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Examining the Impact of Enhanced Trader Competition on Small Herders: Empirical Findings From China's Pastoral Region

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ABSTRACT

This study empirically examines the impact of increased competition among commute traders on the performance of herders in a less competitive livestock market. To achieve this, we conducted a field survey and collected data on 669 households from 104 villages in the pastoral area of China. An instrument variable approach was employed to mitigate potential endogeneity concerns associated with trader competition. The results indicate an inverted U-shaped relationship between farm-gate prices received by herders and the intensity of trader competition. These positive effects can be attributed to the increased information that herders acquire regarding their livestock's quantity and quality due to more frequent interactions with traders. However, the abundance of information may lead to excessive patience among herders, driving them to seek higher prices and potentially causing them to miss out on optimal offers. The results suggest an essential role of increased competition from traders in improving the market gain of small farmers in developing regions.

JEL Classification: D02, D83, Q02, Q12, Q13

1 | Introduction

Local agricultural markets in developing regions are often incomplete due to information asymmetry (Macchiavello and Morjaria 2020). Most small farmers, as the suppliers in second-best markets, mainly sell their agricultural products through commute traders, also referred to as middlemen or intermediaries. Traders frequently possess superior information and market influence compared to small-scale suppliers (Nelson 2018; Sexton 2013). Consequently, small farmers may encounter a decline in their welfare when engaging with traders (Force 2016; Kaboski et al. 2022; Vavra 2009). Enhancing the market performance of small farmers is a well-explored topic. Numerous studies suggest that enhancing the information supply at the farmers' end can boost market performance (Belay and Ayalew 2020). Nonetheless, practical constraints persist, with one critical factor being the limited competition among intermediaries. This underscores the crucial role of enhancing competition in countering intermediary traders' monopoly or oligopsony power (Bloom et al. 2015; Chatterjee 2023; Chen and Lent 1992; Krishna and Sheveleva 2017). Nevertheless, a recent study demonstrates that farmers might incur welfare losses in a weakly institutionalized environment due to increased competition among traders (Macchiavello and Morjaria 2020). Due to the uncertain effects of trader competition, further empirical research is warranted.

This study examines the impact of increasing competition among commute traders in the market outcomes of small farmers in a developing pastoral region where livestock constitutes the primary transactional commodity. The commute traders, acting as intermediaries connecting small herders with larger livestock markets, also profit from the price difference between individual herders and the standardized market price. Competition among traders encompasses various dimensions, including competition in acquisition prices, acquisition services, and market share (Allain et al. 2017; Ma et al. 2019), rendering precise measurement challenging (Casaburi and Reed 2017). Drawing on the theoretical framework proposed by Krishna and Sheveleva (2017) and the empirical analysis conducted by Macchiavello and Morjaria (2020), we quantify the degree of traders' competition by calculating the ratio of commute traders to the total number of households in a village. Herders' market performance was assessed using livestock farm-gate prices per sheep unit and per kilogram of livestock. Traders' competition is frequently endogenous to the market activities of small farmers due to unobserved factors that impact both, such as market structure. To determine the causal impact of traders' competition, we used an instrumental variable (IV) approach, besides controlling for various household and village characteristics.

The primary findings reveal an inverse U-shaped relationship between herders' market performance and the degree of competition from traders. The positive effects observed in the ascending section of the U-shaped curve can be attributed to the enhancement of herders' knowledge regarding their livestock's weight and quality, resulting from increased interactions with traders during negotiations. However, the surplus of information might induce patient herders to seek higher prices from the next trader, potentially causing them to overlook the optimal price, leading to a decline in herders' market outcomes in the descending section of the U-shaped curve. The results imply a crucial role for competition among agricultural product traders in enhancing the market performance of small farmers, which can be fostered through well-designed policy incentives.

This study contributes to the literature from several fronts. First, this illustrates how farm-gate competition influences livestock sales in the pastoral region. Grassland farming is one of the most sustainable food systems globally (McGahey et al. 2014). It is also the primary type of land utilization in arid and semi-arid areas and an important source of income for herders (Li et al. 2023; Undargaa and McCarthy 2016). Consequently, the stability and competitiveness of the livestock market are of utmost importance to the rural economy and the livelihoods of countless smallholder herders. Existing studies have predominantly concentrated on analyzing market power among farmers in the agricultural planting sector (Belay and Ayalew 2020; Chatterjee 2023; Geng 2024; Seifert et al. 2021). However, unlike commodities in the planting sector that often exhibit high homogeneity, selling cattle or sheep in pastoral regions involves greater heterogeneity in livestock characteristics. This study serves as a complementary endeavor to investigate the market power of herders, with a specific focus on pastoral regions.

Second, this study furnishes additional evidence regarding the effects of competition from intermediary traders in agricultural sectors within developing regions. Previous studies concur that competition is vital in enhancing management practices for underperforming firms or less efficient markets (Bloom et al. 2015). Chatterjee (2023) also discovered that augmenting spatial competition among intermediaries leads to higher prices farmers receive. Conversely, Macchiavello and Morjaria (2020) observed that the presence of additional competing mills reduces the overall quantity of coffee supplied to mills by farmers and leaves farmers worse off. The less-than-optimal outcome can be attributed to competition hindering relational contracts, as farmers fail to adhere to these contracts when confronted with increased competition among traders. Therefore, the impact of competition is context-based and needs more evidence.

