

Institutions and the Rate of Return on Cattle: Evidence from Bangladesh

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This study extends the recent debate on the rate of return on cattle rearing in India, triggered by Anagol, Etang, and Karlan (2017) and followed by others, to the Bangladeshi context and finds that the apparent paradox of widespread cattle rearing despite negative returns in India is absent in Bangladesh. We use a nationally representative two-year panel data for rural Bangladesh and find that the average and marginal returns on raising cows and bullocks are positive and high in both 2011 and 2015. We show that appreciation of the value of cattle is the major contributing factor to positive returns. The existence of cattle markets where cattle can be freely traded for slaughter, milk production, or for any other purpose—which is constrained to various degrees in India—is the key to high and positive returns in Bangladesh.

Keywords: Bangladesh, livestock, poverty, rural development

JEL codes: C23, L25, O12, Q12

I. Introduction

Anagol, Etang, and Karlan (2017) unleashed a debate over raising livestock in India. They used survey data collected from Uttar Pradesh to estimate returns from raising livestock and found that the median return to cows was -7% , and 51% and

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45% of households earned negative returns on cows and buffaloes, respectively. When labor costs were included, they found that more than half of milk cows had negative returns. This, they claimed, contradicts the fundamental tenets of capitalism where activities generating negative returns would have been given up. They discussed a comprehensive list of factors that could explain the puzzle of negative returns: measurement errors, preference for illiquid savings, insurance, variation of returns over the years, labor market failures, milk market failures, and social, cultural, and religious values.

Two subsequent papers joined the debate and added some interesting dimensions. Attanasio and Augsburg (2018) argued that the data used by Anagol, Etang, and Karlan (2017) came from a drought year characterized by scarcity of fodder and lower milk production, resulting in low returns. Attanasio and Augsburg used a three-year panel data to show that returns were positive in normal years (good rain, low fodder costs, and higher milk production because of better nutrition) and negative in drought years (bad rain and high fodder costs). Subsequently, Gehrke and Grimm (2018) joined the debate to check the generalizability of the results and introduced an analysis of marginal returns and economies of scale. They also found that most households operated at unprofitable levels and returns to livestock varied by quality of cattle, size of stock, and annual rainfall. Those with cattle of better quality had higher returns and those with a larger herd enjoyed economies of scale due to decreasing labor costs. To summarize, the debate has generated four main results: returns to raising livestock are predominantly negative, they vary from one year to another, there are scale economies with larger farms showing diminishing costs, and cattle of better quality generate higher returns.

This study contributes to the debate by extending the geographical horizon and testing the results mentioned above in the context of livestock rearing in Bangladesh. This shift in geographical focus from India to Bangladesh involves a shift in religious and cultural beliefs that have relevance for the debate. There are no restrictions on buying and selling of cows, slaughtering, movement across the country, or on the consumption of beef in Bangladesh. Unrestricted and widespread markets for cattle imply that they can be sold at any time in their life cycle, and their value as an asset is not constrained by trading restrictions. Thus, Bangladesh provides a counterfactual to India where most states have restrictive cattle trading and slaughtering policies.

We use household-level panel data from the Bangladesh Integrated Household Survey (BIHS) of the International Food Policy Research Institute (IFPRI), which is representative of the rural areas of all eight administrative divisions of the country. For the sake of brevity and clarity, we combine survey years 2011 and 2015 for our

main analysis. However, we also present results for 2011 and 2015 separately in the online appendix to highlight year-specific characteristics.¹

The key finding of this study is the predominance of positive and high rates of return to raising cattle (i.e., large ruminants such as bullocks and cows) in Bangladesh.² We also find that the average annual return from raising livestock is 31.2% for the combined sample, with a higher return in 2015. These results are also robust for small ruminants. Our data reveal that appreciation of the value of cattle is the major contributing factor to large positive returns. Over a period of 12 months, the value of cattle appreciated by 39%, and this figure is as high as 53% for households that own only bullocks. In contrast, Anagol, Etang, and Karlan (2017) estimated that the median value of cows depreciated by 3.1%, while Gehrke and Grimm (2018) estimated a 40% depreciation in the value of cattle.³

We find that average returns tend to decrease with herd size, reaching a maximum when herd size is equal to one. Thus, unlike India, there are diseconomies of scale from livestock rearing in Bangladesh. BIHS data do not provide information on the breed of the livestock but there is secondary evidence showing that, similar to India, livestock of better variety generate higher returns in Bangladesh (Jabbar et al. 2005, Kabir and Talukder 1999, Gisby 2010).

Higher returns from raising livestock in Bangladesh are largely due to appreciation of the market value of livestock. This is particularly true for bullocks that are raised for their meat value. There is no reason to believe that Bangladeshi farmers are more “rational” than Indian farmers or face more competitive markets for milk, fodder, and other inputs and outputs. The difference lies in the cultural and religious contexts that maximize the market value of cattle in Bangladesh but not in India. Article 48 of the Constitution of India mandates the state to prohibit the slaughter of cows and calves and other milk and draft cattle (Ministry of Law and Justice 2020). Out of 29 states in India, 24 currently have various regulations prohibiting the slaughter of cows. States such as Kerala, Meghalaya, Mizoram, and Nagaland have no restrictions on cattle slaughtering. Other factors including state-level politics may have also constrained the cattle market. For example, in both

¹The online appendix can be accessed at: https://www.researchgate.net/publication/354776441_ONLINE_APPENDIX.

²Livestock includes cows (female) and bullocks (male) only. Buffaloes are not included because they represent only 6% of the cattle population of Bangladesh. We use the term cattle as consisting of cows and bullocks only and use it interchangeably with the word livestock.

³The difference in depreciation rates of these two studies is largely driven by the nature of the sample, as the sample of Anagol, Etang, and Karlan (2017) includes a large number of heifers (Gehrke and Grimm 2018).

Uttar Pradesh (surveyed by Anagol, Etang, and Karlan 2017) and Andhra Pradesh (surveyed by Gehrke and Grimm 2018), slaughtering cows is banned, but bullocks and buffaloes can be slaughtered upon obtaining a “fit-for-slaughter” certificate that the animal is not economical or is not likely to become economical for the purpose of breeding or draft/agricultural operations (Citizens for Justice and Peace 2018). However, transportation of cattle within Uttar Pradesh and between this state and other states (without permit) is forbidden, but not in Andhra Pradesh. This indicates a wide variation in institutional setups across states, which may have adversely affected the performance of the market for buying and selling livestock.

Our study has a bearing on the literature on anti-poverty programs based on asset (livestock) transfers and the return on capital of microenterprises in developing countries. There is a growing evidence that suggests that if livestock, generally cows or goats, are given away to extremely poor households along with a set of complementary inputs such as skills training, health support, consumption support, etc., the beneficiaries tend to increase their labor supply and, as a result, their income and assets likewise increase (Bandiera et al. 2017, Banerjee et al. 2015). In a recent paper, Banerjee, Duflo, and Sharma (2020) found that such programs also have substantial long-term impacts. Taking better advantage of opportunities to diversify into more productive wage employment and migration has been found to contribute to such successes. However, these studies could not separate the impact of livestock from other inputs as the interventions were delivered as a bundle. Therefore, the rate of return on livestock can be very high due to the presence of other complementary inputs.

The rest of the paper is organized as follows. The next section describes the data and presents relevant descriptive statistics. Revenue, costs, profit, and average and marginal returns to raising livestock are estimated in Section III, while heterogeneity in returns is analyzed in Section IV. We perform robustness checks in Section V. We discuss overall findings in Section VI, and Section VII draws the conclusions.

