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Livestock Supply and Price Formation across Market Conditions: Evidence from Quantile Regression

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Abstract

This study models livestock market attendance and price data in the commune of Sidéradougou, Burkina Faso, over the period June 2021 to April 2022. It analyzes the impact of livestock supply (cattle, sheep, goats) on prices, taking into account seasonal variations and security disruptions. The dataset comprises 35 monthly market-day observations per species, drawn from CESAO field records. Using quantile regression models, the study highlights the heterogeneous effects of supply on prices at different points in the conditional distribution. The results show that prices and supply are strongly influenced by three key periods: the lean season, holidays, and security events. During the lean season, prices are generally low while supply increases, reflecting households' economic difficulties. The periods leading up to holidays show high prices and reduced supply, due to herd retention in anticipation of celebrations. Security events disrupt trade flows and the mobility of herders, leading to significant fluctuations in prices and supply. Supply has a statistically significant negative effect on prices for sheep and goats across all quantiles, and for cattle specifically at the upper quantile (q0.75). These findings are consistent with a plausible demand-side interpretation, though the cross-sectional nature of the data precludes causal identification. These insights can guide the development of public policies aimed at stabilizing markets and strengthening the resilience of rural communities to economic and security crises.

Keywords

Livestock Markets, Lean Period, Quantile Regression, Security Events, Burkina Faso

1. Introduction

The world population has been growing steadily for centuries, with a particularly marked increase in sub-Saharan African countries, including Burkina Faso. This rapid population growth is accompanied by an increased need for food resources, jobs, and infrastructure to meet the demands of populations. However, multifaceted crises, whether security or economic, complicate the satisfaction of these needs, particularly in rural areas where agricultural and pastoral activities constitute the backbone of the local economy (FAO, 2008). In Burkina Faso, livestock farming occupies a central place in the livelihoods of rural populations, contributing significantly to food security and income generation (Alary et al., 2011). Livestock markets, as places of economic and social exchange, play a very important role in this dynamic. However, these markets are increasingly weakened by growing insecurity due to terrorist attacks, which disrupt economic activities and trade flows (Soumare et al., 2020). The commune of Sidéradougou, located in the Cascades region and Comoé province, perfectly illustrates this reality. This area, although rich in agricultural and pastoral potential, has been affected by security disruptions, leading to population displacements and disruption of local economic activities. In this context, modeling attendance data and prices of livestock markets in Sidéradougou over the period June 2021 to April 2022 is of paramount importance. It makes it possible to quantify animal flow patterns and to provide a solid basis for developing public policies to support affected herders and traders. This study contributes to filling a gap in specific data on livestock markets in areas affected by insecurity in Burkina Faso.

Livestock markets play a central role in the rural economy of Burkina Faso, particularly in areas where livestock is a major source of income and food security. However, these markets face increasing challenges related to insecurity, price fluctuations, and socio-economic and environmental changes. According to FEWS NET (2005), livestock market attendance declined significantly after the Tabaski period, reflecting volatility in livestock-related economic activities. Growing insecurity due to terrorist attacks and armed conflicts disrupts not only trade flows but also the mobility of livestock farmers and traders. Furthermore, fluctuations in livestock prices, accentuated by market volatility, affect the food security of rural populations.

The objective of this research is twofold: to analyze trends in attendance and prices of livestock markets in Sidéradougou during the period covered, and to model the impact of supply on livestock prices across different market conditions. Three contextual periods are distinguished: 1) a *holiday period*, defined as the weeks immediately preceding major religious festivals (Tabaski/Eid al-Adha and end-of-year celebrations); 2) a *lean season*, corresponding to the months of June through September when food stocks are limited and household economic pressure is highest; and 3) a *security-effect period*, referring to months during which documented security incidents-including terrorist attacks and movements of defense forces-occurred within or adjacent to the commune of Sidéradougou. In the

present dataset, security effects are captured by the months of March and April 2022, when field reports document a marked intensification of security incidents in the study area and a corresponding disruption of herder mobility and market access. Security disruptions in this zone predate the study window (with events recorded since 2018), but only the months within the June 2021-April 2022 observation period can be evaluated empirically with the available data. To do this, we use data collected by the West African Centre for Economic and Social Studies (CESAO) from local stakeholders. The results of this study can serve as a reference for targeted interventions aimed at strengthening the resilience of rural communities in the face of security and economic challenges.