Third, we contribute further evidence concerning mitigating information asymmetry between traders and farmers in the context of quality identification. This helps elucidate how increased competition among traders enhances farmers' market performance. Existing literature reveals that small farmers often fall prey to the market power wielded by traders, and enhancing farmers' information-gathering skills can enhance their market performance (Seifert et al. 2021; Sharma et al. 2024). Prior research has consistently documented the beneficial impact of accessing price information on farmers' market outcomes (Aker 2010; Belay and Ayalew 2020; Courtois and Subervie 2015; Didero et al. 2021; Goyal 2010; Mitra et al. 2018). This study proposes that increased competition among traders can enhance farmers' market outcomes by promoting greater symmetry in information regarding the weight and quality of livestock. Specifically, with the proliferation of itinerant traders, herders have increased opportunities to negotiate with a larger number of traders and update their information regarding the weight and quality of their livestock. The alignment of livestock attribute information between herders and traders has the potential to mitigate herders' disadvantages and enhance their market power.

The findings of this study provide valuable policy insights for promoting the engagement of small farmers in markets and enhancing their performance through increased competition. The Chinese government has been proactive in policies to enhance the supply of cattle and sheep in the pastoral region, primarily through input subsidies for herders. However, there have been limited policy instruments that specifically target the market to incentivize small herders. Encouraging competitive and diverse purchasing businesses can not only help to reveal the true value of livestock, but also promote herders to be active and influential in the livestock market. These market-oriented insights aimed at enhancing the market power of small farmers may also hold relevance for other countries facing similar circumstances.

The remainder of the article is organized as follows. Section 2 introduces a brief theoretical framework. Section 3 presents the data collection design and describes the main variables. Section 4 presents the primary empirical results of traders' competition on herders' market outcomes. Section 5 explores the explanation from asymmetric information. Lastly, Section 6 concludes the paper.

2 | Theoretical Framework

In this section, we build on the theoretical framework developed by Krishna and Sheveleva (2017) to explore the potential impacts of increased competition among commute traders in the livestock market in the pastoral region of China. Livestock markets in these regions are primarily organized through local fairs or bazaars, which are sparsely distributed and serve multiple villages within their vicinity. These fairs play a crucial role in sustaining local livestock markets. However, the pastoral region is characterized by low population density and vast geographical expanses. Our field survey reveals that the average village covers nearly 35,000 hectares, with an average distance of 20 km between neighboring villages. This sparse distribution makes it prohibitively costly for most herders to directly access livestock fairs or bazaars to sell their livestock. In this context, professional commute traders serve as critical intermediaries, bridging the gap between small-scale herders and livestock markets. Importantly, our field survey indicates that nearly 50% of these traders are outsiders who lack familiarity with local herders. As a result, they are less likely to engage in repeated or preferential interactions with herders, which justifies the assumption of random interactions between traders and sellers. Given these market characteristics, the assumption of random interactions in the basic model developed by Krishna and Sheveleva (2017) remains applicable to the livestock market in China's pastoral regions.

We assume the number of commute traders is N_T, and the number of herders is N_H in a village, in most case, $N_H > N_T$. A given trader competes with other traders to search for rent from the gap between herders' farm-gate price (p) and market price (P). Given herders' reservation price R ($R < P$), the trader decides what price to offer to the herders he meets and maximizes his expected profit π_T. The trader faces competition from others and let $\Pr_1$ be the probability that he meets another competitor at the farm gate. We assume that the encounters between traders and herders are independent. The probability that a given trader meets a herder is $1/N_H$. The probability that at least one of the remaining $N_T - 1$ traders also meet the same herder is $\Pr_1 = 1 - (1 - 1/N_H)^{N_T - 1}$. For large N_H and N_T, we can approximate $\Pr_1$ as:

$$\Pr_1 = 1 - \left(1 - \frac{1}{N_H}\right)^{N_T - 1} \approx 1 - e^{-\frac{N_T - 1}{N_H}} \approx \theta e^{-\theta}, \qquad (1)$$

where $\theta = \frac{N_T}{N_H}$, $\Pr_1$ increases with θ. We can use θ to measure the degree of competition among traders. A larger θ indicates a higher probability for a herder to meet with competing traders.

For an arbitrary farm-gate price p, we assume traders have the same probability of winning the bid when they meet another rival. If the trader wins, he will receive a profit of $(P^* - p)$, where P^* is market equilibrium price. The trader's expected profit can then be expressed as:

$$\begin{aligned} \pi_T &= \frac{1}{2}\Pr_1(P^* - p) + (1 - \Pr_1)(P^* - p) \\ &= (P^* - p)\left(1 - \frac{\theta e^{-\theta}}{2}\right). \end{aligned} \qquad (2)$$

The first derivative of π_T with respect to θ is $\partial\pi_T/\partial\theta = (P^* - p)\frac{e^{-\theta}(\theta - 1)}{2}$. If $P^* - p > 0$ and $\theta < 1$, then $\partial\pi_T/\partial\theta < 0$. This implies that the expected profit of traders decreases as competition. A moderate increase in competition among traders can, therefore, benefit herders by increasing their farm-gate price. Livestock is a crucial source of income. They can sell their livestock to commute traders when $p \geq R$, or retain their livestock for other purposes when $p < R$. We assume herders interact with various traders at their farm gate throughout the year. As herders negotiate with traders, they gather new information, which allows them to enhance their market power (Belay and Ayalew 2020; Courtois and Subervie 2015). The more negotiations they engage in, the more information they acquire. These may be the reason why herders benefit from increased competition among traders.