II. Context, Data, and Descriptive Statistics

A. Livestock Sector in Bangladesh

The livestock sector plays an integral part of the rural economy of Bangladesh. About 37.6% of rural households in Bangladesh had at least one livestock in 2015 (IFPRI 2015). It is estimated that about 20% of employment in the rural economy is

directly associated with the livestock subsector, and this figure is about 50% when we consider indirect employment (GOB 2018).

Though the livestock sector grew by 3.2% in 2016, its contribution to gross domestic product (GDP) fell from 2.2% in 2008 to 1.7% in 2016 (GOB 2016). The contribution of the livestock sector to the overall agriculture sector was almost static at around 13% during the same period. The number of bovine populations (cattle, buffalo, goat, and sheep) has increased since 1960, but their growth could not match the growth of the human population (Huque and Huda 2016). As a result, the per capita bovine population in Bangladesh declined from 0.4 in 1960 to 0.2 in 2018.

Meat consumption in Bangladesh steadily increased from 11.6 grams per person per day (g/p/d) in 1995 to 18.6 g/p/d in 2010 (BBS 1995, BBS 2010a). Beef consumption increased by about 11% between 2010 and 2016 (BBS 2016). Per capita milk consumption in Bangladesh is about 126 milliliter per person per year which is significantly lower than other countries in the region (Kabir, Islam, and Reza 2018). According to the household income and expenditure survey (BBS 2010a), 79% of Bangladeshi households eat meat no more than two days in a fortnight. Only about 63% of households drink milk and 60% eat eggs in a fortnight (Toufique and Belton 2014).

Existing studies estimating returns from livestock rearing in Bangladesh have found them to be generally profitable. All the studies estimated returns without taking into consideration appreciation or depreciation of livestock assets except for the study undertaken by Gisby (2010).⁴

B. Data

There are several advantages of using the Bangladesh Integrated Household Survey (BIHS of the International Food Policy Research Institute [IFPRI] dataset [IFPRI 2011, IFPRI 2015]). First, the sample is nationally representative of rural Bangladesh and representative of rural areas of each of the seven administrative divisions of the country. Second, the BIHS conducted two rounds of surveys in 2011 and 2015 on the same households. We combine them to create household-level panel data, which allow us to control household-level time-invariant heterogeneity in estimating marginal returns. Third, since the objective of the survey is to study agriculture, food security, nutrition, and poverty, detailed data are collected on

⁴Table A14 of the online appendix lists the names, data, methodology, and main findings of the relevant literature in the context of Bangladesh. Note that the appendix is available as an online supplement due to space limitations of the journal.

livestock raised by households. The survey contains information on livestock ownership (large/small ruminants and poultry), including the livestock's current and last year's values, revenues, and costs.

It is imperative to discuss whether the 2 sample years are normal years, as year-specific shocks can influence the rate of return on cattle substantially. Data from the World Bank's Climate Change Knowledge Portal (2021) show that the average amounts of rainfall in 2011 and 2015 were 233.2 and 212 millimeters, respectively. Note that average rainfall for the period 1990–2015 was 194.8 millimeters, indicating that our sample years experienced flood, particularly in 2011. However, our data show that only 48 households (4.5% of the working sample) in 2011 and 34 households (3.9% of the working sample) in 2015 experienced crop loss due to floods. We found that farm income as a share of total household income was 60% in both 2011 and 2015. Hence, the loss of income due to flood was not significant in our sample. However, the floodwaters may wash away haystacks and damage grass fields. The market demand for cattle and milk may also decrease due to floods. But our data show that the rate of appreciation of cattle value was higher in 2011 than in 2015 (44% versus 33%). However, other factors such as higher fodder costs and wages for hired labor may lead to an underestimation of costs to some extent in 2011. If this is the case, we may be estimating some lower bounds of the rate of return on livestock rearing. This, in fact, corroborates our overall results that the rate of return on livestock rearing is positive and high in Bangladesh.

The number of households included in the first (2011) and second rounds (2015) of the BIHS was 4,423 and 4,419, respectively. Out of these households, 41.1% (1,817) and 37.2% (1,643) owned cattle in the first and second rounds of the surveys, respectively (Table 1). Farm animals in Bangladesh consist of cattle, buffalo, goat, and sheep, but in this study, we only considered cattle, which consist of cows and bullocks. As buffalo is not a common type of livestock in Bangladesh, we dropped buffalo-owning households from the analysis.⁵

The BIHS data provide information at the household level only. The data record the total number of cattle by type (cows, bullocks) for each household, and associated revenues and costs are also presented in the aggregate. Information on cattle was collected for the last 12 months in both survey rounds. The BIHS data recorded all transactions in cattle that resulted in either depletion or accumulation of stock at the end of the survey year.⁶

⁵In the agricultural census of 2008, only 0.7% of rural households reported owning buffaloes (BBS 2010b). In the BIHS, only 20 households in 2011 and 10 in 2015 reported owning a buffalo.

⁶BIHS data provide two data points (beginning and end of the survey year) on size and value of cattle stock in both rounds of surveys (2011 and 2015).

The size of the herd can change from the initial period for the following reasons: (i) sale of cattle, (ii) purchase of a cattle, (iii) exchange of cattle as gift, (iv) lease of cattle from other households, (v) slaughter of cattle for consumption of meat, and (vi) loss of cattle due to theft or death. We could only account for cattle sales (i) and loss of cattle (vi) because the price of cattle sold and the value of cattle lost are reported in the survey. For cases (ii) to (v), the information to calculate the rate of appreciation and hence the rate of return on cattle is incomplete. Therefore, we drop cases (ii) to (v) in our analysis, which leaves us with 1,065 and 884 households in 2011 and 2015, respectively (Table 1).

To capture the heterogeneity of returns by gender of cattle, we divide all households with livestock into three categories: (i) households with only bullocks, (ii) households with only milk cows, and (iii) households with both bullocks and milk cows (i.e., households with cattle of both gender). Note that Anagol, Etang, and Karlan (2017) and Gehrke and Grimm (2018) considered milk cows and milk buffaloes only.

C. Descriptive Statistics

We first check whether the households omitted from our sample are different from the sample households in a systematic way since we had to drop 41% and 46% of cattle-owning households from our 2011 and 2015 sample, respectively, as shown in Table 1. The table also shows the number and percentage of households with livestock, households dropped from the sample, and households in the working sample for each type of cattle. If the households were dropped in a systematic way, it would create a selection bias in our sample. To this end, we report in Table 2 the distribution of the four categories of households that were dropped from the sample due to incomplete information on purchases, gifts, lease, and home consumption of cattle for 2011 and 2015. The table shows that purchases comprise about 60% of the dropped sample in both years. The second-largest category at about 21%–23% is leasing. In the sample of cattle-owning households, only 17% of the households that purchased in 2011 likewise purchased cattle in 2015. Hence, these are not the same households purchasing cattle in both years. If they were the same households, one could argue that these households always expand herd size and thus share some common characteristics that have bearing on returns. This potential “systematic pattern” could create a bias in our sample. Our data also show that the households that purchased cattle come from different income groups. About 43% of the dropped samples are from the first two quintiles of per capita expenditure. As we will see later, average returns tend to be lower for these lower quintiles. Since the share of the

Table 1. Number of Households with Livestock, Households Dropped, and Households in Working Sample by Type of Cattle

Households with	2011				2015			
	No. of HHs with Livestock		No. of HHs in Working Sample		No. of HHs with Livestock		No. of HHs in Working Sample	
	Dropped	No. of HHs in Working Sample	Dropped	No. of HHs in Working Sample	Dropped	No. of HHs in Working Sample	Dropped	No. of HHs in Working Sample
Only bullocks	641 (35.27)	319 (42.42)	322 (30.23)	593 (36.09)	357 (47.0)	236 (26.70)		
Only milk cows	569 (31.31)	188 (25.00)	381 (35.77)	495 (30.12)	185 (24.4)	310 (35.07)		
Both bullocks and milk cows	607 (33.40)	245 (32.57)	362 (33.99)	555 (33.77)	217 (28.6)	338 (38.24)		
All	1,817 (100.00)	752 (100.00)	1,065 (100.00)	1,643 (100.00)	759 (100.00)	884 (100.00)		

HH = household.