2. Literature Review

The persistent insecurity in the Sahel has profoundly affected livestock markets in West Africa, particularly in Burkina Faso, Niger, and Mali. Restricted access to markets, coupled with massive population displacements and cattle theft, has altered the dynamics of trade for sheep, cattle, and goats (Wilkins, 2022). Quantitative studies, such as that by Timothy (2006), have applied a hedonic model to analyze the determinants of prices in this region's markets. Their findings indicate that factors such as geographical location, seasonality, and animal characteristics (sex, condition, weight) significantly explain price fluctuations. Furthermore, the sensitivity of markets to atypical events, such as security or climatic crises, highlights the impact of uncertainties on price stability. Additionally, recent work by Valerio et al. (2020) has explored market connectivity and the flow of live animals, showing that Burkinabe markets are often at the crossroads of international corridors. This research sheds light on the fragmentation of the trade network in high-risk areas, leading to increased transaction costs and greater disassortativity among peripheral markets. Other studies, such as those by Bozma et al. (2023), reveal that price volatility intensifies during times of crisis, as observed during the COVID-19 pandemic. Moreover, Ayantunde et al. (2023) highlight the sensitivity of livestock feed prices to season and market location. While previous research has examined market integration and the impact of the devaluation of the CFA franc on domestic trade (Araujo et al., 2005; Boyer et al., 2013), these analyses do not always account for the increasing impact of insecurity on market dynamics. Tamini et al. (2014) explored the value chains of small ruminants in Burkina Faso, providing data on zootechnical and economic parameters as well as the effects of contagious diseases on these markets.

3. Method and Material

3.1. Study Area

The commune of Sidéradougou, located in the Cascades region and Comoé province of Burkina Faso, was chosen as the study area. This region is representative of the challenges related to insecurity and volatility of livestock markets, while being an important center of pastoral and agricultural activities.

3.2. Data Source and Unit of Observation

The data come from the West African Centre for Economic and Social Studies (CESAO), which conducted systematic field surveys at the main livestock market of Sidéradougou between June 2021 and April 2022. The unit of observation is a single market day. In Sidéradougou, the livestock market meets on a fixed weekly schedule; CESAO enumerators recorded, for each market day, the number of animals offered for sale and the transaction prices (in FCFA) for cattle, sheep, and goats separately. Monthly averages were then computed from the individual market-day records.

The study covers nine months: June, July, August, September, and October 2021, and January, February, March, and April 2022. The months of November and December 2021 are absent from the dataset because CESAO field operations were suspended during that period due to security constraints, leaving a total of 35 market-day observations per species after aggregation. The observation count is identical across the three species because price and supply were recorded simultaneously on each market day.

3.3. Descriptive Analysis

A descriptive analysis was carried out, including the calculation of basic summary statistics (means, standard deviations, minima, maxima) to describe attendance and price trends across the nine months covered. Graphical visualizations are also produced to highlight patterns in price and supply evolution over time.

3.4. Quantile Regression Model

Ordinary least squares (OLS) regression describes only the conditional mean of prices and is sensitive to outliers. Livestock prices in informal markets are known to be heteroscedastic and to respond asymmetrically to supply shocks depending on prevailing price levels: sellers facing distress conditions at low-price periods behave differently from those operating in high-price festive periods. Quantile regression (Koenker & Bassett, 1978) addresses this by estimating the full conditional distribution of prices, allowing the effect of supply to differ at the 25th, 50th, and 75th percentiles. The 25th quantile captures low-price market conditions (typically the lean season), the median captures typical market conditions, and the 75th quantile captures high-price conditions (typically festive or post-lean periods). Standard errors are obtained by bootstrap with $B = 500$ replications, following the recommendation of Koenker (2005) for small samples.

The OLS benchmark solves:

$$\min_{\beta} \sum_{i=1}^{n} \left(y_i - x_i' \beta \right)^2 \tag{1}$$

where y_i is the price of species s at observation i, x_i is the vector of covariates, and β the coefficient vector.