The second derivative of π_T with respect to θ is $\partial^2\pi_T/\partial\theta^2 = (P^* - p)\frac{e^{-\theta}(1 - \theta)}{2}$. If $\theta > 1$; or if traders offer farm-gate price $p > P^*$, then $\partial^2\pi_T/\partial\theta^2 < 0$. The negative second derivative suggests that as the competition intensifies, the decline in trader profits slow down. When competition becomes overly intense, traders' profit margins diminish, which strengthens herders' market power. To sustain profitability under such conditions, traders might turn to collusion. These results suggest the possibility of an inverse U-shaped relationship between competition and farm-gate prices. Moderate competition can enhance herders' gains, but excessive competition may erode these benefits, aligning with empirical observations.

3 | Data and Description

Our data set was collected from a field survey in the pastoral area of Inner Mongolia, Xinjiang, and Tibet provinces in China in 2018. Inner Mongolia, Xinjiang, and Tibet are the three major pastoral provinces, which cover approximately 55% of the grassland area in China (NBS, N. B. o. S. o. C. 2020). They are home to about 5 million herders whose primary economic activity is grassland grazing. Government statistics show that 55% of herder income comes from animal husbandry in these regions. Besides, 41% of cattle and 61% of sheep in pastoral areas in China are bred in the three provinces (CAHY 2020).

A stratified sampling strategy is used to select households for a field survey. Five counties in Inner Mongolia and six counties in Xinjiang and Tibet, are selected according to annual income per capita and grassland type. We then select three to four townships from each county according to per capital grassland area. Similarly, two to three villages are sampled from one township. In each village, we randomly select six to nine households. Finally, we surveyed 669 households in 104 villages, 51 townships, and 17 counties. Table A1 presents the detailed sample size.

To acquire information on traders' competition in a village-level livestock market, we asked village leaders whether commute traders existed in their villages in 2018. To clarify village leaders' understanding, we define commute traders as those who purchase livestock from herders and sell it to big

livestock fairs or bazaars. If the answer was yes, we further asked the number of commute traders who usually visited their village. The village leader may not know enough about all traders, so we asked the herders the same question to confirm this number. Figure 1 shows that nearly 75% of the villages had more than one trader in 2018. However, the intensity of traders' competition varies among villages. Half of the villages with two to four traders may compete less in the intravillage livestock market than those (approximately 35% of all villages) with more than four traders. We further calculated a "standardized trader number" variable, the number of commute traders divided by the number of households in a village, defined as traders' competition level.

We conducted face-to-face interviews with household heads to acquire information on herders' market performance. We first asked household heads whether they had sold livestock in 2018. If yes, we recorded the revenue, number, time, average weight, and the average age of livestock sold for each livestock type (cattle, sheep, or others). Furthermore, we asked the transaction information about livestock selling, such as the channels, location, contract types, whether they bargain with buyers in the transaction, and any percent price increase after bargaining. Based on this raw data, we used farm-gate price per sheep unit and farm-gate price per kilogram as indicators for herders' market performance. We calculate both the farm-gate price per sheep unit and the farm-gate price per kilogram for each household by dividing the sales revenue by livestock in sheep equivalent units and livestock weight[1], respectively.

From our survey data, 83% of households (552 out of 669 households) had participated in the livestock market, and the remaining 17% of households only raised a few livestock for self-consumption rather than selling in the market this year. The livestock selling modes, such as selling channels and contracts, vary among households (Table 1). There are three main selling channels, including selling to commute traders, selling to other herders, and selling to cooperatives or enterprises. The most important selling channel is selling to commute traders, which is used by 81% of households in 2018. Eighty percent of households used door-to-door acquisition service from buyers, meaning most of the transactions are farm-gate. However, long-term supply agreements between households and buyers are rare (only 7.8%), with most transactions being one-off sales. At last, 85% of households bargained with buyers in transactions, and they reported an average gain of 15.5% price increase after bargaining.

