per capita

incomes between poor and non-poor households is also highly significant. The absolute value for the antilog of predicated average incomes are ZMK4031.44 (US$1293.14) and ZMK 1293.14 (US$ 337.68) yielding a difference of ZMK2738.30 (US$715.18). From panel B, we note that endowment and coefficients are positive and statistically significant. This suggests that poor households would statistically earn more than non-poor households if poor households retained their coefficients but had endowments comparable to those of non-poor households. Similarly, poor households would earn significantly more than non-poor households if poor households retained their endowment but had the coefficients of the non-poor households

Table 7 presents a summary of decomposition results to determine how much of the differential is attributable to productivity differences (differences in the means of variables) and statistical discrimination (differences in coefficients).

Table 6. Summary of the Decomposition Results (as percentages)

	Bias unadjusted	Bias adjusted
Amount attributable:	-203.7	-123.9
- due to endowments (E):	33.2	33.2
- due to coefficients (C):	-236.8	-157.1
Shift coefficient (U):	372.4	292.7
Raw differential (R) {E+C+U}:	168.8	168.8
Adjusted differential (D) {C+U}:	135.6	135.6
Endowments as % total (E/R):	19.7	19.7
Discrimination as % total (D/R):	80.3	80.3

Note: U = unexplained portion of differential (difference between model constants); D = portion due to discrimination (C+U)
positive number indicates advantage to non-poor group
negative number indicates advantage to poor group

The results show that the inter group differences in characteristics or productive differences accounts for 123.9% in favor of poor households. However, this productivity difference is not enough to offset the 292.7% advantage in shift coefficient (U). The difference between the

raw differential (168.8%) and the adjusted differential (135.6%) is small (only 33.2). Overall, statistical discrimination accounts for 80.3% of the income differential in favor of non-poor households and this is made up of the differences in the shift coefficient (U) and differences in how the endowments are rewarded (C).

Conclusion

This article investigates the welfare effects of participation in cattle markets using propensity score matching decomposition techniques and nationally representative household survey data from Zambia. After correction for selection bias, we find evidence that participation in cattle markets leads to an increase in cattle-raising households' incomes by 52-64%. However, the decomposition results show that most of the benefits are captured by non-poor households where about 19.7% of the differences in household income is due to differences in endowment while 80.3% of the income differential is due to discrimination. The results show suggest that with appropriate interventions, participation in livestock markets can enhance the welfare of smallholder households and contribute to poverty reduction. One possible strategy is to promote livestock production through restocking programs. Increasing livestock ownership may increase the number of animals sold thus increasing the household income.

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