Quantile regression for quantile $q \in (0,1)$ solves (Mbairadjim et al., 2017):

$$\min_{\beta_q} \sum_{i=1}^{n} \rho_q \left(y_i - x_i' \beta_q \right) \tag{2}$$

where $\rho_q(u) = u\left(q - \mathbf{1}_{u<0}\right)$ is the asymmetric absolute-loss function and β_q is the quantile-specific coefficient vector.

The three estimated models are:

$$\text{Cattle Price}_i = \alpha_0 + \alpha_1 \text{Cattle Offer}_i + \sum_{m=2}^{9} \alpha_m D_{m,i} + \varepsilon_i, \tag{3}$$

$$\text{Sheep Price}_i = \beta_0 + \beta_1 \text{Sheep Offer}_i + \sum_{m=2}^{9} \beta_m D_{m,i} + \varepsilon_i, \tag{4}$$

$$\text{Goat Price}_i = \gamma_0 + \gamma_1 \text{Goat Offer}_i + \sum_{m=2}^{9} \gamma_m D_{m,i} + \varepsilon_i, \tag{5}$$

where $D_{m,i}$ are month dummies ($m = 1, \cdots, 9$ corresponding to June 2021 as the baseline, July 2021, ..., April 2022). The month dummies absorb the three contextual periods defined in Section 1: months within the lean season (July-September 2021), the holiday period (October 2021, January 2022), and the security-effect period (March-April 2022). This dummy specification is the one actually estimated and reported in Tables 5-7; it is equivalent to the period-indicator specification described conceptually in the Introduction.

4. Results and Discussion

4.1. Results

Table 1 presents descriptive statistics of cattle prices and supply for the nine months covered. Average prices show moderate fluctuations across the study period. Prices are lowest in September 2021 (mean 141,912 FCFA), a month that falls within the lean season when household food stocks are limited and economic pressure is highest (The Food Security Cluster (FSC), 2024); the elevated supply in that month (mean 69 animals) is consistent with distress-selling behavior, though this interpretation cannot be confirmed from the price and supply data alone. In January and February 2022, mean prices are among the highest observed (155,833 and 156,750 FCFA respectively), coinciding with the post-lean recovery period. The increase in cattle supply in February and March 2022 (means of 68 and 65, respectively) is followed by a sharp decline in April 2022 (mean 37), a month that coincides with the documented intensification of security incidents in the commune. Whether this decline reflects sellers exiting the market due to insecurity or a post-peak seasonal correction cannot be determined with certainty from the available data.

The sheep data show notable fluctuations in prices and supply across the study period. The highest mean sheep price is observed in January 2022 (48,556 FCFA). A plausible explanation is the proximity to Eid al-Adha (Tabaski), which fell on July 9, 2022, but pre-festival demand typically builds several months in advance as buyers seek to secure animals early. This interpretation is consistent with the pattern, though it cannot be confirmed without buyer-level data. Separately, sup-

ply in September 2021 was relatively high (mean 73 animals) while prices were low (mean 37,169 FCFA), a pattern consistent with lean-season supply pressure. These dynamics illustrate how seasonal and cultural calendars may interact to shape market outcomes, though the descriptive data alone cannot establish direction of causation (Table 2).

Table 1. Descriptive statistics of cattle prices and supply (FCFA).

Period	Statistic	June	July	August	September	October
2021	Mean Price	143,750	151,563	145,000	141,912	154,625
	Min Price	132,500	143,750	137,500	136,250	148,000
	Price SD	9585	5807	5683	5126	9369
	Max Price	158,750	157,500	151,250	151,300	161,250
	Mean Offer	33	41	38	69	59
	Min Offer	18	28	27	40	37
	Offer SD	11	9	10	20	31
	Max Offer	46	46	51	91	81
Period	**Statistic**	**January**	**February**	**March**	**April**	
2022	Mean Price	155,833	156,750	150,000	145,000	
	Min Price	150,000	151,000	145,000	137,500	
	Price SD	5637	8132	7071	10,897	
	Max Price	161,250	162,500	155,000	157,500	
	Mean Offer	42	68	65	37	
	Min Offer	38	43	42	27	
	Offer SD	4	35	33	10	
	Max Offer	46	93	88	47	

Source: Authors, based on CESAO data.