Finally, a range of characteristics related to the livestock market at the household-, village-, and town-level socioeconomic variables were also collected. The household-level variables include household size—the number of people, the proportion of pastoral (or off-pastoral) labor—the percent of people engaged in grazing (or nonpastoral job market) in a household, mean education level of labor, contracted grassland size per capita and whether the household is a member of cooperatives that target livestock production chain. The village-level variables include grassland endowment per capita—total grassland area divided by the number of people. The distance to the nearest

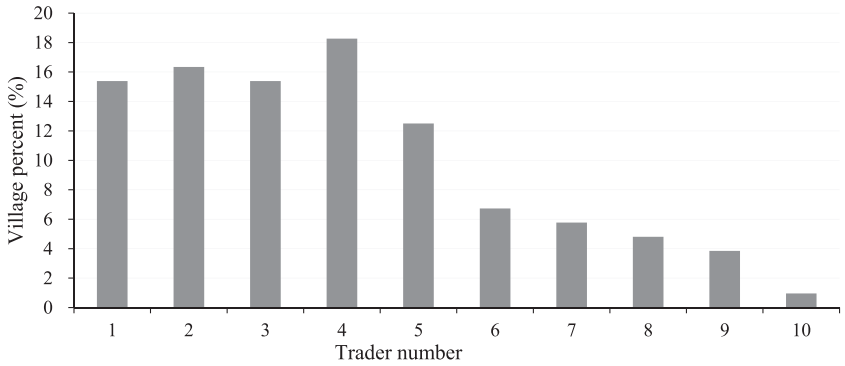

FIGURE 1 | Percentage of villages with different trader number.

TABLE 1 | Livestock selling channel and other information.

Variable	Households number	% of households that sell livestock ($n = 552$)
Livestock selling channel		
Commute traders	448	81.16
Other herders in the village	59	10.69
Cooperatives or enterprises	44	7.97
Buyer door-to-door acquisition	443	80.25
Having long-term written sale contract	43	7.79
Whether bargaining with buyers in the transaction	470	85.14

Note: The number of households with livestock sale in 2018 is 552.

local livestock market and paved road in a village is used to indicate market access. Whether the village has 4G telecommunication infrastructure is used to indicate market information accessibly, whether the village committee intervenes in selling is used to indicate market freedom, and whether the village invests in artificial grassland indicates public investment in grassland production. In addition, the grass price and livestock market price are town-level price, averaged from the village price that is answered by the village leader. For further mechanism analysis, we asked herders whether they have enough patience to sacrifice the present to achieve future goals, five levels are available to choose from, including 1 = very impatient, 2 = impatient, 3 = neither patient nor impatient, 4 = patient, 5 = very patient. We also ask village herders about the main measurement for herders when selling livestock, including weighted by a scale, counting by number, or both. The descriptive statistics of the above variables are shown in Table A2.

4 | Empirical Models

To identify the effects of trader competition on livestock market performance, we specify an empirical model as follows:

$$Y_{ij} = \alpha_0 + \alpha_1 C_j + \gamma H_{ij} + \varphi V_j + u_p + \varepsilon_{ij}, \quad (3)$$

where Y_{ij} represents herders' market performance variables for household i in village j, which are measured by farm-gate price per sheep unit and farm-gate price per kilogram. As the farm-gate price is only observed when a household sells livestock, we use a Heckman selection model to account for potential selection bias (Certo et al. 2016; Heckman 1976). C_j is the standardized trader number in village j, indicating traders' competition. H_{ij} is a vector of household-level control variables, including household size, the proportion of pastoral labor, the proportion of off-pastoral labor, mean education level of labor, contracted grassland size per capita in log form, total livestock number in log form, the proportion of cattle in the sale, the proportion of sheep in the sale, the month of centralized sale, livestock average weight and average age, dummy of whether household having an improved livestock breed, whether household getting livestock price information before selling and whether the household is a member of cooperatives. V_j is a vector of village-level control variables, including grassland endowment per capita in log form, distance to the nearest paved road, distance to the nearest local livestock market, whether the village has a 4G signal, whether the village committee intervenes selling and whether the village has artificial grassland. Town-level grass price, a major cost factor for herders, and town-level livestock market price, which serve as a proxy for the output price traders receive at local fairs or bazaars, are also included. u_p captures province-fixed effects, as we assume the provincial livestock market is stable. ε_{ij} represents the random error term. The coefficient α_1 is of primary interest. Robust standard errors clustered at the village level are used for statistical inference.

We controlled for as many related variables as possible in Equation 3 to separate the competition effects from other confounding factors. However, there are still some omitted variables that simultaneously affect traders' competition and herders' market outcomes, bringing about the endogeneity problem. Therefore, an instrument variable (IV) estimation approach is employed to test whether traders' competition is endogenous. The ideal IV is the mean of sunk entry cost of commute traders in the targeted village, which correlates with traders' competition and only impacts herders' market outcomes through competition. However, we lack direct information on the sunk entry cost of traders. Similar with a control function approach for handling endogeneity in choice models (Petrin and Train 2010), we infer the sunk entry cost from the existing competition level and use the residue of the following model to measure it:

$$C_j = \varphi V_j + u_p + \epsilon_j, \quad (4)$$

Where the definition of variables in Equation 4 is the same as Equation 3, except ϵ_j represents a random error term at the village level. $\hat{C}_j$ is used to indicate the predicted value of C_j. Then, $IV = C_j - \hat{C}_j$ may reflect the effects of the sunk entry cost on traders' competition.

For the livestock market in the pastoral area, as discussed in the data section, many herders had sold their livestock to commute traders, and bargaining was common. Bargaining with more traders may help herders improve their information about livestock characteristics. Existing studies have shown that improved access to market information positively impacts farmers' market power (Courtois and Subervie 2015; Mitchell 2017).

