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Beyond Herd Size: Livestock Assets, Paid Work, and Household Welfare across Rural, Urban, and Nomadic Somalia

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Research Article

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Abstract

Livestock underpins food-system livelihoods across Somalia, yet larger herds may not translate uniformly into household economic welfare when market access, paid work, mobility, and shock exposure differ across livelihood settings. This study examines how livestock assets and complementary paid work relate to consumption-based welfare among livestock-keeping households and whether these relationships vary across rural, urban, and nomadic populations. Using the 2022 Somalia Integrated Household Budget Survey, we identify 2,523 livestock-keeping households, of which 2,502 link to the official welfare aggregate. Livestock holdings are standardized as Tropical Livestock Units (TLU). Household-weighted log-linear models estimate associations with real per-capita expenditure; poverty status provides a secondary outcome, while residence interactions test livelihood-system heterogeneity. In the fully adjusted national model, ln(TLU + 1) was not independently associated with welfare (1.1%; 95% CI -2.2 to 4.5; p = 0.528), whereas household access to paid work in the preceding week was associated with 10.6% higher expenditure (95% CI 2.1 to 19.8; p = 0.013) and lower odds of poverty (OR 0.74; 95% CI 0.59 to 0.92; p = 0.007). The livestock asset-welfare association was positive among rural households (6.2%; 95% CI 1.4 to 11.2; p = 0.010) but not among urban or nomadic households. These findings show that livestock capital cannot be interpreted as a uniform proxy for current welfare across Somalia's livestock-based food system. Strengthening dryland livelihoods requires combining productive-asset protection with differentiated labor, market-access, mobility, and risk-management strategies.

1 Introduction

Livestock policy in dryland economies is often built around a compelling intuition: because animals constitute productive capital, food, savings, and marketable wealth, households with more animals should be economically better positioned. That intuition is important but incomplete. Pastoral and agro-pastoral households convert animals into welfare through production, sales, milk and meat consumption, mobility, social exchange, and risk management, and each of these channels depends on ecological and market conditions. In the Horn of Africa, herd size also interacts with drought exposure, feed constraints, mobility, transaction costs, and the timing of food purchases and livestock sales. Consequently, a stock of animals can represent substantial wealth while generating very different flows of current consumption across households and locations [1–4].

This distinction is especially consequential in Somalia. Livestock supports a large share of livelihoods and export earnings, and current national strategies continue to place livestock, agriculture, jobs, and climate resilience at the center of economic transformation. FAO reports that livestock supports roughly 60–65% of Somalia's population and around 80% of national exports, while recent investments in fodder value chains seek to stabilize productivity and incomes in the face of recurrent feed deficits and drought [5]. The National Transformation Plan 2025–2029 similarly links sustainable economic transformation with employment, human capital, and climate resilience [6]. Yet the livestock economy is under severe climatic pressure. The 2021–2022 Horn of Africa drought was intensified by anthropogenic climate

change, and renewed drought conditions in 2025–2026 again reduced pasture, water availability, animal body condition, and milk production in Somalia [7, 8].

Recent Somalia evidence confirms that livestock vulnerability is not simply a matter of aggregate herd numbers. Drought-related camel mortality varies sharply by geography and residence, with nomadic households facing particularly high exposure [9]. Household research in southwest Somalia documents the erosion of natural, financial, physical, human, and social livelihood assets under drought, including severe livestock losses and declining market opportunities [10]. A national analysis of SDHS 2020 likewise links livestock mortality to food insecurity [11]. At the same time, market-based arrangements can modify the welfare return to animals without necessarily increasing herd ownership: camel leasing in Somaliland has been associated with regular payments, greater savings, schooling, and asset accumulation among participating pastoralists [12]. These findings point toward a broader question than whether households own livestock: under what conditions does livestock capital translate into realized household welfare?

The wider rural-development literature provides a second reason to ask that question. Livelihood diversification has long been understood as a response to both opportunity and constraint. Households combine farm, livestock, wage, self-employment, migration, and transfer income because different activities carry different returns, seasonal profiles, and risks [13–15]. More recent evidence suggests that the welfare consequences of diversification are strongly context-dependent. In Uganda, the benefits of diversification differed across rural and urban locations and by type of income activity [16]. In rural Ethiopia, nonfarm diversification is associated with higher consumption and other welfare measures, but local conditions and factor endowments shape who can diversify and into what [17]. Across Burkina Faso, Malawi, and Uganda, off-farm wage employment is associated with improved food security during lean seasons in many settings, while the extent of seasonal labor reallocation remains constrained by the scarcity of rural opportunities [18]. These findings are consistent with broader evidence that sub-Saharan Africa's structural transformation remains unusually dependent on on-farm livelihoods and that access to off-farm wage and self-employment can have substantial poverty-reducing potential [19, 20].

Diversification, however, is not automatically protective. Furbush et al. [21] find no general food-security benefit from livelihood diversification during the large covariate shock of the COVID-19 pandemic, underscoring that the type and scale of shocks matter. Similarly, recent Food Policy evidence on crop-livestock diversification in Ethiopia shows that nutrition gains depend on whether foods are home produced or purchased and on market access [22]. For pastoral systems, market participation itself is conditional. In the Horn of Africa, livestock sales are shaped not only by prices but also by household food needs, herd mobility, feed scarcity, and market-chain position [3]. In drought-prone Ethiopia, greater goat-market participation is associated with higher income and lower poverty, but participation depends on transaction costs, flock size, and veterinary access [23]. Thus, both livestock assets and complementary economic activities operate through institutions and constraints rather than as universally welfare-enhancing inputs.

A close contemporary comparator is Tshifhiwa et al. [24], who examine income among communal smallholder livestock-farming households in South Africa. They find employment status to be a stronger correlate of household income than livestock holdings, suggesting that the welfare of livestock households may depend on livelihood opportunities beyond the herd. Somalia offers a demanding test of that proposition because its livestock-keeping population spans three sharply different livelihood geographies: urban, settled rural, and nomadic. These groups differ in labor-market access, service density, grazing systems, mobility requirements, and market integration. The same number or value-equivalent of animals may therefore have different welfare relevance across residence types.

This paper uses the 2022 Somalia Integrated Household Budget Survey (SIHBS) to examine that heterogeneity. The paper is intentionally distinct from general SIHBS welfare analyses. Osman et al. [25], for example, use the full SIHBS sample to study remittances, mobile money, consumption, food security, and housing. Here, the analytical population is restricted to livestock-keeping households, and the focus is on standardized livestock capital, paid work, livestock commercialization, livestock losses, and residence-specific welfare relationships. This distinction is substantively important because a general household model cannot identify whether the welfare relevance of livestock capital differs within the livestock economy itself.