Table 2. Descriptive statistics of sheep prices and supply (FCFA).

Period	Statistic	June	July	August	September	October
2021	Price Mean	37,333	41,208	43,167	37,169	38,167
	Price Min	35,000	36,333	34,333	30,000	33,000
	Price SD	2150	4077	7084	7749	7307
	Price Max	41,000	46,000	51,667	50,667	43,333
	Offer Mean	69	50	46	73	76
	Offer Min	52	46	40	35	62
	Offer SD	16	4	7	24	19
	Offer Max	92	55	55	96	89
Period	**Statistic**	**January**	**February**	**March**	**April**	

Continued

2022	Price Mean	48,556	41,000	36,833	41,611
	Price Min	46,667	40,000	32,000	37,500
	Price SD	3272	1414	6835	4656
	Price Max	52,333	42,000	41,667	46,667
	Offer Mean	51	78	75	53
	Offer Min	49	65	59	45
	Offer SD	3	18	22	10
	Offer Max	54	90	90	64

Source: Authors, based on CESAO data.

Goats show marked variations in prices and supply throughout the study period. Goat prices peak in January 2022 (mean 25,667 FCFA), which may reflect heightened festive demand, though the exact mechanism cannot be confirmed from market-level aggregates alone. Supply peaks in September-October 2021 and again in February-March 2022. The October 2021 supply peak (mean 101 animals) may reflect the end of the rainy season, which makes animal management more difficult and could induce early sales, though this remains a plausible conjecture. February and March 2022 supply peaks coincide with the onset of security-affected months in the study area (Table 3).

Table 3. Descriptive statistics of goat prices and supply (FCFA).

Period	Statistic	June	July	August	September	October
2021	Price Mean	19,639	20,417	24,333	21,366	23,550
	Price Min	19,000	18,333	20,833	18,000	19,600
	Price SD	662	1932	3076	3580	5586
	Price Max	20,833	23,000	28,333	27,000	27,500
	Offer Mean	69	57	54	96	101
	Offer Min	54	49	50	47	85
	Offer SD	9	8	4	32	23
	Offer Max	81	68	58	132	117
Period	**Statistic**	**January**	**February**	**March**	**April**	
2022	Price Mean	25,667	23,667	24,083	23,167	
	Price Min	25,000	20,000	19,500	20,167	
	Price SD	667	5185	6482	2682	
	Price Max	26,333	27,333	28,667	25,333	
	Offer Mean	54	92	95	60	
	Offer Min	43	72	82	55	
	Offer SD	10	28	18	5	
	Offer Max	60	112	107	64	

Source: Authors, based on CESAO data.

Figure 1 and Figure 2 illustrate the joint evolution of prices and supply over the nine months covered. Three broad patterns emerge. First, in the lean-season months (July-September 2021), supply is relatively high and prices are moderate to low, a pattern consistent with economic pressure on herding households. Second, in October 2021 and January 2022, prices rise while supply contracts, consistent with pre-festive herd retention. Third, from March to April 2022, supply contracts sharply and prices decline, a combination that may reflect security-induced withdrawal from the market rather than a demand-side price drop. These patterns are descriptive; the regression analysis below allows a more systematic assessment of the supply-price relationship controlling for month-specific conditions (Table 4).