To test whether the dissipation of asymmetric information can help to explain the effect of traders' competition, we first use Equation 3 to identify the impact of traders' competition on herders' bargaining behavior. In this context, the dependent variables are a dummy for bargaining with traders or not in the transactions and the percentage gain in price after bargaining, respectively. Other settings are the same as in Equation 3.

Second, we analyze the heterogeneity of competition effects under different degrees of information asymmetries between traders and herders. An interaction term of standardized trader number and other explanatory variables measuring asymmetric information of livestock weight and quality are added in Equation 3.

$$Y_{ij} = \alpha_0 + \alpha_1 C_j + \alpha_2 C_j \bullet X_{ij} + \gamma H_{ij} + \varphi V_j + u_p + \varepsilon_{ij}, \quad (5)$$

where Y_{ij} is market performance measured by farm-gate price per sheep unit, X_{ij} are variables measuring the degree of asymmetric information on livestock weight and quality between herders and traders. The detailed sets of X_{ij} are displayed bellow.

Quantifying the extent of weight-based asymmetric information directly poses inherent challenges. Therefore, an alternative approach involves the utilization of an indirect indicator in the form of a categorical variable. In the context of

weight-based asymmetric information, X_{ij} represents the variable categorizes the methods employed for weight assessment during livestock transactions, encompassing the use of scales, livestock number counting, or a combination of both techniques. For herders, if a scale is used, there will be less or no weight information friction between them and traders. If counting by number is used, even if the herders have some experience in livestock weight estimation, information friction still exists between them and traders, since traders can always accurately estimate livestock weight. Increasing traders' competition may make traders use scales more in transactions, reducing asymmetric information in weight and improving herders' market performance.

For asymmetric information in livestock quality, X_{ij} represents a binary variable defined as one if the household has an improved breed and zero otherwise. Improved breeds are different from local breeds in appearance and shape, which traders and herders can easily identify. Hence, improved breeds bring less quality information friction, suggesting limited gain in quality information due to increased traders' competition. However, for local breeds, herders may benefit substantially from more information about livestock quality as a result of bargaining activities with more traders.

Furthermore, acquiring additional information through bargaining could make herders more patient and wait for better market opportunities. Paradoxically, this might lead these herders to miss the optimal moment and enter a downward phase in the context of the inverse U-shaped relationship. To investigate this, we use "whether herders have enough patience to sacrifice the present gain to achieve future goals" as an indicator for measuring herders' patience. We then apply Equation 5 to explore the potential heterogeneous effects of traders' competition across varying patience levels. In the context, X_{ij} represents whether herders have enough patience to sacrifice the present gain to achieve future goals.

5 | Results

5.1 | Basic Results: The Effects of Traders' Competition

The empirical results (Table 2) without considering the potential endogeneity of traders' competition, first suggest that competition from traders improves herders' market performance. For example, when traders' competition, indicated by standardized trader number in a village, increases by one standard deviation (or 3.4 more traders serving 100 households), livestock farm-gate price per sheep unit and livestock farm-gate price per kilogram increase significantly by 6.5% (1.9% × 3.4) and 4.8% (1.4% × 3.4), respectively (Columns 1 and 4, Table 2).

The IV endogeneity tests suggest that standardized trader number is endogenous to herders' market outcomes (Columns 2 and 5, Table 2) and these above preliminary results may underestimate the impacts of traders' competition. Specifically, the IV estimators show that when traders' competition increases by one standard deviation, livestock farm-gate price per sheep unit and livestock farm-gate price per kilogram increase significantly by 12.9% and 9.9%, respectively (Columns 2 and 5, Table 2).

The results from OLS and IV confirm the theoretical implication that herders' market outcomes increase with the number of traders. What will herders' market outcomes be as competition further increases? To answer this question, we include standardized trader number square into Equation 3, the regression results shown in Columns 3 and 6, Table 2. Herders' market outcomes still increase with standardized trader numbers initially. However, as standardized trader numbers further increase, herders' market outcomes decline, particularly when standardized trader numbers exceed 13 (the mean and maximum are 3.6 and 23, respectively). In our sample, 2 out of 104

TABLE 2 | The effects of traders' competition on herders' market performance.

	Livestock farm-gate price (yuan/sheep unit)			Livestock farm-gate price (yuan/kg)		
Variables	**OLS (linear) (1)**	**IVs (2)**	**OLS (quadratic) (3)**	**OLS (linear) (4)**	**IVs (5)**	**OLS (quadratic) (6)**
Standardized trader number	0.019***	0.039***	0.038**	0.014**	0.018*	0.029**
	(0.007)	(0.015)	(0.015)	(0.007)	(0.010)	(0.012)
Standardized trader number square	—	—	−0.001*	—	—	−0.001**
	—	—	(0.001)	—	—	(0.000)
Under-identification test (K-P statistic)	—	9.656***	—	—	9.656***	—
Endogeneity test	—	4.451*	—	—	7.591**	—
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	669	669	669	669	669	669

Note: For (1)–(6), a Heckman selection model was used and the second-stage of the Heckman model was reported. The fixed effect is controlled at province level. The IV is the residue of regression of traders' competition on village controls. Robust standard errors in parentheses are clustered at the village level.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

(3%) villages have experienced excessive competition from traders.