The study asks three questions. First, are larger livestock asset holdings associated with higher consumption-based welfare among livestock-keeping households after accounting for household characteristics and geography? Second, is household access to paid work associated with welfare beyond livestock assets and other livelihood activities? Third, does the livestock asset-welfare relationship differ across rural, urban, and nomadic households? The study contributes to research on livestock-based food systems and household livelihoods in three ways. First, it tests whether standardized livestock assets translate into higher current economic welfare within a national livestock-keeping population that explicitly includes nomadic households. Second, it examines paid work as a complementary livelihood channel through which households may sustain consumption alongside livestock production. Third, it tests whether the livestock asset-welfare relationship differs across rural, urban, and nomadic settings, showing how livelihood geography conditions the economic contribution of productive assets. The broader proposition is not that livestock capital is unimportant, but that its welfare relevance depends on the labor, market, mobility, and risk environments through which households convert animals into food, income, and consumption.

2 Conceptual framework

The conceptual framework separates three objects that are often conflated in pastoral policy: productive asset stocks, livelihood activities, and realized household welfare. Livestock capital is a stock of animals with productive, consumption, savings, insurance, and social functions. Household welfare, by contrast, is a flow outcome measured here through real per-capita consumption expenditure and poverty status. The distinction matters because the mapping from stocks to flows is neither linear nor immediate. In pastoral economies, animals can be retained to reproduce, used for milk, moved to exploit dispersed

grazing, sold in response to food needs, transferred through social networks, or lost during drought. A household may therefore hold substantial livestock wealth while experiencing low current consumption, especially when herd productivity, terms of trade, or market access are weak [1, 2].

Pastoral poverty research has long emphasized thresholds, nonlinear asset dynamics, and the possibility that a climatic shock can have persistent welfare consequences. Herd-history evidence from southern Ethiopia identifies multiple wealth equilibria and poverty-trap dynamics in which biophysical shocks can move pastoral households between very different asset trajectories [26]. More generally, an asset-based poverty framework distinguishes structural poverty from temporary consumption shortfalls and emphasizes the importance of productive-asset thresholds [27]. McPeak and Barrett [1] similarly show how heterogeneous risk exposure can generate stochastic poverty traps among East African pastoralists, while Toth [4] identifies herd-size thresholds associated with persistence in mobile pastoral livelihoods. Informal finance does not fully neutralize these dynamics: among southern Ethiopian pastoralists, lending responds to losses but can exclude households that have fallen below critical wealth thresholds [28]. These contributions warn against using current consumption alone to describe pastoral wealth, but they also imply the reverse: herd size alone is not a sufficient welfare measure. The World Bank's recent analysis of Somalia's nomadic population is consistent with this distinction, documenting substantial livestock ownership alongside exceptionally high poverty and inequality [29].

A second channel concerns access to paid work and other non-livestock activities. Rural livelihood diversification can be 'push' driven, when households enter low-return activities because farming or livestock production cannot meet needs, or 'pull' driven, when households exploit higher-return opportunities enabled by education, infrastructure, markets, and capital [13, 15]. Pastoral diversification is not new: among Borana households in southern Ethiopia, non-pastoral activities expanded partly because returns to labor in traditional pastoral production were limited, while younger and more literate households were more likely to diversify [30]. This distinction matters for interpretation. A positive association between paid work and welfare may indicate access to higher-return opportunities, but diversification can also be a response to livestock stress or declining land productivity. Recent evidence from Ethiopia and Uganda likewise shows that the welfare consequences of nonfarm activity depend on activity type, assets, local conditions, and household characteristics [16, 17].

For livestock households, paid work may operate as a complement rather than a substitute for animals. Cash earnings can finance food purchases, water, fodder, veterinary services, school fees, transport, or market participation. Conversely, access to paid work may simply proxy for education, proximity to towns, social networks, or infrastructure. The African diversification literature therefore cautions that livelihood activities reflect both opportunity and constraint and should not be interpreted as exogenous treatments [13, 15, 16]. This study accordingly asks whether a household-level indicator of recent paid work remains associated with welfare after adjustment for head characteristics, household size, region, residence, livestock assets, nonfarm work, crop activity, commercialization, losses, and remittances. Alternative longer-duration employment definitions are examined as sensitivity checks because the primary labor indicator has a short recall period.

A third channel concerns commercialization. Livestock ownership produces monetary welfare only when animals or products can be marketed on terms that are favorable enough to support consumption and reinvestment. Yet pastoral marketing is not a simple response to prices. Little et al. [3] show that mobility, feed constraints, and household food needs shape sale decisions in the Horn of Africa. Market information and transaction costs can further weaken producer returns, while Yitayew et al. [23] find that greater market participation can improve pastoral welfare when constraints are overcome. These findings echo a broader food-system concern that market participation is shaped by transaction costs, service access, and value-chain conditions rather than by asset ownership alone [3, 23]. In this study, commercialization is therefore included as an important correlate, but a null coefficient is not interpreted as evidence that markets are unimportant; the binary measure cannot distinguish strategic commercial sales from distress sales, nor can it fully capture price or transaction-cost conditions.

A fourth channel is risk. Drought can deplete animals, reduce milk production, weaken body condition, force early migration, and alter livestock prices at the same time that food prices rise. In such settings, protecting current consumption and protecting productive assets can become competing objectives. Evidence from northern Kenya shows that index-based livestock insurance can reduce both distress asset sales and consumption cuts after drought, although effects differ by initial wealth [31]. Risk-management policies in the Horn have consequently expanded beyond post-drought restocking toward index-based livestock insurance, market infrastructure, fodder systems, and informal or community-based arrangements [32–34]. This literature motivates distinguishing current livestock holdings from loss exposure and from the institutions that help households protect assets and consumption.

Finally, the framework treats residence as an economic institution rather than a simple demographic control. Urban livestock keepers have denser access to wage labor, services, and output markets but may face limited grazing and higher feed costs. Settled rural households may integrate livestock with crop production and local markets. Nomadic households rely more directly on mobility and rangeland access and can maintain larger herds while remaining far from labor markets, health and education services, and stable market infrastructure. Recent Somalia evidence documents especially high poverty among nomadic households and strong geographic differentiation in drought-related livestock mortality, reinforcing the need to treat livelihood geography as analytically substantive [9, 29]. These differences imply that the marginal welfare association of an additional unit of livestock capital need not be constant. The empirical analysis therefore estimates both a national average and residence-specific TLU slopes. This heterogeneity test is central to the paper's analytical logic: if the asset-welfare relationship varies by livelihood geography, uniform herd-based interventions are unlikely to produce uniform welfare gains.