Note: The numbers in parentheses are column percentages and may not sum up to 100 due to rounding.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

Table 2. Distribution of Households Dropped by Reason

	HHs Dropped Due to Incomplete Information on	Percentage of HHs Dropped in 2011		Percentage of HHs Dropped in 2015	
		No. of HHs Dropped in 2011	(N = 752)	No. of HHs Dropped in 2015	(N = 759)
1	Purchase of cattle	441	58.64	468	61.66
2	Cattle received as gift	61	8.11	58	7.64
	Cattle given as gift	34	4.52	21	2.77
3	Lease of cattle from other HHs	174	23.14	159	20.95
4	Slaughter of cattle for own consumption	42	5.59	53	6.98
	Total	752	100.00	759	100.00

HH = household, N = number of households.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:1902.1/21266> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

dropped sample is not disproportionately higher in these lower quintiles, it lowers the concern for overestimating the rate of return on cattle. The shares of gifts and home consumption of cattle are both very low. Those who leased cattle are not owners, so we drop this group from the sample.

We compare the characteristics of cattle-owning households that are included in the sample with those that are dropped from the sample in Table 3. There is no statistically significant difference between the working sample and the dropped sample in per capita monthly expenditure. This suggests that the two groups are similar in terms of income status. However, per capita food expenditure per month was slightly lower in the working sample than the dropped sample in 2011. The difference was 76 taka (Tk), which could buy about 2 kilograms of rice in 2011. On the contrary, in 2015, per capita food expenditure was slightly higher for the working sample at a difference of Tk59. Thus, this difference is not systematic over the years. These random and meager differences are very unlikely to produce any selection problems.

Table 3 also shows that the working sample is richer in landownership than the dropped sample. This difference is driven by quintile 1 (lowest) and quintile 5 (highest) of the land distribution. Note that it is the homestead land that determines the ownership and herd size of the cattle (Table A12 in online appendix). Since there is no difference in homestead land between our working sample and the dropped sample, the generalization of our results is less likely to suffer from a sample selection problem. The fact that the household head is 2 years older than the dropped sample (48 versus 46) in 2015 is less likely to affect the generalization of results.

To further highlight that the working sample compares well with the dropped sample in farming characteristics, we report the p -value of the mean differences in Table 4. In particular, we focus on those variables that enter into the calculation of returns. We observe that there is hardly any difference in the components of revenue and costs in livestock rearing between these two samples in both years. There is no statistically significant difference between these two samples in the case of revenues from manure and milk, and costs of labor and fodder. The cost of fodder is slightly higher for the working sample than the dropped sample, and the p -value of the mean difference is 0.097 in 2015.

In short, the socioeconomic and the farming characteristics are very similar for the working and dropped samples, lending support for the generalization of results of the working sample. Note that we have a limited set of variables and there might still be some systematic differences, but we cannot check for those. However, given the set of variables we have, we are confident that there is no systematic selection bias.

Table 3. Household Characteristics of Cattle Owners: Working Sample vs. Dropped Sample

	2011						2015						
	Cattle Owners (Working Sample)		Cattle Owners (Dropped Sample)		Difference in Mean		Cattle Owners (Working Sample)		Cattle Owners (Dropped Sample)		Difference in Mean		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
Male household head	0.93	0.26	0.92	0.26	0.678	0.27	0.92	0.27	0.91	0.27	0.91	0.27	0.969
Age of household head	45.97	13.17	45.03	13.19	0.135	12.88	48.2	12.88	45.89	12.8	45.89	12.8	0.000
Household size	4.6	1.71	4.56	1.83	0.632	1.79	4.74	1.79	4.6	1.8	4.6	1.8	0.102
Household head is literate	0.44	0.49	0.41	0.49	0.215	0.49	0.45	0.49	0.44	0.49	0.44	0.49	0.462
Male-female ratio	1.25	0.897	1.21	0.88	0.268	0.87	1.23	0.87	1.27	0.89	1.27	0.89	0.328
Per capita food expenditure (Tk, monthly)	1,029	613	1,105	707	0.013	1,055	996	673	996	623	996	623	0.070
Per capita total expenditure (Tk, monthly)	2,427	2,354	2,539	2,252	0.310	2,514	2,375	2,375	2,375	3,246	2,375	3,246	0.318
Homestead land owned (decimal)	11.01	12.91	10.5	13.45	0.416	10.41	12.07	12.07	9.8	11.54	9.8	11.54	0.297
Total land owned (decimal)	97.00	170.00	77.00	129.00	0.007	104.00	179.00	179.00	85.00	159.00	85.00	159.00	0.019
Observations	1,065		752			884			759				

SD = standard deviation, Tk = Bangladesh taka.

Notes: All figures are in constant 2011 taka. \$1 = Tk74.2.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSXYEL> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSXYEL> (both accessed 1 June 2018).

Table 4. Characteristics of Cattle Farming: Comparison between Dropped and Working Samples

Cattle Farming Variables	Working Sample			Dropped Sample			Mean Difference	
	N	Mean (Tk, yearly)	SD	N	Mean (Tk, yearly)	SD		p-value
2011								
Milk revenue	482	10,164	23,354.60	286	8,836.00	4,275.63		0.385
Manure revenue	1,053	1,974	2,190.70	670	1,830.00	2,445.60		0.107
Fodder cost	883	4,870	10,880.21	619	5,143.00	9,320.26		0.612
Family labor cost	1,055	6,974	5,371.44	714	6,768.21	4,954.18		0.415
Family labor cost: male	895	4,348	5,087.90	628	4,138.33	3,910.29		0.385
Family labor cost: female	994	3,487	2,254.42	679	3,289.59	2,820.85		0.113
Wage labor	23	8,751	15,038.26	7	12,736.36	16,739.37		0.491
Wage labor: male	21	8,937	15,293.28	7	12,736.36	16,739.37		0.523
2015								
Appreciation	884	6,356	12,276.13	260	11,342	18,937.60		0.644
Manure revenue	765	1,540	1,692.97	400	1,598	2,934.97		0.643
Fodder cost	725	4,694	7,568.19	600	4,113	8,498.93		0.097
Family labor cost	882	3,864	2,026.66	732	3,796	2,119.95		0.258
Family labor cost: male	800	2,552	1,622.45	655	2,500	1,696.87		0.278
Family labor cost: female	846	1,614	994.75	710	1,545	959.92		0.085
Wage labor	7	3,588	3,053.30	3	4,541	3,873.91		0.664
Wage labor: male	7	3,588	3,053.30	3	4,541	3,873.91		0.664

SD = standard deviation, Tk = Bangladesh taka.

