Gender bias in customer perceptions: The case of agro-input dealers in Uganda

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Abstract

CONTEXT:

Faced with incomplete and imperfect information, economic actors rely predominantly on perceptions and often base decisions on heuristics prone to bias. Gender bias in perceptions favoring men has been found in a variety of settings and may be an important reason why some sectors remain dominated by men and gender gaps in terms of benefits persist. In modernizing food supply chains in a patriarchal context such as the maize sub-sector in Uganda, women may face significant barriers to entry.

OBJECTIVE:

Using a unique dataset of ratings of agro-input dealers provided by smallholder farmers in their vicinity, we test if farmers perceive male-managed agro-input shops differently than agro-input shops managed by women.

METHODS:

We use a dyadic data set of farmer-dealer links to explicitly control for quality differences between male- and female-managed agro-input shops and use the fact that a farmer has generally rated more than one agro-input to account for farmer-level heterogeneity using fixed-effects regression.

RESULTS AND CONCLUSIONS:

We find that farmers rate male-managed agro-input outlets higher on a range of attributes related to the dealership in general, as well as on the quality of inputs sold by the dealer. After controlling for both dealer and farmer level confounders, we conclude that gender bias in customer perceptions persists.

SIGNIFICANCE:

Our results suggest a comparative disadvantage and an important entry barrier for female agro-input dealers. The gender bias affects social outcomes like women's capabilities, aspirations, and empowerment in seed systems but also impairs development at more aggregate levels: as a considerable share of agro-input shops is managed by women, this finding may impose challenges for varietal turnover, hindering agricultural productivity, food security, and rural transformation. Policies and interventions designed to challenge gender norms and customs are needed to correct this bias.

Keywords: gender bias, perceptions, agro-input dealers, maize seed systems, Uganda

1 Introduction

In the context of incomplete and imperfect information, economic actors rely predominantly on perceptions and use mental shortcuts to make decisions using limited data (Kahneman, 2017). Reliance on instincts and emotions

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becomes dominant if it is difficult to objectively assess the value of a commodity or service being bought and sold. However, perceptions and decision heuristics may suffer from a variety of cognitive biases such as stereotype thinking and availability bias and may be influenced by social and cultural phenomena such as homophily effects and prevailing norms and customs.

Agricultural inputs such as inorganic fertilizers or seed of improved varieties (high yielding cultivars like open-pollinated or hybrid maize varieties), lie somewhere on the continuum between experience goods and credence goods. When farmers inspect products at the agro-input shop, they can assess quality only superficially from readily observable characteristics such as the homogeneity of the seed or by checking if the fertilizer package is intact. Even after farmers used the commodity and observed the yield, it may be difficult for them to learn about the quality of the seed or fertilizer, as many other factors in addition to the input affect yield. That is why perceptions and emotions often take the upper hand when farmers acquire agricultural inputs.

In addition to the difficulty of judging the quality of agricultural inputs, several studies note that there is considerable heterogeneity in the actual quality of these inputs in the market. For instance, Bold et al. (2017) test agricultural inputs purchased in local markets in Uganda and find that 30 percent of nutrients are missing in fertilizer, and hybrid maize seed is estimated to contain less than 50 percent authentic seed. Also in Uganda, Ashour et al. (2019) test herbicides and find that the average bottle in their sample is missing 15 percent of the active ingredient and 31 percent of samples contained less than 75 percent of the ingredient advertised. While it remains unclear if quality-related issues are the result of deliberate adulteration or poor storage and handling, and at what point in the value chain quality starts to deteriorate, the resulting uncertainty makes reliance on perceptions and decision heuristics more likely (Barriga and Fiala, 2020).

In traditional societies with strong gender norms and customs, small businesses along food supply chains are often some of the few options for women to earn money independently from their husbands. While rapid urbanization has led to the emergence of fast-food restaurants, informal food vendors, who tend to be self-employed women, are still the main source of food for most households in sub-Saharan Africa (Giroux et al., 2021). And while supermarkets are emerging throughout the developing world, wet markets where mostly women sell products continue to account for most of the expenditure on fresh produce in many countries (Gorton, Sauer, and Supatpongkul, 2011). In Uganda, we find that a surprisingly large share of agro-input shops are operated and/or managed by women.

However, the same gender norms and customs also mean that perceptions may be stacked against women if they venture into areas such as agro-input provision. Farmers, both male and female, may believe modern agricultural technologies fall in the male domain. Furthermore, agro-input shops primarily deal in seed for semi-commercial crops such as maize or rice, as opposed to food security crops such as beans or cassava. Again, commercial crops are often considered to be the responsibility of men, while women are expected to take care of the household food supply (Dolan, 2001; Orr et al., 2016). A case in point is the recent study by Ntakyo and Van Den Berg (2022) which confirms this traditional stance in the context of smallholder production in Uganda. The authors find a significant negative impact of a commercialization program on women empowerment in crop production and their control over income, clearly showing a power shift to men in rural households. Hence, we conjecture that female-managed agro-input shops may be disadvantaged when farmers form opinions about the quality of services rendered or goods sold, deeming women not to be fit for these commercial roles.

In this paper, we test if farmers perceive agro-input shops managed by women less favorably than agro-input shops under male management using a unique dyadic data set of farmer-dealer links.[1] To operationalize perceptions, we asked farmers to rate agro-input dealers, on a scale of one to five, on a range of characteristics. We then make

[1] The paper builds on earlier exploratory work published in Van Campenhout and De (2023) that looks at gender-related perceptions in Uganda's maize value chain more broadly, and prompted us to formulate a more specific hypothesis and collect data to test this using appropriate quantitative methods.

between-dealers comparisons, explicitly accounting for observable differences in the quality of male- and female-managed shops. Furthermore, we use the fact that a farmer has generally rated more than one agro-input dealer. If the same farmer rates both male and female-managed agro-input shops, we can exploit this within-farmer variation and control for farmer specific observable and unobservable confounders.

