# Appendix

This appendix provides additional summary statistics for our market data (A.1), regression results for the *ex ante* value of pregnancy (A.2), and a summary of the relevant Census data for all of Tanzania used to calculate estimates for all of Tanzania (A3).

## A.1. Market price survey data

In the six livestock markets and twenty farms of non-local livestock owners households visited, the average prices of the different animals were as summarized in Table A1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table A.1.1: Livestock prices, , from livestock markets and keepers | | | | |
| Category of livestock | | N | Market price [TZS] (Min - Max) | SD |
| Local Cattle | All ages (Male & Female) | 124 | 575,161.3 (200,000 – 1,700,000) | 309,672 |
| Pregnant Female | 17 | 538,235.3 (350,000 – 650,000) | 107,310.0 |
| Non-Pregnant Female | 49 | 405,918.4 (200,000 – 900,000) | 151,050.7 |
| Female | 66 | 440,000 (200,000 – 900,000) | 151,931.2 |
| Male | 58 | 728,965.5 (220,000 – 1,700,000) | 367,951.6 |
| ≤12 months | 14 | 337,142.9 (200,000 – 650,000) | 155,979.7 |
| ≤12 months Female | 12 | 329,166.7 (200,000 - 650,000) | 160,819.4 |
| ≤12 months Male | 2 | 385,000 (270,000 – 500,000) | 162,634.6 |
| Non-Local Cattle | Average (Male & Female) | 20 | 937,500 (450,000 – 2,000,000) | 376,575.6 |
| Pregnant Female | 4 | 1,300,000 (1,000,000 – 1,500,000) | 244,949.0 |
| Non-Pregnant Female | 14 | 850,000 (600,000 – 2,000,000) | 348,071.6 |
| Female | 18 | 950,000 (600,000 – 2,000,000) | 374,558.6 |
| Male | 2 | 825,000 (450,000 – 1,200,000) | 530,330.1 |
| ≤ 24 months | 6 | 925,000 (450,000 – 1,500,000) | 373,831.5 |
| ≤ 24 months Female | 5 | 1,020,000 (700,000 – 1,500,000) | 327,108.5 |
| ≤ 24 months Male | 1 | 450,000 (NA) | NA |
| Local Small Stock | Average (Male & Female) | 257 | 81,194.6 (30,000 – 300,000) | 37,157.9 |
| Pregnant Female | 27 | 85,370.4 (50,000 – 180,000) | 29,869.1 |
| Non-Pregnant Female | 86 | 74,697.7 (30,000 – 160,000) | 27,094.9 |
| Female | 118 | 76,517.0 (30,000 – 180,000) | 27,695.8 |
| Male | 139 | 85,165.5 (30,000 – 300,000) | 43,317.4 |
| ≤ 6 months | 9 | 37,222.2 (30,000 – 45,000) | 5,651.9 |
| ≤ 6 months Female | 4 | 33,750 (30,000 – 35,000) | 2,500.0 |
| ≤ 6 months Male | 5 | 40,000 (30,000 – 45,000) | 6,123.7 |
| Non-Local Small stock | Average Male & Female | 37 | 103,918.9 (30,000 – 200,000) | 43,030.0 |
| Pregnant Female | 27 | 120,000 (80,000 – 150,000) | 33,303.0 |
| Non-Pregnant Female | 11 | 106,363.6 (50,000 – 150,000) | 40,068.1 |
| Female | 37 | 103,918.9 (30,000 – 200,000) | 43,030.0 |

## A.2. The value of a pregnancy given abortion risk: Regression results

We apply hedonic regressions to estimate the marginal value of a pregnancy while controlling for other characteristics of livestock. The dependent variable is the logarithm of the market price of an animal. The results of these regressions for cattle, sheep and goats combined (“Small Stock All”), goats, and sheep are presented in Table A.2. These regressions were estimated using the Stata *glm* regression package with the link(log) option(38) (StatCorp 2021). The parameter of interest in Table A.2 is associated with the indicator variable *Pregnant*. Because the logarithm of the dependent variable is used, the parameter estimates do not directly represent the marginal value of pregnancy. Table A3 provides the marginal value of pregnancy based on these regressions. The estimates were calculated using the Stata 17 *margins* routine.