3 Data and methods

3.1 Data source and survey coverage

The analysis uses de-identified microdata from the Somalia Integrated Household Budget Survey 2022, produced by the Somalia National Bureau of Statistics. SIHBS is the country's national household consumption and expenditure survey and includes modules on demographics, education, labor, household businesses, crops, livestock, remittances, shocks, assets, services, and food security. A key strength for this study is explicit coverage of rural, urban, and nomadic populations, which allows livelihood-system heterogeneity to be examined within a single national survey framework [35]. The survey employed a stratified multistage probability design and covered 601 enumeration areas. Released household files include an adjusted household weight used for welfare analysis; the public-use modules available for this study do not expose the original primary-sampling-unit and stratum identifiers needed to reconstruct the full survey variance design.

3.2 Study population and analytical sample

The livestock module contains repeated records by household and animal type. We first identified all household identifiers appearing in the livestock_own file and collapsed animal-type records to household level. This yielded 2,523 unique livestock-keeping households. These identifiers were then linked to the official consumption aggregate (consagg), household roster (hhm), household file (hh), household-business information, crop records, and shock/livestock modules using the unique household identifier. Of the 2,523 livestock-keeping households, 2,502 (99.2%) linked to the official welfare aggregate and form the primary analytical sample. Rather than dropping households for 'unknown' age or education codes of the household head, those legitimate survey responses were retained as explicit categories, thereby avoiding unnecessary complete-case attrition. ESM 1, Table S1 documents the sample flow and linkage checks.

3.3 Welfare outcomes

The primary outcome is real per-capita household expenditure (pcer), the official SIHBS consumption-based welfare measure expressed in US dollars per person per year. Consumption expenditure is preferred to a constructed income measure because the survey's income components have different recall periods and because using wage earnings, livestock sales, and business profits to construct the dependent variable while simultaneously using those activities as predictors would create a mechanical part-whole relationship. The expenditure distribution is strongly right-skewed, so the primary continuous model uses ln(pcer). The secondary outcome is the official national poverty indicator (poor), which provides a policy-readable robustness check based on the national poverty line [35].

3.4 Livestock assets and Tropical Livestock Units

Livestock holdings are recorded separately by animal type. Directly summing animals would equate species with very different body size and productive capacity. We therefore convert current holdings to Tropical Livestock Units (TLU), using conventional factors of 1.0 for camels, 0.7 for cattle/oxen, 0.5 for donkeys, 0.1 for sheep and goats, and 0.01 for poultry. The TLU is a long-used biomass-equivalent measure based on a reference animal of approximately 250 kg, although the conventional coefficients necessarily abstract from differences in breed, age, sex, and productivity [36]. Species-specific TLU

values are summed within household. Because the resulting distribution is strongly right-skewed, the primary model uses ln(TLU + 1). Raw TLU and exclusion of the upper tail of the TLU distribution are examined as robustness checks. This approach improves comparability across species while avoiding the stronger and unsupported assumption that the same TLU has identical market value or productivity in every residence setting. The construction of key analytical variables is summarized in ESM 1, Table S2.

3.5 Paid work and complementary livelihood activities

The principal complementary livelihood variable is a household indicator equal to one if any household member reported working for someone else for pay during the preceding week (lab4). This measure captures access to recent paid work rather than permanent formal employment. The distinction is important, particularly in economies where wage and casual labor can be episodic. To test whether the main finding depends on the short recall period, sensitivity specifications use alternative labor definitions based on whether a household member's main job is employee work and whether such work was reported for at least six or ten months. Additional household-level indicators identify nonfarm household-business/work activity and crop activity. These variables are modeled as complementary channels rather than collapsed into a single diversification index because their economic meaning and likely returns differ.

3.6 Commercialization, livestock loss, remittances, and covariates

Livestock commercialization is represented by an indicator for any reported sale of live animals or animals slaughtered for sale in the preceding 12 months. A binary measure is used in the primary model because sales counts and monetary values are highly skewed and because sales may reflect either strategic commercialization or distress responses. Livestock loss is represented by an indicator for any positive number of animals lost during the preceding 12 months after survey special codes are set to missing. Remittance receipt is drawn from the household module. Covariates include household-head sex, age group, education, household size, region, and residence type (rural, urban, or nomadic). Head-age and education categories retain explicit 'unknown' categories where those responses are present in the survey.

3.7 Empirical specification

The empirical strategy is associational rather than causal. The primary model estimates the conditional relationship between livestock assets, paid work, and welfare after adjustment for observed household and geographic characteristics. For household h, the principal specification is:

$$\ln(pcer_h) = \beta_0 + \beta_1 \ln(TLU_h + 1) + \beta_2 Paid_h + \beta_3 L_h + \beta_4 M_h + \beta_5 S_h + \beta_6 R_h + X_h\gamma + \delta_{region} + \delta_{residence} + \varepsilon_h \quad (1)$$

Here, L_h denotes other livelihood activities, M_h livestock commercialization, S_h livestock loss, R_h remittance receipt, and X_h household characteristics. Region and residence fixed effects are

represented by δ_region and δ_residence. Models are estimated sequentially so that changes in the livestock coefficient can be observed as livelihood, commercialization, loss, and remittance variables are introduced.

Because the dependent variable is logged, coefficients for binary and continuous regressors are reported as percentage differences using 100[exp(beta)-1]. Household welfare weights are applied in descriptive estimates and weighted least-squares regressions. Heteroskedasticity-consistent HC1 standard errors are used. This approach does not reproduce full design-based survey variance estimation because PSU and strata identifiers are absent from the released analytical modules; this limitation is stated explicitly and inference is interpreted accordingly.

3.8 Poverty model and residence heterogeneity

A weighted binomial generalized linear model re-estimates the fully adjusted specification with official poverty status as the dependent variable, reporting adjusted odds ratios and 95% confidence intervals. To evaluate livelihood geography, the continuous welfare model then includes interactions between ln(TLU + 1) and residence, with urban households as the reference group. Residence-specific marginal slopes are derived from the fitted interaction model. The joint significance of the residence interactions is assessed with a Wald test; individual residence slopes are also reported because the paper's policy question concerns whether livestock assets have different welfare associations across livelihood systems.