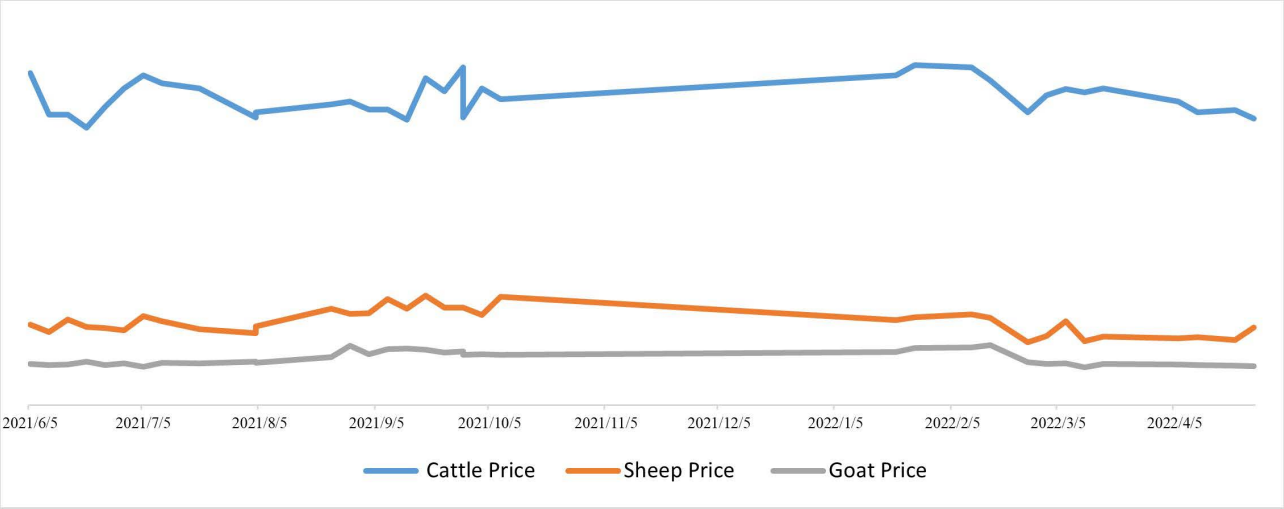

Figure 1. Evolution of livestock prices (June 2021-April 2022). Source: Authors, based on CESAO data.

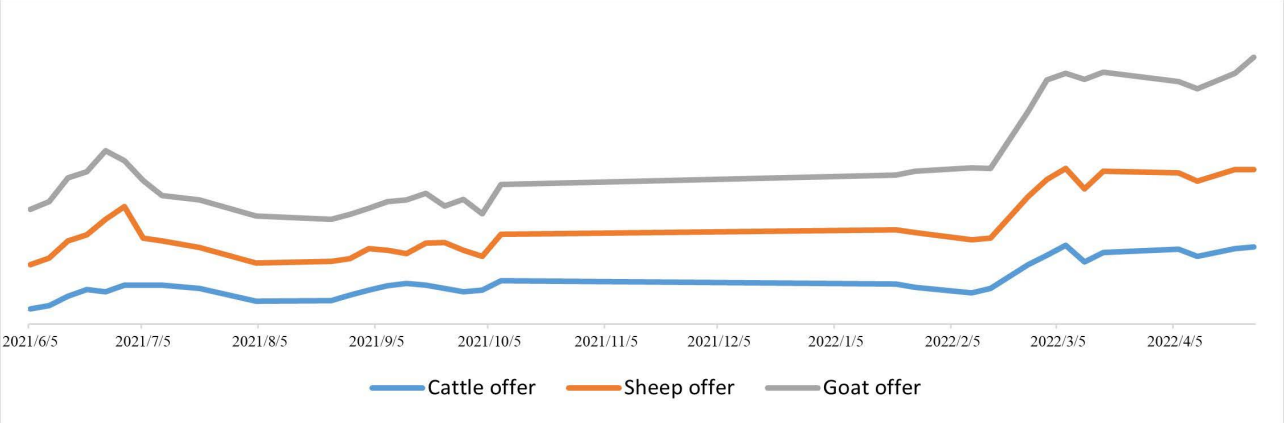

Figure 2. Evolution of livestock supply (June 2021-April 2022). Source: Authors, based on CESAO data.

Table 5 presents the quantile regression results for cattle prices. The supply coefficient is negative across all specifications but reaches statistical significance only at q0.75 (−217.391, $p < 0.05$). It is not significant in OLS, q0.25, or q0.50. This

means that evidence for a supply-price relationship in cattle is confined to the upper end of the price distribution, corresponding to high-price market conditions. One plausible interpretation is that buyers in high-price periods are more sensitive to the volume of animals available, but this remains a conjecture.

Table 4. Summary statistics of livestock prices and supply.