Notes: All monetary figures are in constant 2011 taka. \$1 = Tk74.2. N is the number of households with positive values for various cattle farming variables. The sample size of female wage labor is too small to estimate the p-value of the mean difference.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/21266> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVNBXSYEL> (both accessed 1 June 2018).

Next, we present the main characteristics of cattle farming of the sample households in Table 5.⁷ The BIHS collected information on the current value of livestock as well as their value a year before as reported by respondents. The values of the stock per household at the end of the reference periods were Tk33,810 in 2011 and Tk37,089 in 2015, respectively, in real terms, and the average values of the stock at the end of the reference period were Tk15,581 and Tk16,411, respectively. The increase in average value of the stock may indicate that the quality of cattle increased between the survey years. The herd size is highest for those with both milk cows and bullocks. On the other hand, herd size is slightly higher for those with only bullocks than those with only milk cows. This indicates that many households raise livestock to slaughter for meat production. In both cases, the herd size increased during the survey periods. The herd size of mixed farms slightly declined.

Table 5 also presents the components of revenues and costs. Note that average appreciations (i.e., meat value), defined as the average of the change in the value of the stock between the initial and terminal periods are reported in detail in Table 6. Average revenue from selling milk increased between the survey years, by 6.4% in real terms for households with positive milk revenue. However, the contribution of manure as a source of revenue decreased over time. Fodder contributed the most in the cost of rearing livestock in Bangladesh. Average fodder cost was about Tk4,870 in 2011 and Tk4,694 in 2015 for households with positive fodder costs. The decrease in fodder costs is not statistically significant. Wage labor was hired by only a few households. Family labor was mostly employed in these farms. We observe that family labor costs have declined in real terms and no clear explanation can be given. Female family members worked more hours on cattle rearing than male members. In 2015, male members spent about 368 hours compared to 417 hours by female members.

At the outset, it is important to note that we do not make the returns based on imputed values of family labor salient in our discussion of results. There are two major reasons, which are explained in the following. The explanation also sheds light on why returns are consistently low and negative in most cases in 2011 while high and positive in 2015 when we value family labor at market price.

First, the households in our sample are smallholders—the average cattle size is about 2.2 in 2011 and 2.3 in 2015. Thus, the time that households spend per day to take care of the cattle is also very low. Our data show that time spent by male members of a household on livestock in a year is 368 hours, that is, about one hour per day.

⁷Note that we also present household characteristics of the cattle owners and nonowners in the online appendix in Table A1.

Table 5. Characteristics of Cattle Farming, 2011 and 2015

Cattle Farming Variables	2011			2015			Mean Difference	
	N	Mean	SD	N	Mean	SD		p-value
Value of stock of cattle per HH (Tk)	1,065	33,810.00	29,547.00	884	37,089.00	30,294.17		0.026
Average cattle value (Tk)*	1,065	15,581.00	8,444.29	884	16,411.00	8,941.44		0.035
Herd size: only bullocks	322	1.91	1.19	236	2.03	1.48		0.283
Herd size: only milk cows	381	1.72	1.00	310	1.91	1.39		0.037
Herd size: both milk cows and bullocks	362	2.87	1.66	338	2.73	1.52		0.250
Herd size: all	1,065	2.17	1.41	884	2.26	1.51		0.181
Milk revenue (Tk, yearly)	482	10,164.00	23,354.60	486	10,811.00	18,462.54		0.632
Manure revenue (Tk, yearly)	1,053	1,974.00	2,190.70	765	1,540.00	1,692.97		0.000
Revenue from calves (Tk, yearly)	391	8,467.00	3,088.34	327	8,288.00	3,060.95		0.436
Fodder cost (Tk, yearly)	883	4,870.00	10,880.21	725	4,694.00	6,568.19		0.703
Value of cattle lost (Tk, yearly)	15	29,833.00	36,941.88	6	16,912.00	15,183.65		0.422
Family labor cost (Tk, yearly)*	1,055	6,974.00	5,371.44	882	3,864.00	2,026.66		0.000
Family labor cost: male (Tk, yearly)*	895	4,348.00	5,087.90	800	2,552.00	1,622.45		0.000
Family labor cost: female (Tk, yearly)*	994	3,487.00	2,254.42	846	1,614.00	994.75		0.000
Total time spent on livestock in a year (hours)	1,060	667.00	488.86	883	794.00	397.72		0.000
Male family time spent on livestock in a year (hours)	895	367.00	425.53	884	368.00	273.54		0.938
Female family time spent on livestock in a year (hours)	994	364.00	232.93	884	417.00	277.41		0.000
Total family time spent on livestock in a year (hours)	1,055	655.00	465.82	882	788.00	395.40		0.000
Hired time spent on livestock in a year (hours)	22	729.00	599.37	7	851.00	659.68		0.650

Continued.

Table 5. *Continued.*

Cattle Farming Variables	2011			2015			Mean Difference	
	N	Mean	SD	N	Mean	SD	SD	p-value
Number of calves	391	1.18	0.43	327	1.15	0.43		0.436
Total value of cattle sold (Tk, yearly)	141	27,732.00	19,846.02	153	26,389.00	25,062.70		0.612
Wage labor (Tk, yearly)	23	8,937.00	15,038.26	7	3,588.00	3,053.30		0.380
Wage labor: male (Tk, yearly)	21	8,751.00	15,293.28	7	3,588.00	3,053.30		0.372
Wage labor: female (Tk, yearly)	2	2,425.00	813.17	0

* = calculated values (not reported values), ... = data not available, HH = household, SD = standard deviation, Tk = Bangladesh taka.
 Notes: All monetary figures are in constant 2011 taka. \$1 = Tk74.2. The value of the stock of cattle per household is defined as the total value of cattle owned by all sample households divided by the number of sample households. Average cattle value is defined as the total value of the stock of cattle owned by the sample households divided by the number of cattle. N is the number of households with positive values for various cattle farming variables.
 Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011–12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

Literature suggests that time spent on livestock does not hamper regular work in farm or nonfarm employment. Typically, the time is spent on taking cattle to the grass field, bathing, feeding, etc., which the male members do in between their regular work or after work (Gisby 2010). Hence, the opportunity costs of time spent on livestock is negligible. Gisby (2010, 22) noted “The majority of those looking after cattle stated that they would be ‘idle’ in the absence of having to care for cattle.” The household members do not have to give up any remunerated work time for taking care of cattle. Hence, monetized family labor is negligible in our analysis.

Second, hourly wage of hired labor is what makes the returns in 2011 significantly lower than the returns in 2015. Note that male wage rates in 2011 and 2015 were Tk11.9 and Tk4.2 per hour, respectively. Female wage rate in 2011 was Tk9.6 per hour. These lead to yearly labor costs of Tk8,751 in 2011 and only Tk3,588 in 2015 (Table 5). Thus, when we use these figures to impute the costs of family labor, the figures for 2011 inflate. Our inspection of the data suggests that there are several “large values” that are driving the very high wage rates in 2011. The standard deviation of total wages in 2011 was Tk15,038 whereas it was only Tk3,053 in 2015. We checked wage-related information from the BIHS employment module: the average hourly wage in employment in livestock was about Tk4 in 2011 and Tk4.8 in 2015. This indicates that the hourly wage in 2015 is a more plausible figure than that in 2011. The survey of literature on Bangladesh (Table A14 in the online appendix) for the period 2010–2014 suggests that hired labor costs were much lower than in the BIHS data.⁸

III. Returns to Cattle Holding

The return to livestock comprises two parts: (i) the flow of profits from the sale of livestock products such as milk or manure, and (ii) the appreciation or depreciation of the value of livestock. We follow the empirical specification given by Gehrke and Grimm (2018). Let the production function of a household from raising livestock be:

$$Q = Af(K, L, X, F). \quad (1)$$

⁸Gisby (2010) found that monthly family labor cost (if paid for the opportunity cost of raising a single livestock) varies from Tk108 to Tk295 based on cattle type and variety. Halim et al. (2010) recorded a family labor cost of Tk4,877 per year per cattle. Mondal, Sen, and Rayhan (2010) estimated an average total labor (both family and hired) cost of Tk11.4 and Tk20.2 per cow per day for local-variety and crossbred cows, respectively.