3.9 Robustness and interpretation

Robustness checks include alternative paid-work definitions, raw rather than logged TLU, exclusion of extreme livestock holdings, alternative drought/shock adjustment, and restriction to rural and nomadic households. The primary models are not interpreted as causal effects because employment access, herd accumulation, market participation, residence, and welfare can be jointly determined. Reverse causality is plausible: wealthier households may obtain better employment, maintain larger herds, or choose different residence strategies. Unobserved factors such as local labor demand, market distance, grazing quality, conflict exposure, and animal productivity may also confound associations. The analysis therefore uses the language of association, correlates, and conditional differences throughout.

4 Results

4.1 Analytical sample and household profile

The 2,502 welfare-linked livestock-keeping households represent a heterogeneous economic population rather than a single 'pastoral' category. Weighted poverty prevalence is 52.5%, and median real per-capita expenditure is approximately US$722 per person per year. Median livestock holdings are about 3.0 TLU, but the distribution is highly right-skewed. Roughly 62.8% of households report some livestock loss during the preceding 12 months and 61.3% report at least one form of livestock commercialization. Recent paid work is reported by 31.2% of households. Household business activity and crop activity are

less common, illustrating that access to non-livestock opportunities is uneven within the livestock-owning population.

Table 1
Weighted characteristics of livestock-keeping households

Characteristic	N	Weighted mean / %	Median	IQR
Real per-capita expenditure (USD/person/year)	2502	941.6	721.8	458.8-1154.6
Poor household	2502	52.5%		
Tropical Livestock Units	2502	7.4	3.0	1.0–9.0
Any paid work in preceding week	2502	31.2%		
Any nonfarm household business/work	2502	18.8%		
Any crop activity	2502	12.5%		
Any livestock commercialization	2502	61.3%		
Any livestock loss	2502	62.7%		
Received remittances	2502	19.3%		
Note: Estimates use the SIHBS household welfare weight. TLU = Tropical Livestock Units.				

The coexistence of high commercialization and high poverty is important. It indicates that market participation alone cannot be assumed to signal economic advantage, because sales can occur under very different circumstances. Likewise, widespread livestock loss does not identify a small exceptional group; loss is a common feature of the livestock economy. These descriptive patterns motivate the multivariable approach, where livestock assets, labor opportunities, commercialization, losses, and geography are considered jointly.

4.2 Welfare differences across rural, urban, and nomadic households

Residence groups differ sharply in welfare despite broadly comparable median livestock holdings between rural and urban households and larger median holdings among nomadic households. Weighted median pcer is approximately US$868 among urban livestock keepers, US$614 among rural households, and US$476 among nomadic households. Poverty prevalence follows the reverse gradient: 40.7% in urban, 64.2% in rural, and 76.4% in nomadic households. Median TLU is approximately 2.9 in both urban and rural households but 4.5 among nomadic households. Thus, the group with the largest median livestock asset holding also has the lowest median consumption welfare and highest poverty prevalence. This descriptive contrast is the first indication that herd scale and realized welfare are not interchangeable measures.

Figure 1 presents the residence welfare gradient. The scale of the gap is economically large: median consumption among nomadic livestock households is roughly 45% below that of urban livestock households. These differences motivate strong geographic adjustment in the national models and the subsequent interaction analysis.

Table 2
Welfare and livelihood profile by residence

Residence	N	Median pcer	Poverty	Median TLU	Paid work
Urban	1436	868	40.7%	2.9	34.7%
Rural	712	614	64.2%	2.9	28.5%
Nomadic	354	476	76.4%	4.5	22.5%

4.3 Staged national welfare models

In the baseline model including livestock assets and household/geographic controls, ln(TLU + 1) is not strongly associated with per-capita expenditure. Adding paid work and other livelihood variables leaves the livestock coefficient small. In the fully adjusted model, a one-unit increase in ln(TLU + 1) is associated with a 1.1% difference in expenditure (95% CI -2.2% to 4.5%; p = 0.528). The confidence interval therefore excludes neither modest positive nor modest negative relationships but does not support a strong national asset-welfare gradient after adjustment.

Table 3
Staged weighted models of real per-capita household expenditure

Variable	M0	M1	M2	M3
ln(TLU + 1)	-0.2% [-3.3, 3.0], p = 0.907	1.0% [-2.2, 4.2], p = 0.552	1.0% [-2.4, 4.5], p = 0.578	1.1% [-2.2, 4.5], p = 0.528
Recent paid work	—	11.2% [2.7, 20.5], p = 0.009	11.2% [2.6, 20.5], p = 0.009	10.6% [2.1, 19.8], p = 0.013
Nonfarm business/work	—	0.3% [-7.2, 8.3], p = 0.946	0.3% [-7.2, 8.3], p = 0.947	-0.2% [-7.7, 7.8], p = 0.951
Crop activity	—	-2.2% [-11.2, 7.7], p = 0.652	-2.2% [-11.2, 7.7], p = 0.652	-1.9% [-11.0, 8.0], p = 0.694
Livestock commercialization	—	—	-0.1% [-6.9, 7.2], p = 0.980	0.8% [-6.8, 9.0], p = 0.848
Livestock loss	—	—	—	-2.4% [-9.7, 5.4], p = 0.538
Remittance receipt	—	—	—	-4.2% [-10.6, 2.7], p = 0.225
Note: Percentage differences are 100[exp(beta)-1]. All models include household-head age, sex, education, household size, region, and residence. N = 2,502.				

Recent paid work shows a different pattern. In the fully adjusted national model, households with at least one member reporting paid work in the preceding week have 10.6% higher real per-capita expenditure than otherwise similar livestock-keeping households (95% CI 2.1% to 19.8%; p = 0.013). The association remains similar across staged specifications, suggesting that it is not explained by the inclusion of commercialization, livestock loss, or remittances. Nonfarm household-business/work activity, crop activity, commercialization, livestock loss, and remittances do not show independently significant national associations in the full model.

These null coefficients require cautious interpretation. The commercialization measure does not distinguish high-return commercial sales from distress sales, and the loss indicator does not measure severity relative to initial herd size. Their lack of independent significance therefore does not imply that market access or livestock mortality are unimportant for livelihoods. Rather, the available binary measures do not explain additional cross-sectional variation in consumption after livestock assets, paid work, household characteristics, region, and residence are included.