|  |  |  |  |  |  |  |  |  |
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| Table A.2.1. Hedonic regression for market price. Dependent variable: ln(Price), 1000s TZS. | | | | | | | | |
|  | Cattle | | Small Stock All | | Goats | | Sheep | |
|  |  |  |  |  |  |  |  |  |
| Pregnant | 0.36 | \*\*\* | -0.034 |  | 0.02 |  | -0.00026 |  |
| hybrid | 0.39 | \*\*\* | 0.36 | \*\* | 0.33 | \*\* |  |  |
| Pregnant X hybrid | 0.20 |  | 0.18 |  | 0.12 |  |  |  |
| agesq | 0.000064 | \*\*\* | 0.000093 | \*\* | 0.00017 | \*\*\* | -0.00019 |  |
| BCS | 0.18 | \*\*\* | 0.15 | \*\*\* | 0.17 | \*\*\* | 0.39 | \*\*\* |
| LONGIDO | -0.16 |  | -0.12 |  | -0.24 | \*\* | 0.2 | \* |
| MGAGAO | -0.72 | \*\*\* | -0.25 | \*\* | -0.22 | \* | 0.092 |  |
| MTO WA MBU | -0.43 | \*\*\* | -0.36 | \*\* | -0.31 | \* | -0.063 |  |
| NAMANGA |  |  | 0.034 |  | -0.16 |  | 0.28 | \*\*\* |
| NJIA PANDA | -0.31 | \*\*\* | -0.32 | \*\*\* | -0.41 | \*\*\* | 0.21 |  |
| SELELA | -0.28 | \*\*\* | -0.35 | \*\*\* | -0.31 | \*\*\* | -0.3 | \*\* |
| WERUWERU | 0.18 | \*\*\* | 0.046 |  | -0.056 |  |  |  |
| Intercept | 5.6 | \*\*\* | 3.9 | \*\*\* | 3.9 | \*\*\* | 2.7 | \*\*\* |
| N | 84 |  | 154 |  | 110 |  | 44 |  |
| \*\*\* p<.01, \*\* p<.05, \* p<.1 | | | | | | | | |

Table A.2.2 shows that the value of pregnancy for a local cattle breed averages TZS 171,366, while the value of pregnancy for hybrid cattle averages TZS 622,288. The rest of the conditional estimates in Table A.2.2. are not statistically different from zero, and some are negative. Given that we hypothesize that pregnancy generally provides positive value, we provide the differences in the raw averages by breed in Table A4.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table A.2.2 Estimated marginal value of pregnancy in TZS, based on regressions in Table 5. | | | | | | | | | | |
|  | Cattle | | Small Stock All | | | | Goats | | Sheep | |
|  |  |  | | |  |  |  |  |  |  |
| Local | 171,366 | \*\*\* | -2,614 |  | | | 1,670 |  | -17 |  |
| Hybrid | 622,288 | \*\*\* | 15,967 |  | | | 14,436 |  |  |  |
| \*\*\* p<.01, \*\* p<.05, \* p<.1 | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table A.2.3. Raw difference in sample means of pregnant versus not-pregnant animals. | | | | | | | | | | |
|  | Cattle | | Small Stock All | | | | Goats | | Sheep | |
|  |  |  | | |  |  |  |  |  |  |
| Local | 132,317 | \*\*\* | 11,160 | \* | | | 16,434 | \*\* | 5,639 |  |
| Hybrid | 450,000 | \*\* | 23,800 |  | | | 23,800 |  |  |  |
| \*\*\* p<.01, \*\* p<.05, \* p<.1 | | | | | | | | | | |

The differences in the unconditional means between pregnant and non-pregnant animals shown in Table A.2.3. indicate that on average in our sample, pregnant animals tend to be more valuable than non-pregnant animals in all cases, and in contrast to Table A.2.2, the estimated value of pregnant small stock is positive and significant at the 10% level and at the 5% level for goats alone. For the purposes of our calculations, we use the estimates from Table A.2.2 for cattle, but the estimates from Table A.2.3. for small stock.