In this production function, Q = milk, calves, and manure; K = current/end period value of cattle; L = labor; X = land; F = fodder; and A = household- and region-specific characteristics that influence the total factor productivity (TFP) of the inputs. Gehrke and Grimm (2018) lumped X and F together and noted that land entered into the production function through F . Since we have data on homestead land, we treat X and F separately. Note that in the case of bullocks, the production function becomes trivial as Q includes only revenue from manure. The profit function is given by:

$$\pi = P \cdot Q - cK - wL - gF - rX - S + \delta K, \quad (2)$$

where P = price of outputs; w = wage rate (both market and imputed); g = price of fodder; r = rent of land; c = other costs associated with K (medical, purchase, or sale of related costs, etc.); S is the value of cattle lost; and δ = rate of appreciation/depreciation.⁹ Following Gehrke and Grimm (2018), we assume the price of capital to be zero. We also assume that the rental value of land, r , is equal to 0. We first calculate the household-level annual profit and then estimate average and marginal returns of raising livestock. The following equation shows the average return on raising livestock:

$$\frac{\pi}{K} = P \cdot \frac{Q}{K} - c - \frac{wL}{K} - \frac{gF}{K} - \frac{S}{K} + \delta. \quad (3)$$

Following Gehrke and Grimm (2018), we estimate marginal returns using both linear production and Cobb–Douglas production technology, using pooled OLS and panel fixed effects (FE). First, with the linear production function, we estimate profit (π_{it}) as a function of the value of herd size (value of the livestock, K) and several control variables at the household level:

$$\pi_{it} = \alpha_0 + \alpha_1 \log(K_{it}) + \alpha_2(X_{it}) + e_{it}, \quad (4)$$

where i and t stand for households and time, respectively. X_i includes labor cost, homestead land owned, fodder cost, herd size, and a year dummy. α_1 is the marginal return of holding livestock of value K for a one-year period. Second, we use a Cobb–Douglas production technology to estimate marginal return. The marginal return of this type of production function is the first derivative of equation (2) with respect to K :

$$\pi'(K_{it}) = P \cdot Q'(K_{it}) - c + \delta. \quad (5)$$

⁹ $\delta = (K - K_0)/K_0$, where K_0 is the value of the cattle stock at the initial period and K is the end period value of the same stock. For households with constant herd sizes between the two survey periods, calculation of the rate of appreciation/depreciation is straightforward ($\delta = (K - K_0)/K_0$). In cases with nonconstant herd sizes and households with calves, calculation of δ involves several intermediate steps described in the online appendix.

If Q is a Cobb–Douglas production function such that

$$Q_{it} = A \cdot K_{it}^{\alpha_1} L_{it}^{\alpha_2} F_{it}^{\alpha_3}, \quad (6)$$

where all parameters lie strictly between 0 and 1. We get α_1 from the following logarithmic transformation of the production function in equation (6):

$$\log(PQ_{it}) = \alpha_0 + \alpha_1 \log K_{it} + \alpha_2 \log L_{it} + \alpha_3 \log F_{it} + \alpha_4 X_{it} + \epsilon_{it}, \quad (7)$$

where X_{it} includes log of homestead land, herd size, and a year dummy. We then plug in the estimated value of α_1 into equation (5) and get the marginal return from raising livestock in the following form:

$$\pi'(K_{it}) = P \cdot \alpha_1 \cdot \frac{Q_{it}}{K_{it}} - c + \delta. \quad (8)$$

A. Appreciation and Depreciation

In Anagol, Etang, and Karlan (2017), the price of a cattle, $P(t)$, is reported by the farmer. They used self-reported values of dairy animals to establish a relationship between cattle values and age. This helped them to estimate appreciation as the difference in cattle values over a period of one year, $P(t) - P(t - 1)$. On the other hand, Attanasio and Augsburg (2018) could not estimate depreciation because their data did not contain information on the age of livestock, although they had information on the value of livestock. Gehrke and Grimm (2018) did not follow Anagol, Etang, and Karlan (2017) on the estimation of appreciation or depreciation of cattle because they also did not have information on age. Instead, Gehrke and Grimm (2018) used information from secondary sources and assumed that a cow depreciates by 1,240 Indian rupees (₹) (US\$27) every year, and that the end-of-fertility value of a cow is ₹1,400 (US\$30), which is based on an annual depreciation of 20%.

The approach taken by these papers for estimating appreciation reflects the institutional setup that exists in the respective Indian states: “Since cattle cannot be sold for slaughter, this implies that the value of a cow will be zero once it is no longer of reproductive age” (Gehrke and Grimm 2018, 682). This rationalized the use of age as an appropriate indicator for estimating appreciation (Anagol, Etang, and Karlan 2017), the use of secondary sources of information (Gehrke and Grimm 2018), or ignoring measurement of depreciation altogether (Attanasio and Augsburg 2018).

Our method of estimating appreciation is similar to Anagol, Etang, and Karlan (2017) in the sense that we take the difference between initial and terminal values of cattle as appreciation, and then divide the difference by the initial value to get the rate of appreciation. The BIHS data include, for each year, the current value of cattle and

their value in the previous 12 months, as reported by the respondents. This is appropriate in the Bangladeshi context where there is no restriction on selling cattle for slaughter. The value of livestock depends not only on age but also on other factors such as weight of cattle, location, and time. Market conditions may also change between the initial and terminal period, and the appreciation rate may reflect these market conditions. These factors are incorporated by the respondents while reporting the value of their cattle. The BIHS data do not present information on age, weight, or breed of the cattle and hence we could not estimate the relationship between these factors and the value of cattle. We would expect these to be incorporated by the respondent while valuing the livestock. Dependence on self-reported values of cattle likely involves overreporting by the sellers as they have private information on the quality of the cattle that is not available to the buyers. This problem is less acute when cattle are sold for slaughter, as weight is more visible than the potential milk production of a cow. We also think that any bias that is generated from reported values of cattle by the respondents is carried over to the next period and thus can cancel out when estimating how much the cattle stock has appreciated. This asymmetric information is not handled adequately in existing studies and this study is no exception. As mentioned before, we have information on the value of cattle sold during the reference period. We have considered that value as the end period value of the cattle.

B. Revenue

The BIHS data provide information on three items of revenue: milk, manure, and calves.

1. Milk and Manure

Households report value and quantity of milk and manure sold in the last 12 months. We consider net milk production by accounting for the amount of spoil. We used two sets of prices to determine the value of milk. For households who sold milk in the market, we estimated the price by dividing the value of the milk sold by the quantity of milk sold. About 53% and 55% of households sold milk in the market in 2011 and 2015, respectively. For households that consumed all the milk they produced, they provided information on the value of that milk consumed and this allowed us to determine the market price. Though Anagol, Etang, and Karlan (2017) mentioned that households may value their milk higher than the price it can fetch in the market, we find that there is hardly any difference between the self-reported price

and market price. This is true for the full sample as well as for all eight administrative divisions in the country. The BIHS data also provide information on manure.