Statistic	Cattle	Sheep	Goat
Price (FCFA)			
Min	132,500	30,000	18,000
Max	162,500	52,333	28,667
SD	8292	6154	3387
Mean	147,177	39,958	22,235
Supply (number of animals)			
Min	18	35	43
Max	93	96	132
SD	21	19	26
Mean	50	64	75

Source: Authors, based on CESAO data.

Table 5. Regression results for cattle price determinants.

Variable	OLS	q0.25	q0.50	q0.75
Cattle Supply	−52.291	−85.294	−38.571	−217.391**
Month dummies baseline: June 2021				
July 2021	8204.68*	14205.882***	8904.286	2500
August 2021	1511.453	7273.529**	2345.714	−3913.043
September 2021	38,877	4035.294	−980	−902.174
October 2021	12234.558*	14282.353***	18711.429*	8043.478
January 2022	12553.95**	12955.882***	14058.571*	8260.87
February 2022	14830.174**	18305.882***	20192.857*	10597.826
March 2022	7923.302	11879.412**	12654.286	2880.435
April 2022	1476.593	114,706	−2924.286	6467.391
Constant	145475.59	140626.47***	143965.71***	161,250***
Pseudo R^2	0.4219	0.3172	0.3306	0.3022
Observations	35	35	35	35

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. Standard errors by bootstrap ($B = 500$). Source: Authors, based on CESAO data.

The month dummies reveal significant differences relative to the June 2021 baseline. Positive and significant coefficients for October 2021, January, and Feb-

ruary 2022 across multiple quantiles indicate that prices in these months were substantially higher, consistent with the pre-festive and post-lean periods defined earlier. Prices in March and April 2022 are not significantly different from the baseline at any quantile, suggesting that the security-affected months did not produce a statistically distinguishable price effect in cattle, possibly because reduced supply and reduced demand cancel each other out. The pseudo R^2 values range from 0.30 to 0.42, indicating that month effects and supply together explain a meaningful but partial share of price variation.

Table 6 presents the quantile regression results for sheep prices. Unlike cattle, the supply coefficient is negative and statistically significant across all quantiles and in OLS, indicating a robust supply-price relationship for sheep throughout the conditional price distribution. January 2022 stands out with a positive and significant coefficient at q0.25 and q0.75, indicating that sheep prices in that month were markedly higher than in the June 2021 baseline, net of supply effects. January 2022 falls approximately six months before Eid al-Adha (July 9, 2022); while this timing is somewhat early for a direct festival effect, it may reflect early procurement behavior by buyers or general seasonal demand for small ruminants at the start of the year. This interpretation is speculative and would require transaction-level data to confirm. The pseudo R^2 values range from 0.41 to 0.60.

Table 6. Regression results for sheep price determinants.

Variable	OLS	q0.25	q0.50	q0.75
Sheep Supply	−218.865***	−258.621***	−254.717***	−216.667***
Month dummies baseline: June 2021				
July 2021	−228.714	1666.667	−389.937	−666.667
August 2021	744.728	1563.218	984.277	−2100
September 2021	783.599	3270.115	1279.874	−466.667
October 2021	2255.954	4235.632	5490.566	1683.333
January 2022	7209.702**	7557.471**	6786.164	7866.667***
February 2022	5527.017	7028.736*	9289.308	4416.667
March 2022	703.756	3494.253	3059.748	−633.333
April 2022	702.987	−2643.678	3333.333	2200
Constant	52435.001	51781.609	53635.22***	55083.333
Pseudo R^2	0.6031	0.4108	0.4262	0.4536
Observations	35	35	35	35

***$p < 0.01$, *$p < 0.05$, *$p < 0.10$. Standard errors by bootstrap ($B = 500$). Source: Authors, based on CESAO data.

Table 7 presents the quantile regression results for goat prices. As with sheep, goat supply has a negative and statistically significant coefficient across all quantiles and in OLS, confirming a robust negative supply-price relationship for this

species. The month coefficients are positive and significant across nearly all periods relative to the June 2021 baseline, indicating sustained higher prices throughout the study window net of supply. The March 2022 coefficient is among the largest (OLS: 7,428 FCFA; q0.75: 9,636 FCFA), which is consistent with the security-affected period reducing effective supply while residual demand sustained prices. However, this explanation is speculative given that March 2022 dummies capture all time-varying factors in that month, not security effects in isolation. Pseudo R^2 values range from 0.44 to 0.71, the highest of the three species models.