## A.3 Census data for all of Tanzania

Table A.3.1 provides relevant summary statistics for all of Tanzania analogous to those presented in Table 4. These are calculated in exactly the same way as those in Table, but summed or averaged over all Tanzanian regions rather than just the three Northern Tanzania regions.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Table A.3.1. Census data for all Tanzania, analogous to Census data presented in Table 4. | | | | | | |
|  | cattle | | | small stock | | |
|  | Local | Nonlocal | Total | Local | Nonlocal | Total |
| Reprod. females1 | 15,176,525 | 632,679 | 15,809,204 | 18,083,923 | 243,004 | 18,326,927 |
| Pregnancies2 | 6,502,210 | 311,182 | 6,813,392 | 8,911,040 | 111,619 | 9,022,659 |
| Born3 | 6,083,774 | 283,674 | 6,367,448 | 7,076,464 | 102,317 | 7,178,781 |
| Pregnancies scaled5 | 8,388,624 | 401,461 | 8,790,085 | 11,528,667 | 144,407 | 11,673,074 |
| bortions scaled5 | 539,832 | 35,488 | 575,320 | 2,373,485 | 12,034 | 2,385,519 |
| 1Census data Tables 4.7 and 4.8. Summed over three northern regions.  2 The number of pregnancies is calculated as the number of reproductive age females from the Census data  times the pregnancy rate from our study (This table and Table 2). .  3 Number of animals born. Census data provided the number cattle, sheep, and goats born,  but not broken down to indigenous versus hybrid. Table 4.10 for calves born and  Table 4.37 for goats and sheep. Estimates for individual breed are  (see Equation 17).  4 Scaling factor such that , where is the number of births for species reported  in the Census data and = is the sum of local and nonlocal births for species .  5 The number of pregnancies scaled to be consistent with Census data birth estimates is calculated.  Summed over three northern regions.  6 The number of abortions is calculated as .  Summed over three northern regions. | | | | | | |

## A.4 Sensitivity Analysis

Table A.4.1 provides a results showing the sensitivity of economic losses due to 10% decreases or increases in abortion rates , pregnancy rates , the share of husbandry costs to newborn , the share of households who chose not to consume milk after an abortion , the *ex ante* value of pregnancy (*Vpreg*), and the annual discount rate ().

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table A.4.1. Sensitivity analysis. Losses ( for Northern Tanzania and change in Loss from baseline in response to a 10% reduction or increase in the parameter ( or , respectively), holding all other parameters constant. Baseline values for Gross and Net losses are $59.5 million and $28.3 million, respectively. | | | | | | | | |
|  | Gross Loss (L, %Δ) | | | | Net Loss (L, %Δ) | | | |
| parameter | -10% | | +10% | | -10% | | +10% | |
|  |  |  |  |  |  |  |  |  |
|  | 53.5 | 10.0 | 65.4 | -10.0 | 25.5 | -10.0 | 31.1 | 10.0 |
|  | 53.5 | 10.0 | 65.4 | -10.0 | 25.5 | -10.0 | 31.1 | 10.0 |
|  | 59.5 | 0.0 | 59.5 | 0.0 | 31.0 | 9.8 | 25.5 | -9.8 |
|  | 56.9 | 4.4 | 62.1 | -4.4 | 26.1 | -7.9 | 30.5 | 7.9 |
| Vpreg | 59.5 | 0.0 | 59.5 | 0.0 | 28.0 | -0.96 | 28.6 | 0.96 |
|  | 55.9 | 5.94 | 63.0 | -5.94 | 27.6 | -2.46 | 29.0 | 2.46 |
|  | 57.1 | 4.06 | 61.9 | -4.06 | 26.4 | -6.58 | 30.1 | 6.58 |
|  | 59.5 | 0.00 | 59.4 | -0.1 | 28.3 | 0.0 | 28.2 | 0.3% |

Table A.4.1. shows, for example, that when abortion and pregnancy rates and (for each stock type and breed) are 10% lower or higher than our baseline abortion rate estimates, total gross and net losses decrease or increase by 10%, respectively. This is because in both cases, abortion rates work proportionately in our model through the livestock population. A change in the share of husbandry costs attributable to the newborn () does not change gross losses, but net losses are higher if the newborn share is lower and the pregnancy share of husbandry costs are higher. Gross losses also do not change if the market premium for a pregnant animal (*Vpreg*), but net losses increase by only about 1% if *Vpreg* is 10% higher, because it implies higher implicit husbandry costs and therefore lower net benefits of successful pregnancy and therefore lower losses from abortion as well. A 10% higher proportion of households choosing not to consume milk after an abortion leads to a lower abortion loss by 4.4%. Aggregate losses vary inversely to the price of milk and the price of newborns , but are more responsive to differences in the price of milk --- gross losses increase by about 6% with a 10% increase in the price of milk. Changing the annual discount rate by 10% has very little effect on the outcomes because the time frames to which the discount rate applies are short (time between market sale and expected newborn delivery, and one year between birth and potential sale at 12 months old. If the discount rate is set to 5% instead of the baseline 2.5, gross loss falls to $58.8 million (-1%), and net loss falls to $27.9 million (-1%).