The BIHS data lumped together revenues from manure and milk by aggregating small ruminants such as goat and sheep and large ruminants. It is therefore not possible to separate milk and manure revenues for households that raise both cattle and small ruminants. About a quarter of households who own cattle also have small ruminants. However, milk revenues from small ruminants are very small: they comprise 6% and 9% of average milk revenues for 2011 and 2015, respectively. Small ruminants, on the other hand, hardly have any relevance to manure revenue.

2. Calves

The BIHS data provide information on the number of calves born in the last 12-month period, but not calves' market price. We take the calf price to be Tk7,151 in both 2011 and 2015 from the data collected for the Final Impact Evaluation Survey of the Second Participatory Livestock Development Project (BIDS 2010). We consider the calves as a separate component of revenue in the return calculation; they are not part of herd size.

C. Costs

Unlike revenue, cost data are presented by type of livestock. Three components of costs are recorded: feed or fodder, medicine or treatment, and labor costs.

1. Fodder

Fodder is a major component of the costs of raising livestock in Bangladesh. With the gradual diminishing of grazing grounds and other common property resources, most of the cattle in Bangladesh are stall-fed. Common items of fodder are straw, green grass, and concentrate. The BIHS data do not provide any information on collected or home-produced fodder and report the value of purchased fodder only. Halim et al. (2010) have found that home-produced and collected fodder comprise about 20% of total purchased fodder when valued at market price. We used this information to inflate fodder costs by 20% and estimate average and marginal returns.

2. Labor

The BIHS data provide labor use and labor cost information by gender as well by source (family and hired). Labor use is presented as the number of hours spent on

raising livestock. Family labor is unpaid but hired labor is paid, and the BIHS records information on hired labor cost. About 98%–99% of labor time used in livestock farming is provided by family labor. Thus, we present labor cost in two ways: (i) assume it is 0 for family labor and (ii) monetize family labor. The process of monetizing family labor is described in the online appendix. Table 6 presents the breakdown of costs and revenue for three different types of households for the 2 years combined.

As is evident from Table 6, the highest stock appreciation is observed for the households who only raise bullocks; within a year, the average value of their stock increases by more than half, and this is true for both years (Tables A2 and A3 in the online appendix). Relative appreciation is similar (higher for bullocks) to those found by Gisby (2010) who found that bulls appreciated more than cows, both the local variety (13% compared to 6%) as well as the crossbred variety (21% compared to 12%). For the full sample, the average annual appreciation at the household level was 39%.

As expected, the share of milk revenue is highest for households with only milk cows. Fodder and family labor are the major cost components for all household categories. Cost and revenue components are similar in 2011 and 2015.

D. Profits and Average and Marginal Returns

Profit from raising livestock is positive (excluding family labor cost) in all categories in the combined sample (Table 7) as well as for both 2011 and 2015 (Tables A4 and A5 in the online appendix). Once family labor is valued at market price, profit decreases considerably and becomes negative for households with bullocks only. The value of calves and the revenue from selling cattle (Table 5) increase the profits for households with only milk cows and those selling cattle, respectively.

Both average and marginal returns are positive for the combined sample in both years except for the average return (with family labor) in 2011. For all household categories together, the average return (without family labor) from holding cattle is 31.2%. Marginal return using the Cobb–Douglas production function is positive and high at about 48% (Table 7).¹⁰ Intuitively, the annual return from investing an additional one dollar to the existing stock is about 48 cents.¹¹

¹⁰We are aware that the value of herd size (K) can be endogenous due to simultaneity bias. Higher profit from livestock rearing can motivate households to raise certain breeds and thus affect the value of K . Due to lack of valid instruments, we did not consider instrumental variables estimation.

¹¹See Table A10 of the online appendix for the regressions to estimate the marginal returns of capital stock.

Table 6. Components of Revenue and Cost (Combined Table for 2011 and 2015)

	Revenue					Costs				
	Appreciation									
	Initial Period Cattle Value (K1) (K0)	End Period Cattle Value (K1) (K0)	Milk (K1 - K0) *100/(K0) (Tk)	Manure (Tk) (K1)	Calf (Tk) (K1)	Wage Labor (Tk)	Family Labor (Tk)	Purchased and Nonpurchased Fodder Cost (Tk)	Medicine and Other Cost (Tk)	Value of Cattle Lost (Tk)
Households with only bullocks (N = 558)	19,184	29,351	53	NA	NA	54	5,130	3,884	292	549
Households with only milk cows (N = 691)	21,039	30,086	43	6,369	3,673	27	5,419	4,267	381	350
Households with both bullocks and milk cows (N = 700)	34,022	42,187	24	8,218	2,000	240	5,941	5,897	513	0
Full sample (N = 1,949)	24,620	34,222	39	5,209	1,671	111	5,524	4,743	403	281

N = number of households, NA = not applicable, Tk = Bangladesh taka.

Notes: \$1 = Tk74.2. Appreciation (depreciation) is the real rate of increase (decrease) of the cattle stock in 12 months. All revenue and cost components are the average numbers for the sample households (N = 1,949). Nonpurchased fodder cost has been assumed as 20% of the purchased fodder cost.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

Table 7. Average and Marginal Returns from Raising Livestock (Combined Table for 2011 and 2015)

	Total Annual Profit (Tk)		Average Return (%)		Marginal Return
	With Family Labor	Without Family Labor	With Family Labor	Without Family Labor	
	Family Labor	Family Labor	Labor	Labor	
Households with only bullocks (N = 558)	-3,101	2,028	-18.22	8.28	0.54
Households with only milk cows (N = 691)	5,673	11,092	13.79	40.09	0.54
Households with both bullocks and milk cows (N = 700)	8,218	14,159	20.75	40.67	0.37
Full sample (N = 1,949)	4,075	9,599	7.12	31.19	0.48

N = number of households, Tk = Bangladesh taka.

Notes: \$1 = Tk74.2. "With family labor" implies monetized value of family labor, and "without family labor" implies only hired labor costs.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011-12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

IV. Heterogeneity in Average and Marginal Returns

In this section, we discuss the heterogeneity of returns from two aspects: (i) herd size and (ii) household food expenditure. For the first aspect, we explore if there are any economies of scale in herd size; and for the second, we check whether rates of return change for different poverty groups as indicated by household food expenditure quintiles (including home-produced food expenditure).

Table 8 shows that for both survey years combined, average return is maximized at herd size one and minimized at herd size four when family labor cost is not monetized. However, when we value family labor at market price, no systematic patterns exist in the relationship between average returns and herd size. This is true for 2011 (Table A6 in the online appendix). But we find that even if we consider family labor, we observe the highest average returns at herd size one in 2015 (Table A7 in the online appendix). Thus, it appears that there are no economies of scale in raising livestock in Bangladesh. To shed more light on this issue, we examine the sources of the costs of rearing that can potentially lead to economies of scale and whether such costs were incurred in large amounts in the context of rural Bangladesh. Cattle rearing involves the following cost components: fodder, medicine, space, and hired labor to take care of the cattle. Consider fodder and medicine first. The per unit cost (the cost for one cow or bullock) of fodder and medicine is unlikely to vary much with herd size since these costs are very specific to each animal. In the case of space in the homestead where cattle are housed, there is scope for economies of scale. However, for a small herd size, which is about 2.2 animals, additional cattle may cost little in terms of

Table 8. Herd Size and Returns (Combined Table for 2011 and 2015)

Herd Size	Average Value of Total Stock (Tk)	Average Return with Family Labor (%)	Average Return without Family Labor (%)	Marginal Return	Observations
1	17,130	7.4	41.04	0.58	742
2	15,804	7.97	29.62	0.48	608
3	14,492	6.32	23.11	0.34	317
4	14,839	2.4	17.62	0.47	152
> 4	14,856	9.03	17.87	0.25	130

Tk = Bangladesh taka.