4.4 Poverty robustness model

The poverty model reinforces the paid-work result using a different welfare outcome. Conditional on the same covariate set, households with recent paid work have lower odds of being below the national poverty line (adjusted OR 0.74; 95% CI 0.59–0.92; p = 0.007). The direction is therefore consistent with the continuous expenditure model. Livestock assets remain weak in the national poverty specification, and commercialization, loss, crop activity, nonfarm work, and remittances do not show robust independent associations. The consistency across expenditure and poverty outcomes strengthens the interpretation that access to paid work identifies an economically distinct subset of livestock-keeping households, while still not establishing causality.

Table 4
Fully adjusted weighted poverty model

Variable	Adjusted OR	95% CI	p-value
ln(TLU + 1)	0.97	0.87–1.08	0.604
Recent paid work	0.74	0.59–0.92	0.007
Nonfarm business/work	0.91	0.71–1.15	0.410
Crop activity	0.95	0.71–1.27	0.717
Livestock commercialization	0.95	0.77–1.17	0.612
Livestock loss	1.14	0.92–1.42	0.225
Remittance receipt	1.06	0.82–1.35	0.668

4.5 Residence-specific livestock asset associations

The national average masks important heterogeneity. Figure 2 shows adjusted residence-specific associations between ln(TLU + 1) and welfare. Among rural livestock-keeping households, a one-unit increase in ln(TLU + 1) is associated with 6.2% higher real per-capita expenditure (95% CI 1.4% to 11.2%; p = 0.010). By contrast, the corresponding slopes are close to zero and statistically imprecise among urban and nomadic households. The rural-versus-urban interaction is individually significant, while the joint Wald test for the two residence interactions is borderline (p = 0.068). We therefore interpret the heterogeneity as suggestive but substantively important rather than as definitive evidence of completely different structural regimes. Detailed residence-specific slopes are reported in ESM 1, Table S4.

This pattern changes the interpretation of the national null result. The absence of a national livestock coefficient does not mean that livestock assets have no welfare relevance. Instead, their relationship with current consumption appears strongest in rural settings where livestock may be more tightly integrated with household production and local livelihood portfolios. The absence of a comparable slope among nomadic households is consistent with the descriptive finding that larger herds can coexist with very low current consumption and high poverty.

4.6 Sensitivity analyses

Alternative labor definitions produce similar, though less precisely estimated, coefficients. Defining paid work through main-job employee status yields a positive association; restricting that definition to employment reported for at least six months produces an effect of similar magnitude, while the ten-month definition remains positive but less precise. The short-recall paid-work result is therefore not driven entirely by a one-week anomaly. The rural/nomadic subsample also shows a larger positive association between paid work and welfare than the national model. Alternative TLU specifications and removal of extreme holdings do not materially alter the central finding that the national asset-welfare association is weak while the rural-specific association is stronger. Full sensitivity estimates are provided in ESM 1, Table S3.

5 Discussion

The results support a more differentiated interpretation of livestock wealth than an asset-centered policy narrative would imply. Three findings are central. First, standardized livestock assets are not strongly associated with consumption welfare in the pooled national model once household and geographic differences are controlled. Second, household access to recent paid work is consistently associated with higher expenditure and lower poverty odds. Third, the livestock-welfare relationship is heterogeneous: it is positive among rural livestock keepers but not evident among urban or nomadic households. Taken together, these results suggest that the economic relevance of livestock capital depends on the livelihood system in which that capital is embedded.

5.1 Why herd size is not a sufficient welfare indicator

The national result is consistent with long-standing concerns in pastoral poverty research about equating livestock stocks with current welfare. Little et al. [2] argue that pastoral poverty cannot be understood through a single monetary or asset proxy because mobility, market integration, household composition, and livelihood diversification create substantial heterogeneity. McPeak and Barrett [1] and Toth [4] further show that livestock dynamics can be nonlinear and path dependent: households near or below critical asset thresholds face different livelihood trajectories from wealthier herders. Our finding adds a complementary cross-sectional point. Even above zero ownership, standardized livestock scale does not map uniformly onto current consumption across residence types.

The nomadic profile is especially revealing. Nomadic households have the largest median TLU in the sample but the lowest median consumption and highest poverty prevalence. This apparent paradox is not inconsistent with pastoral economic theory. Animals perform insurance, reproduction, mobility, social, and future-income functions that may not be realized as current consumption. Maintaining mobile herds also involves costs, and weak access to services, infrastructure, and markets can reduce the consumption return to livestock wealth. The World Bank's 2025 policy brief on Somalia's nomadic population similarly documents very high poverty and emphasizes that livestock ownership among poorer nomadic households has been heavily affected by drought. The policy implication is not to abandon livestock metrics, but to interpret them alongside consumption, market access, and livelihood opportunities [29].

5.2 Paid work as a complementary welfare correlate

The positive paid-work association connects the Somali livestock economy to the broader rural structural-transformation literature. Barrett et al. [13] emphasized that diversification patterns reflect both opportunities and constraints, while recent evidence shows that the welfare return to off-farm activities varies by activity type and context. Khan and Morrissey [16] find substantial rural-urban and gender heterogeneity in Uganda. Abate et al. [17] report a positive link between diversification and household welfare in Ethiopia, and Guthoff et al. [18] show that off-farm wage employment is associated with better seasonal food security in multiple African countries. At a global scale, De la O Campos et al. [19] find that rural sub-Saharan Africa remains less engaged in off-farm wage employment than comparable regions despite potentially large poverty-reduction gains.

Our result should not be interpreted as evidence that moving households out of livestock production will automatically improve welfare. Paid work may complement rather than replace livestock. Cash earnings can stabilize food purchases and finance animal health, feed, water, transport, and schooling during periods when livestock income is seasonal or disrupted. Somalia-specific evidence supports this complementarity. Omer et al. [37] identify wage labor as an important component of rural livelihood portfolios in Maroodijeex, while Decker et al. [12] show that a market arrangement centered on camel assets can create regular payments, savings, and schooling benefits. These examples illustrate that the key economic question may be how livestock is connected to cash-flow opportunities, not whether households choose 'livestock' or 'employment' as mutually exclusive livelihoods.

At the same time, the short recall period of the primary paid-work variable remains an important limitation. Recent employment could reflect temporary casual work, seasonal labor, or more stable wage employment. The positive coefficients under alternative main-job and longer-duration employee definitions are reassuring, but the survey does not allow a full characterization of job quality, wages, contractual stability, or whether paid work is distress-driven. The policy interpretation should therefore emphasize access to viable and remunerative work rather than simply any employment.