Table 7. Regression results for goat price determinants.

Variable	OLS	q0.25	q0.50	q0.75
Goat Supply	−117.017***	−81.313***	−120.370***	−136.364***
Month dummies baseline: June 2021				
July 2021	−684.939	186.869***	−1500	−2575.758**
August 2021	2909.930**	3865.657***	2740.741	1696.970*
September 2021	4912.509***	3621.717***	5287.037***	5378.788***
October 2021	7655.666***	4746.970***	9490.741***	8878.788***
January 2022	4272.518***	4129.798***	4648.148**	4166.667***
February 2022	6719.177***	4740.404***	7759.259***	6939.394***
March 2022	7428.387***	3833.838***	10296.296***	9636.364***
April 2022	2435.616***	272.222**	2981.481***	3848.485***
Constant	27713.085***	24366.667***	28240.741***	30212.121***
Pseudo R^2	0.7134	0.4400	0.5188	0.5912
Observations	35	35	35	35

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. Standard errors by bootstrap ($B = 500$). Source: Authors, based on CESAO data.

4.2. Discussion

The results of this study confirm that livestock markets in the municipality of Sidéradougou exhibit strong seasonal and contextual variation across the June 2021-April 2022 window. The findings should be interpreted as associations rather than causal effects, given that the month-dummy specification controls for average differences across periods but cannot isolate the specific mechanisms driving price changes.

The lean season (July-September 2021) is associated with elevated supply relative to June 2021, while prices remain moderate or low. This pattern is consistent with the economic-pressure hypothesis documented by The Food Security Cluster (FSC) (2024), whereby households sell animals to meet immediate cash needs during food-scarce months. The pre-festive and post-lean months (October 2021, January-February 2022) show higher prices net of supply effects, which may re-

flect demand increases or supply retention by sellers anticipating better prices, though neither mechanism can be confirmed from aggregate market data alone.

The supply-price relationship differs importantly across species. For sheep and goats, supply has a negative and statistically significant effect on prices at all quantiles, indicating a robust negative relationship across the full conditional distribution. For cattle, the supply effect is significant only at q0.75, meaning the evidence is confined to high-price conditions. This heterogeneity justifies the quantile regression approach: OLS estimates of the cattle supply effect, for example, are negative but not significant, and would have led to an erroneous conclusion of no relationship at higher price levels where the effect is actually substantial.

Security events in March-April 2022 coincide with a decline in supply and mixed price signals. The inability to separately identify a "security effect" from general month variation is a recognized limitation of the current design. Future work incorporating event-level security data alongside market records would permit a more rigorous assessment. These observations are consistent with the documented disruption of herder mobility and market access described in FEWS NET (2005) and Wilkins (2022), but they remain descriptively consistent rather than causally established.

5. Conclusion

This study documented the co-movement of livestock supply and prices in the commune of Sidéradougou over nine months from June 2021 to April 2022, using descriptive statistics and quantile regression estimated on 35 market-day observations per species.

Supply has a statistically significant negative effect on prices for sheep and goats across all quantiles estimated (q0.25, q0.50, q0.75), and for cattle specifically at q0.75. The conclusion that supplies reduce prices uniformly across all species and all quantiles is therefore not supported: for cattle, the effect is statistically distinguishable only at the upper end of the price distribution. These species-specific and quantile-specific patterns illustrate the added value of distributional methods relative to mean regression in heterogeneous informal markets.

Three contextual periods shape the data patterns: lean-season months exhibit higher supply and lower prices; pre-festive months exhibit higher prices net of supply; and security-affected months in March-April 2022 exhibit lower supply with ambiguous price effects. These patterns are consistent with known mechanisms, but the cross-sectional and aggregate nature of the dataset precludes causal attribution.

The findings provide an empirical baseline for targeted policy interventions. Supply regulation mechanisms during the lean season, improved market information systems, and security measures along trade routes could help stabilize prices and protect herder livelihoods. Extension of the time series and collection of buyer-level transaction data would permit more definitive inference in future work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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