Our finding seems to imply an inverse U-shaped relationship between herders' market performance and traders' competition for the livestock market in pastoral China. On the one hand, the phenomenon suggests that small herders will benefit from increased competition from traders, as the literature has conjectured (Bloom et al. 2015; Chatterjee 2023; Krishna and Sheveleva 2017). On the other hand, this phenomenon also suggests that small herders' market outcomes may not obey "more competition will be better" under a realistic situation. A wide range of variables, including household and village characteristics and the market price, is controlled in the models, suggesting that the effect of traders' competition should not come from these observed covariates. Our results that increased competition does not necessarily lead to better outcomes are consistent with the findings of Macchiavello and Morjaria (2020), who found that more buyers' competition reduces farmers' welfare, as more competition may lure farmers into not complying with the contract. We conduct further evidence to explore the causal effect pathways between traders' competition and herders' market outcomes.

5.2 | Explanation From Livestock Characteristics Asymmetric Information

The results in Table 3 indicate that herders' likelihood of engaging in bargaining and the efficacy of bargaining, as measured by the price increase after negotiations, improve in response to increased competition among traders. Specifically, when the standardized trader number increases by one standard deviation, the probability of bargaining with traders during transactions increases by 2.1%–3.1% (Columns 1 and 2, Table 3). After bargaining, the final sale price of livestock experiences an increase of 0.8%–1% (Columns 4 and 5, Table 3). Interestingly, bargaining behavior (Column 3, Table 3), and the final accepted price (Column 6, Table 3) may decline with further competition, aligning with our inverse U-shape findings. The bargaining process is inherently an information exchange (Geng 2024). Our empirical results suggest that, in low-competition environments, herders often lack information and bargaining power, allowing traders to monopolize the market and purchase livestock or agricultural products at lower prices (Krishna and Sheveleva 2017). As the number of traders increases and competition intensifies, traders may raise purchase prices or offer better information to attract herders and secure market share, ultimately benefiting herders' well-being. However, when competition becomes excessively fierce, traders' profit margins shrink, leading to an increase in herders' market power. In an effort to maintain profitability, traders may resort to undesirable practices, such as providing misleading information about livestock quality through collusion, as observed in the field survey, mirroring the findings of Sexton (2013). Meanwhile, herders, seeking to maximize their gains, may delay decisions or breach contract, similar to the behavior observed by Macchiavello and Morjaria (2020) in the coffee supply chain, in hopes of obtaining "better information." This raises an important question: what specific aspects of information, livestock weight or quality, is more crucial in bargaining?

Additional empirical results using Equation 5 reveal that increasing traders' competition reduces asymmetric information regarding livestock characteristics, particularly weight and quality, between traders and herders. First, the impacts of traders' competition on herders' market outcomes are more pronounced when information disparities related to livestock weight are more significant. Figure 2a demonstrates that traders' competition has no statistically significant impact on farm-gate price if weight measurement uses a scale. However,

TABLE 3 | The effects of traders' competition on herders' bargaining behavior.

	Whether bargain with buyers in the transaction (1 = yes)			Any percent price increase after bargaining (%)		
Variables	**OLS (linear) (1)**	**IVs (2)**	**OLS (quadratic) (3)**	**OLS (linear) (4)**	**IVs (5)**	**OLS (quadratic) (6)**
Standardized trader number	0.009**	0.006*	0.027**	0.294**	0.243**	0.970**
	(0.004)	(0.003)	(0.011)	(0.137)	(0.124)	(0.409)
Standardized trader number square	—	—	−0.001*	—	—	−0.041*
	—	—	(0.001)	—	—	(0.021)
Under-identification test (K-P LM statistic)	—	10.66***	—	—	10.66***	—
Endogeneity test	—	11.22***	—	—	3.295*	—
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	669	669	669	669	669	669
R^2	0.546	0.545	0.545	0.202	0.202	0.205

Note: For (1)–(6), a Heckman selection model was used and the second-stage of the Heckman model was reported. The fixed effect is controlled at province level. The IV is the residue of regression of traders' competition on village controls. Robust standard errors in parentheses are clustered at the village level.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

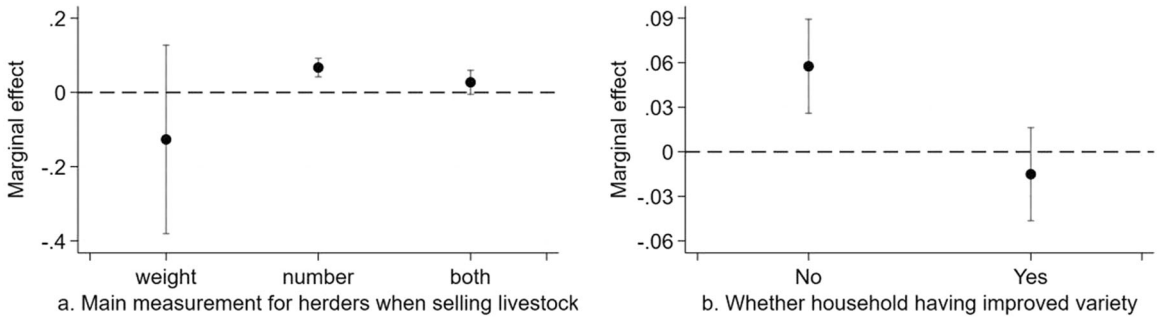

FIGURE 2 | Explanation from livestock characteristics information friction.