5.3 Why livestock assets matter more in rural households

The rural-specific TLU association is one of the paper's most policy-relevant findings. Rural households may be better able than urban households to integrate animals with crop production, local grazing, household labor, and nearby livestock markets, while facing fewer mobility constraints than nomadic households. In such settings, an additional unit of livestock capital may generate milk, offspring, manure, sales, and savings that translate more directly into consumption. This interpretation is consistent with evidence that crop-livestock integration can improve household nutrition through multiple pathways and that market access can strengthen those relationships [22]. It is also consistent with dryland production research showing that species composition and production systems matter for sustaining output under resource constraints [38].

For urban livestock keepers, animal ownership may have a different function. Feed and space constraints can raise costs, households may rely more heavily on wage or business income, and livestock may be held as supplementary assets rather than the core production system. The near-zero urban TLU slope is therefore plausible. For nomadic households, the absence of a positive consumption slope despite higher median TLU may reflect higher exposure to climate risk, distance from services and markets, greater mobility costs, and the need to retain animals as productive and insurance assets. Omar et al. [9] find nomadic residence strongly associated with drought-related camel mortality, while FAO's 2026 monitoring describes early and extended migration, low body condition, and low milk production during drought. These constraints can weaken the short-run consumption return to animal stocks.

5.4 Commercialization and livestock loss: interpreting null coefficients

Neither the commercialization indicator nor the any-loss indicator is independently significant in the final national model. These results should not be read as rejecting the importance of markets or shocks. The Horn of Africa literature shows that pastoral market participation is shaped by more than the decision to sell. Little et al. [3] find that food needs, mobility, and feed scarcity influence sales, and Yitayew et al. [23] show that transaction costs and veterinary access condition the welfare gains from goat markets. A binary 'any sale' variable cannot distinguish high-return commercial participation from forced sales during stress. This measurement limitation likely compresses heterogeneous market behaviors into one category.

The same logic applies to livestock loss. A household that loses one goat and a household that loses half a camel herd are both coded as having experienced a loss in the primary model. Moreover, consumption can be buffered through insurance, remittances, social networks, credit, humanitarian assistance, or asset sales. Research from Ethiopia shows that social capital can buffer consumption against shocks [39], while pastoral insurance research demonstrates both the potential and the implementation challenges of index-based products [32, 33]. Somalia-specific evidence on camel leasing likewise points to alternative market and social arrangements that can stabilize income after shocks [12]. The null coefficient therefore indicates limited independent explanatory power of the available annual loss indicator, not the absence of welfare consequences from severe livestock mortality.

5.5 Relation to recent Somalia SIHBS welfare research

The study also clarifies how a livestock-specific welfare analysis differs from broader SIHBS research. Osman et al. [25] analyze the full household sample and find remittances and mobile-money channels associated with consumption and other welfare measures. In the livestock-only sample examined here, remittance receipt does not remain independently associated with pcer after adjustment. This difference need not be contradictory. Livestock-keeping households constitute a selected livelihood population with different asset structures, residence composition, and income portfolios. The result reinforces the value of explicitly defining the policy population rather than assuming coefficients from the national household population generalize to livestock-dependent households.

5.6 Strengths and limitations

The study has several strengths. SIHBS provides a large national household sample with direct coverage of nomadic populations, detailed livestock modules, an official consumption aggregate, poverty status, labor information, and geographic identifiers. The household linkage rate between livestock and welfare modules is very high, and the analysis separates standardized livestock assets from the welfare outcome rather than using a composite wealth measure. The staged models, alternative labor definitions, poverty robustness outcome, residence interactions, and TLU sensitivities reduce dependence on a single specification.

The limitations are equally important. First, the cross-sectional design cannot establish causal effects. Herd size, residence, employment, market participation, and welfare are jointly determined, and omitted variables may influence all of them. Second, the public-use files do not include the original PSU and strata identifiers, preventing full reconstruction of design-based variance estimates; weights and heteroskedasticity-robust standard errors are used instead. Third, TLU standardizes animal numbers but not breed, age, sex, health, productivity, location-specific prices, or grazing access, a recognized limitation of conventional TLU aggregation [36]. Fourth, paid work is measured primarily over the preceding week, while welfare is annualized; sensitivity definitions partly address but do not eliminate this temporal mismatch. Fifth, commercialization and livestock loss are simplified binary measures in the main models and cannot distinguish strategic from distress sales or minor from catastrophic loss. Finally, welfare is measured through consumption and poverty. Pastoral wellbeing also includes mobility,

herd reproduction, social obligations, food self-provisioning, and resilience capacities that are not fully captured by expenditure.

6 Food-system and livelihood implications

Evidence from Somalia speaks to a wider class of dryland livestock-based food systems in which productive assets generate welfare through markets, labor opportunities, mobility, services, and risk-management institutions. The results therefore caution against treating herd size as a sufficient proxy for current household welfare or as a uniform intervention lever. Instead, they support a portfolio approach that links livestock productivity and asset protection with context-specific opportunities for market participation, paid work, service access, and risk management.

6.1 Differentiate livestock support across livelihood systems

The rural-specific positive TLU association suggests that livestock asset support can be welfare relevant where households are embedded in settled production systems that allow animals to generate regular food, income, and complementary farm benefits. Rural interventions can therefore justify herd-health services, fodder, water infrastructure, veterinary access, breeding, market information, and commercialization support. However, the weak national and nomadic TLU slopes caution against assuming that adding animals will produce the same welfare gain everywhere. Asset-transfer or restocking programs should be preceded by livelihood-system diagnostics that assess feed availability, mobility, market access, household labor, and post-transfer risk. This is consistent with Horn of Africa evidence that pastoral market responses are shaped by non-price constraints and with current Somalia investments that emphasize fodder value chains and inclusive livestock systems rather than herd numbers alone [3, 5].

6.2 Treat paid work as a complementary welfare and food-access channel

The consistent paid-work association points toward the importance of labor-market policy within livestock development. This does not imply replacing pastoralism with wage labor. Rather, dryland households can benefit from livelihood portfolios that allow labor to move into remunerative activities when livestock production is seasonal or disrupted. Policy options include skills development linked to local demand, public and private employment around livestock value chains, animal health services, transport, fodder production, processing, cold chains, digital market services, and construction or maintenance of water infrastructure. Such activities can retain economic linkages to the livestock system while broadening household cash-flow sources. The finding aligns with recent evidence that off-farm wage employment can strengthen food security in rural Africa but remains constrained by limited opportunities [18, 19].