Note: \$1 = Tk74.2.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011–12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/21266> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

Table 9. Livestock Variables and Per Capita Food Expenditure Quintiles (Combined Table for 2011 and 2015)

Per Capita Food Expenditure Quintiles (Q)	% of HHs with Livestock	Herd Size	Average Value of Total Stock (Tk)	Average Return without Family Labor (%)	Average Return with Family Labor (%)	Marginal Return
Q1	56.70	2.31	14,298	28.10	4.14	0.46
Q2	43.27	2.17	15,075	30.76	6.36	0.49
Q3	36.01	2.20	15,220	27.92	3.45	0.45
Q4	32.35	2.16	16,777	34.51	9.35	0.59
Q5	27.32	2.21	18,421	34.67	12.32	0.39

Tk = Bangladesh taka.

Note: \$1 = Tk74.2.

Source: Authors' calculations using data from the International Food Policy Research Institute, "Bangladesh Integrated Household Survey (BIHS) 2011–12," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/21266> and "Bangladesh Integrated Household Survey (BIHS) 2015," <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BXSYEL> (both accessed 1 June 2018).

extending the space or house. Moreover, this cost is a fixed cost, which is not considered in the costing exercise. Hired labor is the potential source of economies of scale—the average cost of taking care of the cattle may drop significantly with herd size, particularly for smaller sizes. However, only 22 households in 2011 and 7 households in 2015 used hired labor for cattle rearing. Hence our finding of no economies of scale in cattle rearing by smallholders is not implausible.

Poorer households raise more livestock. Table 9 shows that in the combined sample, the incidence of livestock rearing by households in the bottom quintile (Q1) is more than twice of those households in the top quintile (Q5). We find that although poorer households raise more livestock, they earn a lower annual return than their richer counterparts (Q4 and Q5). To examine further, we regress the incidence of cattle rearing and herd size on the quintiles of food consumption, controlling for other covariates. The results show that the lower quintiles are more likely to raise cattle and have lower herd size. The results for 2011 and 2015 are reported in Tables A8 and A9 of the online appendix.

V. Robustness Check

Since we have dropped a large sample for which we could not calculate the appreciation rate, we use the working sample's average appreciation rates of cattle to

impute the rates for the dropped sample as a robustness check. These appreciation rates are 0.4 for 2011 and 0.3 for 2015. With these imputed rates, the average returns without monetizing family labor are 25.6% in 2011 and 36.8% in 2015 for the dropped sample (Table A13 in the online appendix). These two rates compare very well with the appreciation rates of the working sample for both years. The marginal returns of livestock rearing for both working and dropped samples are also very similar.

In the context of rural Bangladesh, households depend less on the market for fodder. We find that our results of high average returns are robust to accounting for imputed fodder costs. All the above rates of returns we have discussed so far are for large ruminants only. Since a large number of households are also raising small ruminants (goats and sheep) along with large ones, the rate of return must also be high for small ruminants. We find that the average returns from raising only small ruminants are 26% and 35% in 2011 and 2015, respectively (Table A11 in the online appendix). The marginal returns are also high at 42% and 53% in these 2 years.

The above exercises suggest that our estimates of returns from rearing livestock are very robust.

VI. Discussion on the Debate

This paper is motivated by the debate triggered by Anagol, Etang, and Karlan (2017) and the availability of the nationally representative BIHS data that contain information on livestock holdings. This allowed us to estimate rates of return from rearing livestock in rural Bangladesh and check whether these are similar to those found in India. The estimation of positive and high rates of return kept us pondering why, unlike India, this is the case in Bangladesh. We strongly believe that this is due to two factors. First, a cow in Bangladesh has value not only for the capacity to produce milk but also for producing meat for consumption. Second, markets for buying and selling cattle for meat consumption freely exist that help farmers dispose of their cattle whenever needed and for whatever purpose. As an asset, a cow is therefore more liquid in Bangladesh than in India.

A milk cow has two main attributes: it provides milk, and it also provides meat. A bull, on the other hand, has only one major attribute, that of providing meat. The relevance of livestock as draft power has severely diminished over time in Bangladesh due to the mechanization of agriculture, and other benefits such as manure from livestock are minor. In India, livestock are raised mainly to produce milk, and meat can be viewed as a by-product. This is not the case in Bangladesh where a cow

can be sold not only for its milk but also for its meat. This is the basis of our classification of households into three categories, those who own only bullocks and only milk cows, and those who have both. About 35% of the households raise only milk cows. About 27%–30% of the households rear only bullocks. Those who rear only cows do so mainly because of milk, either for home consumption, to sell at the market, or both. We do not have enough information about the extent of selling cows for slaughter. A survey carried out by Toufique, Iqbal, and Ibon (2018) on the cattle markets established for the sacrificial Eid-ul-Adha found that about 8% of the cattle sold for slaughter are cows. A cow is least preferred because of the common perception that a pregnant cow cannot be sacrificed, and buyers do not want to take the risk of buying a cow. The BIHS data show that about 30% of cattle sold in a year comprise cows. This figure includes cows bought for milk, but a part of it represents those sold for meat. Thus, a cow can be sold at any time in its life and has value for both milk and meat.

In both Uttar Pradesh and Andhra Pradesh, cows can never be slaughtered irrespective of their age and therefore cows are traded only for their milk.¹² The existence of a market for cattle, where they can be sold anytime either for milk or meat or both, implies that the value of cattle is determined not only by age alone but also by their breed (recognized by Anagol, Etang, and Karlan 2017), overall health, buyers' preference, condition of the market, etc. When a bull or cow can be bought for slaughter, the value of the cattle includes the value of the meat, a component that is largely missing in most Indian contexts. Since a cattle market for meat consumption does not exist in many states in India or exist only for a limited type of cattle, such as old, worn out, or unproductive cattle, the value of cattle is not maximized because the meat value is almost zero.¹³ India's beef industry is predominantly based on the slaughtering of water buffaloes. According to the existing meat export policies in India, the export of beef (meat of cows, oxen, and calves) is prohibited.

A reexamination of depreciation of the value of livestock by Anagol, Etang, and Karlan (2017) justifiably used age as a determinant of the value of a cow in the context of restrictions on slaughtering or meat consumption in most states in India. In a linear depreciation method, as used by Gehrke and Grimm (2018), the value of livestock always declines by a fixed amount each year as there is a finite period during which holding livestock is useful. This observation leads Gehrke and Grimm (2018, 682) to

¹²In Andhra Pradesh, bullocks can be slaughtered when it is certified unproductive, normally at the age of 15.

¹³However, there is evidence that beef/buffalo meat consumption has increased among the Hindu population in India (See Bansal 2016, Sathyamala 2018).

comment: “we assume that the market value of a cow approaches 0 with the end of its fertility.”