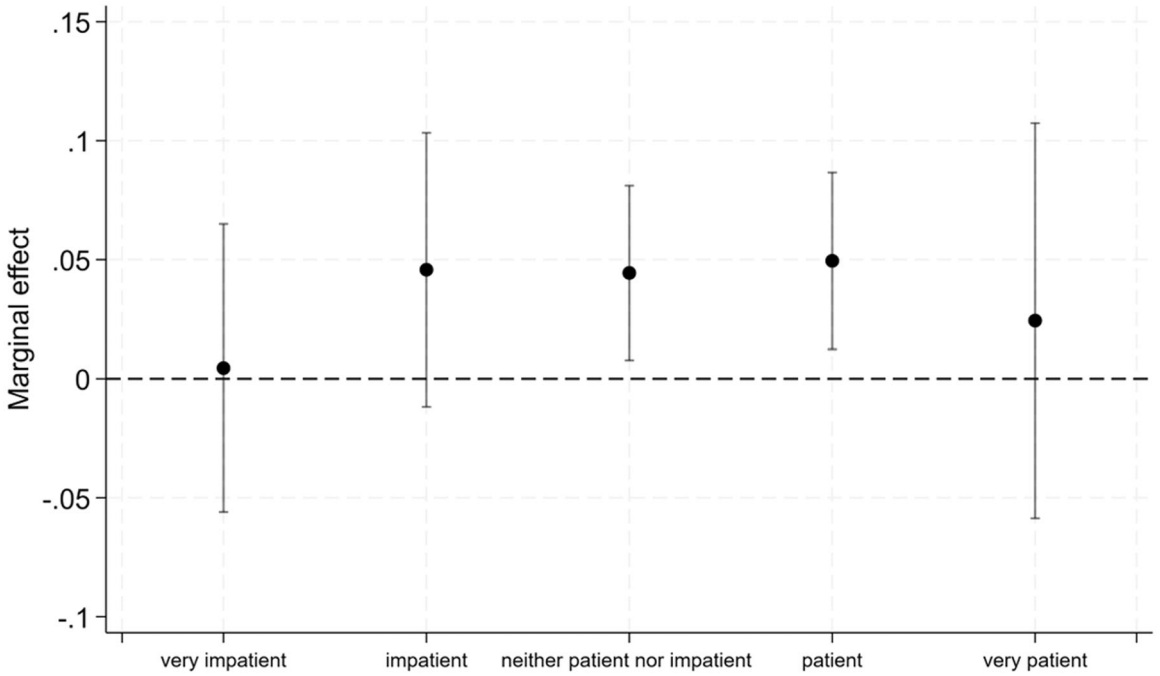

FIGURE 3 | Heterogeneity effects of traders' competition regarding herder patience.

when weight is measured by counting livestock numbers, traders' competition has a positive and significant effect. Moreover, when herders use both measurement methods, the influence of competition is positive but less prominent. In our sample, approximately 4% of villages sell livestock by weight measurement, 36% by numerical counts, and 60% use both methods.

Second, the effects of traders' competition on herders' market outcomes are less pronounced when the information gap concerning livestock quality between traders and herders is narrower. Results for Figure 2b show that traders' competition positively impacts the farm-gate price for households selling local breeds. However, this impact is insignificant for households selling improved breeds, suggesting less asymmetric information from livestock quality and fewer benefits from increasing traders' competition. In our sample, 33% of households have improved breeds.

Regarding the heterogeneity in herders' patience level, the most patient or impatient herders benefit less compared to those who are moderately patient. Figure 3 shows that traders' competition positively impacts herders who are neutral or moderately patient, yet the impact remains statistically insignificant for those categorized as very impatient, impatient, or very patient. These heterogeneous effects regarding patience are consistent with the findings in the inverse U-shaped relationship presented in Table 2. Impatient herders may lack the persistence required to bargain with multiple traders. Conversely, due to the heterogeneity of livestock and the fact that sellers outnumber buyers, herders often perceive livestock markets as neither frictionless nor predictable. As a result, the most patient herders may miss optimal offers, continually hoping for higher prices from future traders. This situation suggests that we may observe inefficiencies in the livestock market before the equilibrium supply curve shifted.

6 | Conclusions and Discussion

Market power within the agricultural production chain is a globally significant concern (Kaboski et al. 2022; Sexton and Xia 2018). Using 669 households survey data in the pastoral

areas of Inner Mongolia, Xinjiang, and Tibet provinces of China, we examine the effectiveness of traders' competition on herders' market outcomes.

This paper provides empirical evidence that increasing traders' competition can improve herders' performance overall. However, excessive competition also reveals an inverse U-shaped relationship between herders' market performance and traders' competition. The primary reason for the positive effects is reducing the information gap between traders and herders. With growing traders' competition, herders have more opportunities to negotiate with a broader array of traders, improving their understanding of their livestock. In particular, the narrowing information gap pertains to the weight and quality of livestock. Nonetheless, the availability of more information may entice excessively patient herders to pursue higher prices, causing them to miss optimal offers and experience a decline in their market outcomes, thereby moving into the descending portion of the U-shaped curve.