6.3 Nomadic welfare requires more than herd-based targeting

The nomadic profile presents the clearest warning against using livestock stocks as a stand-alone poverty proxy. Nomadic households in the sample hold more livestock on average than urban and rural households but experience markedly lower consumption and higher poverty. Policies that infer economic wellbeing from herd ownership alone risk under-targeting nomadic poverty. Mobile veterinary and health services, market access along migration corridors, water and grazing governance, education models compatible with mobility, drought early warning, and financial instruments designed for mobile households are therefore central complements to livestock assets. World Bank evidence already identifies the nomadic population as facing Somalia's highest poverty and inequality, while recent camel-mortality analysis demonstrates concentrated geographic and nomadic drought risk [9, 29].

6.4 Manage livestock risk before and after losses

The prevalence of reported livestock loss is high even though the binary loss indicator is not independently significant in the cross-sectional welfare model. Policy should therefore focus on the mechanisms through which losses are prevented and absorbed. Index-based livestock insurance has demonstrated sufficient policy relevance to scale across parts of the Horn, but supply, trust, implementation, and access remain critical constraints [32, 33]. Complementary instruments include fodder reserves, water systems, animal-health surveillance, flexible credit, savings, social protection, market-based leasing, and support for informal risk-sharing institutions [12, 34, 39]. A portfolio of ex-ante risk reduction and post-shock liquidity support is more consistent with the evidence than repeated restocking alone.

6.5 Implications for dryland livestock-based food systems

The broader lesson extends to pastoral and agro-pastoral systems in Ethiopia, Kenya, the Sahel, and other drylands. Asset-based development programs are attractive because animals are visible, measurable, and culturally and economically central. Yet the welfare return to the same asset can differ by market density, labor access, ecological conditions, and mobility. Pastoral poverty-trap research, African livelihood-diversification evidence, and Horn of Africa market and insurance studies all point to these conditioning mechanisms [1, 2, 19, 32]. Evaluations of livestock programs should therefore report both asset outcomes and realized welfare outcomes, and should test heterogeneity across livelihood systems rather than relying on pooled averages. The Somalia case demonstrates why livestock-based food systems should be analyzed as integrated livelihood systems in which productive assets, labor opportunities, mobility, markets, and risk management jointly shape household welfare.

7 Conclusion

This study examines whether livestock capital is sufficient to explain economic welfare among livestock-keeping households in Somalia. Using 2,502 livestock households from SIHBS 2022, the analysis finds

no strong national association between standardized livestock assets and real per-capita expenditure after household and geographic adjustment. Household access to recent paid work, however, is associated with higher expenditure and lower odds of poverty. The pooled national result also conceals important heterogeneity: livestock assets are positively associated with welfare among rural households but not among urban or nomadic households.

These findings do not diminish the economic importance of livestock. Instead, they show why herd size should not be treated as a sufficient welfare indicator or a uniform policy lever. Animals generate welfare through production systems, markets, mobility, labor allocation, risk-management institutions, and complementary cash-flow opportunities. The same stock of livestock can therefore support different levels of current consumption in different livelihood settings.

For Somalia and other dryland economies, the practical implication is a shift from isolated herd support toward differentiated livelihood portfolios. Rural livestock investment can be paired with productivity, veterinary, market, and crop-livestock measures; nomadic strategies must address mobility, drought risk, services, and market access alongside animals; and paid-work opportunities can complement livestock rather than substitute for it. These findings have broader relevance for dryland food systems in which livestock simultaneously functions as productive capital, a source of food and income, a store of wealth, and a buffer against shocks. Future research should use longitudinal data and richer measures of animal productivity, market conditions, job quality, and shock severity to identify causal pathways. The central message is simple but consequential: improving welfare in livestock-dependent economies requires looking beyond the herd to the economic system in which the herd is used.

Declarations

Data availability

The Somalia Integrated Household Budget Survey (SIHBS) 2022 public-use microdata analyzed in this study are available from the Somalia National Bureau of Statistics through the Somali National Data Archive (SoNADA), reference ID DDI-SOM-SNBS-SIHBS-2022-v02 (https://microdata.nbs.gov.so/index.php/catalog/59). The raw public-use microdata are not redistributed with this manuscript. Variable construction and sensitivity specifications are documented in ESM 1.

Ethics statement

This study is a secondary analysis of de-identified public-use data from the Somalia Integrated Household Budget Survey 2022. No new data were collected, no respondents were contacted for this study, and the author had no access to direct personal identifiers. The secondary analysis was conducted using the public-use files released by the Somalia National Bureau of Statistics and did not attempt to identify any respondent.

Consent to participate
Not applicable.

Consent to publish
Not applicable.

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Author contributions

Ahmed Hussein Ismail: Conceptualization; methodology; data curation; formal analysis; visualization; writing - original draft; writing - review and editing.

Competing interests

The author declares no competing interests.

AI declaration

During preparation of this manuscript, the author used ChatGPT (OpenAI) to support language editing, literature-search assistance, and code review. All statistical analyses were executed on the SIHBS microdata, and all numerical results, references, interpretations, and final text were reviewed and verified by the author, who retains full responsibility for the content of the article.