When cattle can be slaughtered for meat consumption and there are competitive markets for buying and selling cattle, the price of cattle can be considered as a more reliable indicator of the current value of cattle. The cattle owner will likely sell, ignoring distress sales, when the value of the cattle is highest, and this may depend on many factors, although age and number of lactations continue to play a major role. For example, in Bangladesh, cattle can fetch the highest value before the Eid-ul-Adha when cattle are sacrificed for religious purposes. Many households buy and fatten cattle to get the most of their investment from this occasion. Appreciation of buffaloes is also estimated by using the same method. But since there are no restrictions on transactions of buffaloes, including slaughtering them, age may not be the only determinant of their value. In the case of buffaloes, weight is likely to be a better determinant of asset value. We also observe a wide variation of values of both cows and buffaloes for any given age.

The BIHS data include the value of cattle over a period of 1 year as reported by the respondents. This helped us to estimate the appreciation or depreciation of cattle by taking the price difference during this period. These values not only incorporate the age of the cow but also the value of meat or other factors that are relevant to prices. We find appreciation to be very high and mostly positive. For example, the price of bullocks increased by more than half within a year. Such high appreciation is also reported by Gisby (2010). Gisby (2010) estimated asset gain as measured by the difference between buying and expected selling prices of cattle. For bullocks, they find a monthly asset gain of approximately 13% for local-variety bulls and 22% for crossbred bulls. The corresponding figures for cows are 6% and 12%, respectively.

We also notice that the rate of appreciation is very different in the two methods used by Anagol, Etang, and Karlan (2017) and Gehrke and Grimm (2018). In Anagol, Etang, and Karlan (2017), depreciation for the full sample is around 3.1% of the median value of a cow. In the method used by Gehrke and Grimm (2018), cows depreciate by 20% each year. In the full sample, depreciation is 40% of the value of the cattle. Attanasio and Augsburg (2018, 318) consider appreciation and depreciation to be a “minor source of costs, so the neglect is unlikely to introduce significant biases.” Thus, there is a wide gap in the estimates of appreciation between Anagol, Etang, and Karlan (2017) and Gehrke and Grimm (2018). The high incidence of negative returns from rearing livestock was found both with relatively low depreciation (Anagol, Etang, and Karlan 2017) as well as with relatively high depreciation (Gehrke and Grimm 2018). On the other hand, looking across states in India, a lower incidence of

negative returns can be expected in Andhra Pradesh than in Uttar Pradesh, because rules on slaughtering cattle are less restrictive in Andhra Pradesh. We have already mentioned that unproductive bullocks can be slaughtered in Andhra Pradesh, and there are various formal and informal restrictions on the movement of cattle in Uttar Pradesh. Besides, possession of beef is also illegal in Uttar Pradesh. The transport of cattle is important because there are incentives to move cattle to states where cattle trading and slaughtering are less restrictive. To cite Gehrke and Grimm (2018, 682), “Of course, reports exist throughout the country of unproductive animals being sold off to other states in which cattle slaughter is not prohibited.”

In the Indian context, various restrictions on slaughtering have strong implications on returns to livestock. Negative returns imply that returns from the sale of livestock products generally fail to account for the depreciation of livestock as an asset. If various restrictions on livestock trading were absent or less restrained, we could have observed relatively higher returns. Since cows cannot be slaughtered, a farmer must retain relatively older cattle for some time as it is difficult to dispose of them. For example, for a farm with 10 crossbred cows, the National Dairy Development Board of India (NDDB 2019) has recommended that farmers dispose of cows that have already had three lactation periods to maintain the productivity of the herd.¹⁴ This also indicates that cows, even when they are allowed to be slaughtered before they reach the age of 15 or beyond, are not that productive. Allowing cows to be slaughtered even at the age of 15 helps farmers to get some revenue that can be used to replenish the stock. The overall public opinion about slaughtering cows also affects the price of cows, as traders find it difficult or risky to move cows across and within states when there are strong restrictions against transporting them, such as in Uttar Pradesh. The restrictions on slaughtering cows have already given rise to the problem of stray cows. These are mostly cows abandoned by farmers as they become infertile and hardly get any buyers. These problems are more acute in states with more restrictive slaughtering rules. In Uttar Pradesh (more restrictive), 5.1% of cattle are stray cattle compared to 0.4% in Andhra Pradesh (less restrictive).¹⁵ These restrictions on cattle trade or movement surely create a black market for trading cows. This is recognized by Gehrke and Grimm (2018, 682) but ignored. This suggests that farmers can find an informal avenue to dispose of their cows, which may have somewhat increased the rate of return.

¹⁴See <http://www.dairyknowledge.in/content/10-crossbred-cow-farm> (accessed 3 October 2019).

¹⁵Indian Livestock Census 2012 figures cited in <https://thewire.in/politics/modi-government-cow-slaughter-stray-cattle> (accessed 3 October 2019).

VII. Conclusion

By using a nationally representative panel dataset for rural Bangladesh, this paper finds that, unlike in India, the rates of return from raising cattle in Bangladesh are high and positive. Positive rates of return in India are either explained by a good year when fodder costs are low (Attanasio and Augsburg 2018) or by the existence of economies of scale where households with larger herd sizes only get positive returns (Gehrke and Grimm 2018). We have argued that positive and high rates of return in Bangladesh are explained by the existence of a market for cattle in an institutional setup where there is no moral or religious stigma attached to meat consumption or trading. Existence of this market adds a new dimension to the relationship between age and market value of cattle because cattle have value beyond milk and draft power. This increases the extent of appreciation of cattle of Bangladesh. A market that is missing in most states in India is present in Bangladesh, and this market increases the value of livestock held by smallholders.

We find that the average rate of return on cattle rearing is about 31% and the marginal return is about 48%. First, these findings are not at odds with the literature on the rate of return on microenterprises (De Mel, McKenzie, and Woodruff 2008).¹⁶ We have also documented the rate of return on cattle found in other studies in Bangladesh (Table A14 in the online appendix). Though the return figures in these studies are accounting returns, they indicate a very high rate of return for cattle. For example, Sarma, Raha, and Jørgensen (2014) found that the rate of return was 52% in the Pabna and Sirajganj districts. Earlier Jabbar et al. (2005) also estimated 44% and 55% returns for crossbred and local cows, respectively. Second, the high interest rate on borrowing in the rural financial market also lends support to high returns from cattle rearing. Rural finance in Bangladesh is dominated by microfinance institutions and informal moneylenders. The effective rate of return on microcredit can be as high as 43% (Faruqee and Khalily 2011). Borrowers also resort to moneylenders for additional funds and the average annual interest rate of moneylenders was found to be about 103% (Mallick 2012). In our sample, we find that 65% of households in 2011 and 70% of households in 2015 had outstanding loans with microfinance institutions or other sources. Third, note that when we value family labor at market prices, the average rate of return drops significantly. For example, in 2015, the average return is 23% when incorporating family labor and 39% without family labor. It is the unaccounted family labor that makes the average return very high. This point is also

¹⁶De Mel, McKenzie, and Woodruff (2008) found a 6% rate of return per month in Sri Lanka.

highlighted in the microfinance literature to explain higher repayment rates (Emran, Morshed, and Stiglitz 2021).

Our findings have strong implications for livestock development and poverty reduction in Bangladesh. Higher rates of return for livestock rearing indicate that there is scope for further development of the livestock sector. Since rates of return are higher for poorer households, the possibility to reduce poverty through livestock transfers remains. There are, however, some worrying signs that justify caution. Though the returns from livestock are high, they are declining. The poorest households have reduced livestock rearing more than others, but the extent of livestock rearing for all households has been falling. This may happen for factors that could not be analyzed with available data. We think that inadequate livestock services, high costs of fodder, and other factors could have set this trend. It should be emphasized that a successful asset-transfer-based anti-poverty program in Bangladesh must be bundled with a provision of livestock services and transfer of cash.

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