Our results indicate that increasing traders' competition leads to distributional effects that redirect economic surplus from traders to herders. These findings carry significant policy implications for improving herders' income in China's pastoral region. On the one hand, the agricultural or livestock management sector may harbor substantial apprehensions regarding market power, particularly traders' power over herders. Competition among traders plays a pivotal role in enhancing the market performance of small farmers. Therefore, implementing policies aimed at encouraging and regulating competition among traders can contribute to the sustainable development of small farmers in the long term.

On the other hand, small farmers require additional training, capacity building, and public infrastructure investment, such as affordable and effective information on product identification to align themselves with the market-driven socioeconomic landscape. Previous research indicates that collective action empowers farmers to mitigate market power and address free-rider issues related to product promotion and quality certification (Lence et al. 2007; Zago and Pick 2004). Establishing controlled marketing organizations for small farmers in the grassland sector can benefit vulnerable herders in gathering market information and managing livestock production.

While our study benefits from one of the most comprehensive surveys conducted in the challenging and costly data collection environment of China's pastoral region, several limitations must be acknowledged. First, using cross-sectional data, despite applying an instrumental variable (IV) strategy, may introduce some limitations in terms of causal identification. Second, the final demand sector (i.e., retail) may be steersmen in the herders-traders market power, but few data about final demanders make us regard it as given. Moreover, as diverse demands for grassland ecological livestock products continue to rise, novel modes of acquisition that incorporate considerations of weight and quality labeling are emerging. Investigating the potential impacts of these new transactional approaches on the livelihood improvement of herders could provide valuable insights for future research.

Author Contributions

Dongqing Li: methodology, data curation, formal analysis, funding acquisition, writing – original draft, software. **Alec Zuo:** writing – review and editing, validation. **Kevin Z. Chen:** supervision, resources. **Lingling Hou:** funding acquisition, conceptualization, project administration.

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Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

[1] Herders estimated the livestock weight without actual weighing. Especially for big-sized and heavy cattle, most herders lack weighing equipment for them. The data on livestock weight may lack precision; we only use farm-gate price per kilogram as a robustness check for herders' market performance.

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Appendix

TABLE A1 | Sample.

Province	County	Town	Village	Household
Inner Mongolia	5	17	34	236
Xinjiang	6	18	36	217
Tibet	6	16	34	216
Total	17	51	104	669

Note: In each province, we combined annual income per capita, grassland type, and geographical position. We sampled three to four townships from each county, two to three villages from one township, and six to nine households randomly selected from each village.

TABLE A2 | Description of variables.

Variables	Obs.	Mean	SD	Minimum	Maximum
Panel A. Household level					
Farm-gate price per sheep unit (yuan)	552	1663	875.7	13.33	6318
Farm-gate price per kg (yuan)	552	17.78	10.77	5	97.91
Percent price increase after bargaining (%)	552	15.49	16.10	0	100
Whether selling livestock (1 = yes)	669	0.825	0.380	0	1
Livestock sale number (sheep unit)	669	86.07	136.1	0	1270
Total livestock number (sheep unit)	669	387.8	497.4	0	9099
Proportion of sheep in sale (%)	669	48.64	43.98	0	100
Proportion of sheep in sale (%)	669	25.04	36.66	0	100
Whether household having improved breed (1 = yes)	669	0.336	0.473	0	1
Household size (the number of people)	669	4.698	2.043	1	12
Proportion of pastoral labor (%)	669	57.70	28.23	0	100
Proportion of off-pastoral labor (%)	669	15.84	21.01	0	100
Mean education level of labors (year)	669	6.627	3.642	0	16.5
Contracted grassland size per capita (ha)	669	95.39	191.9	0	3,365
Livestock average weight in sale (kg)	669	106.7	69.54	10	436.4
Livestock average age in sale (month)	669	16.77	21.69	1	159.5
Whether the household is a member of cooperatives (1 = yes)	669	0.151	0.358	0	1
Risk preference	669	0.168	0.201	0	1
Panel B. Village or town level					
Standardized trader number *100	104	3.578	3.415	0.667	23.08
Commute trader number	104	3.933	2.287	1	10
Total household number	104	173.2	141.7	13	761
Grassland endowment per capita (ha)	104	73.86	109.4	3.727	963.2
Distance to the nearest paved road (km)	104	4.231	12.72	0	70
Distance to the nearest local livestock market (km)	104	23.30	31.17	0	155
Main measurement for herders when selling livestock	104	2.538	0.573	1	3
Whether village having 4G single (1 = yes)	104	0.962	0.193	0	1
Whether village intervening selling (1 = yes)	104	0.058	0.234	0	1
Whether village investing artificial grassland (1 = yes)	104	0.154	0.363	0	1
Grass price at town level (yuan/kg)	51	1.044	0.889	0.318	3.038
Livestock market price at town level (yuan/kg)	51	31.96	8.243	20.55	52.36