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Figures

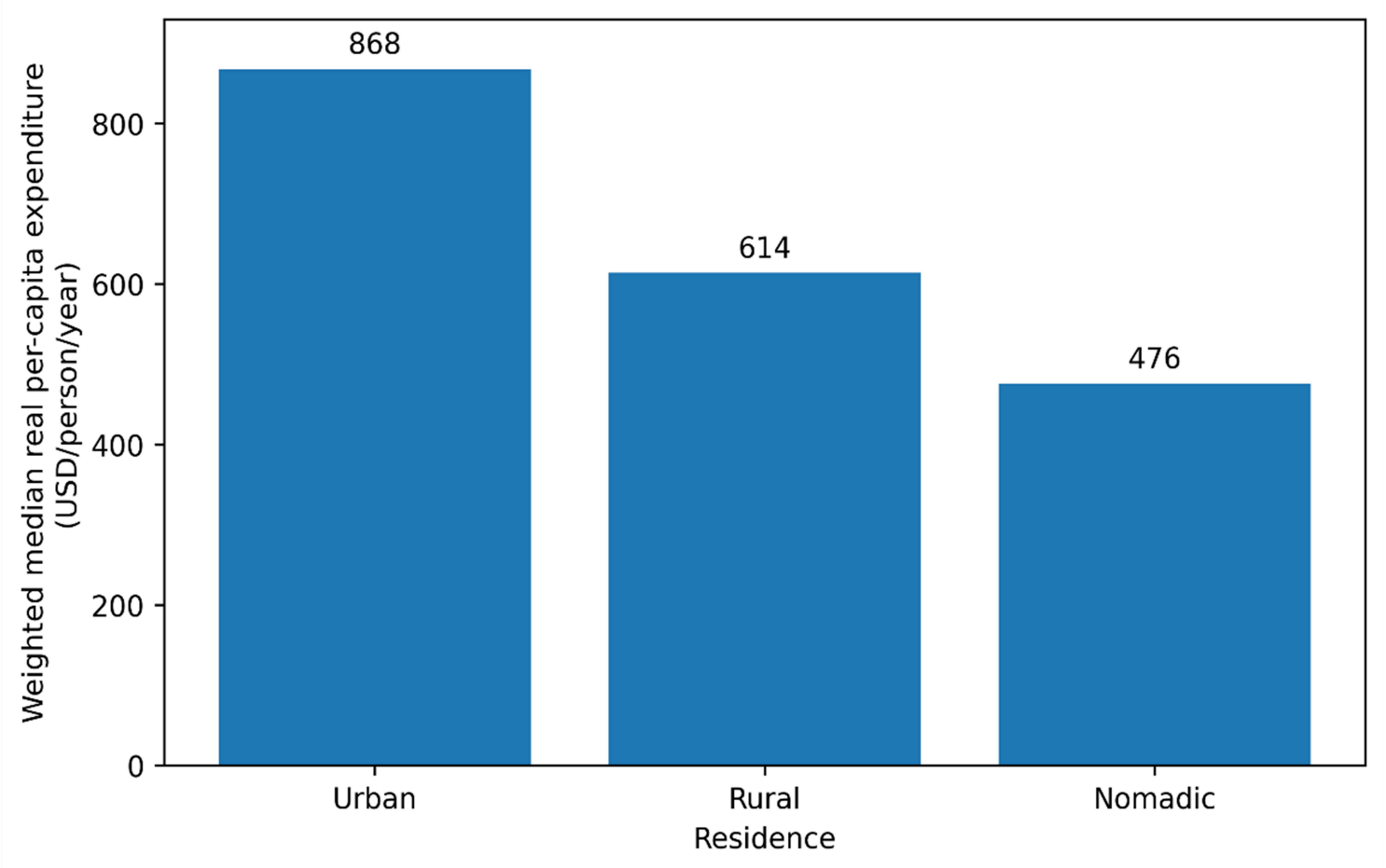


Figure 1

Weighted median real per-capita expenditure among livestock-keeping households by residence

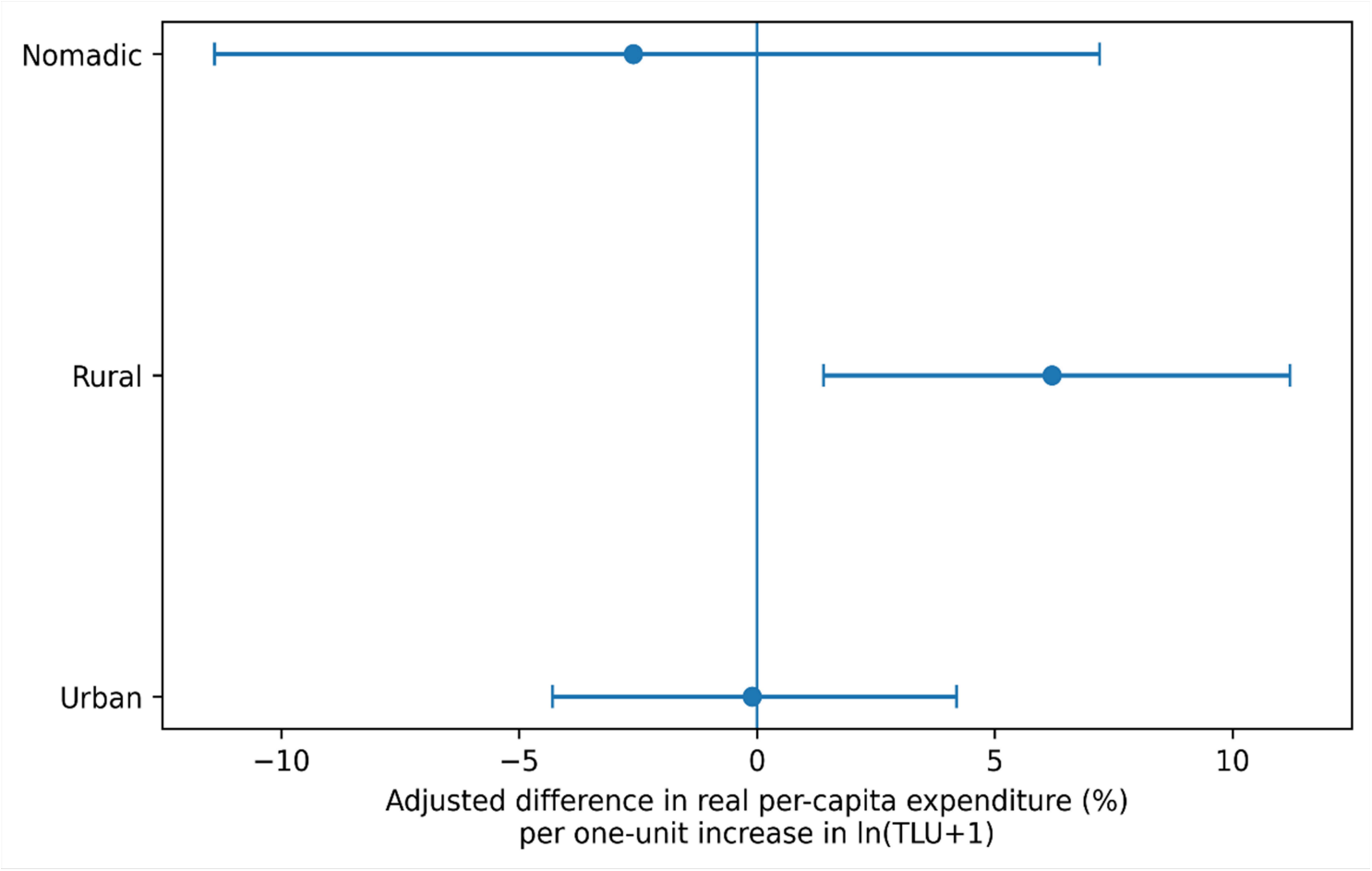


Figure 2

Residence-specific adjusted association between livestock assets and real per-capita household expenditure. Points show percentage differences associated with a one-unit increase in ln(TLU+1); bars show 95% confidence intervals

Supplementary Files

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- 02ESM1SupplementaryInformation.docx