We find that farmers generally rate male-managed agro-input shops more favorably than shops managed by women. The difference in ratings is largest when farmers are asked to rate the agro-input dealership in terms of price competitiveness and in terms of reputation. We also find that the quality of seed from male-managed agro-input shops is rated higher than the quality of seed from shops managed by women. As the differences in ratings persist after explicitly controlling for the quality of the dealerships and the services and products they provide, we conclude that gender-biased customer perceptions persist and create comparative disadvantages and entry barriers for female-managed agro-input shops.

The gender bias we uncover is rooted in the commercialization of the maize subsector as a result of increased regional trade in maize and wider used of improved maize seed varieties in the emerging formal seed sector. In patriarchal societies it has often been observed that men start to dominate once the stakes become high. This gender bias directly affects social outcomes like women's capabilities, aspirations, and their empowerment in agricultural and seed systems. Additionally, there are consequences at more aggregate levels: as almost half of the agro-input shops in our sample are managed by women, the finding that farmers do not trust these shops may impose challenges for varietal turnover, hindering agricultural productivity, food security, and rural transformation.

The remainder of this article is organized as follows. We first situate the research question in the wider literature in Section 2. In Section 3, we provide the context of the study and describe the main economic actors: agro-input dealers and smallholder maize farmers. We also describe how we measure perceptions, the key variable of interest in this study. Next, we lay out the empirical strategy in Section 4, followed by the results in Section 5. A final Section 6 concludes and offers some policy guidance.

2 Research question and relation to the literature

We aim to test if gender related discrimination is present in the way smallholder maize farmers in southeastern Uganda perceive agro-input dealers in their neighborhood. In the wider literature, gender related discrimination is often referred to as gender bias—behavior that shows favoritism toward one gender over another. Gender bias has been confirmed in a wide range of contexts, usually when people are asked to assess the performance of another person. Stereotyping and role congruence are often catalysts for distorted perceptions and false beliefs about the abilities of groups of people. We highlight some of the most important studies that search for systematic bias related to the gender of the person being assessed.

Gender bias often surfaces when individuals decide on who to engage with, be it who to work with, who to elect as leaders, or who to consult. For example, when it comes to hiring decisions, managers must decide based on limited information. Discrimination in labor markets, including discrimination related to gender, has been documented in several studies. Wu (2020) uses data from an online forum for economists called "Economic Job Market Rumors" to measure gender bias in discussions about women versus men. Gender bias is also studied in the context of the wage gap, that is, when women appear to make substantially less money for the same work than their male counterparts. Often, this is also tied to gender bias in performance appraisals, where (often male) managers' gendered beliefs and perceptions creep into evaluations of their subordinates (Correll et al., 2020).

Another area where gender bias has been studied extensively is in scientific publishing using peer review. For instance, Card et al. (2019) look at differences in rejection rates at four top economics journals. They compare male-authored papers to female-authored papers, using citations as a noisy measure of quality to account for potential sources of divergence, other than gender, between the two. They find that editors largely follow referees, resulting in a 1.7 percentage point lower probability of a revise and re-submit verdict for papers with female authors relative to a citation-maximizing benchmark. However, evidence on gender biases in the evaluation of economic research remains mixed. For example, Chari and Goldsmith-Pinkham (2017) find no disparity in the acceptance rates of female- and male-authored papers for National Bureau of Economic Research conferences; Hospido and Sanz (2021) do find a significant advantage for male authors being accepted at three different European conferences. Gender bias has also been studied extensively in student evaluations of teaching. For instance, Mitchell and Martin (2018) find that the language students use in evaluations of male professors is significantly different from their language when evaluating female professors. They also show that a male instructor administering an identical online course as a female instructor receives higher ordinal scores in teaching evaluations.

Gender bias is also pervasive in politics. Pair et al. (2021) use Natural Language Processing to search for gender bias in Kenya's leading newspaper and sentiment analysis to predict quantitative sentiment scores for sentences surrounding female leader names compared to male leader names. They find evidence of improvement in gender equality but also a backlash from increased female representation in high-level governmental leadership. Le Barbanchon and Sauvagnat (2021) find that female candidates obtain fewer votes in municipalities with higher gender earning gaps.

In the context of small and medium-sized enterprises (SMEs), in the agricultural sector in particular, we find few studies that look at gender bias. Alibhai et al. (2019) who study discrimination against female-led SMEs in Turkey come closest. Conducting a novel loan application experiment with 77 officers in banks, they find that 35 percent of the loan officers are biased against female applicants, with women receiving significantly smaller loans than men. The authors argue that loan officers may use gender bias as a heuristic device given limited information and risk aversion.

Gender bias features so prominently in areas such as labor markets, scholarly peer review, or teaching assessments partly because perceptions are made explicit in the process, for instance through review reports, student feedback, or hiring committees. However, in economic transactions, gender biases remain hidden as perceptions are never measured. As a result, differences in outcomes are often attributed to various other causes, such as differences in education or ability between men and women.

3 Context and data

3.1 Study context

The study was conducted in Uganda. As in many traditional agricultural societies, women's roles are mainly domestic, including housekeeping, child rearing, fetching water, cooking, and tending to community needs. Strong gender norms and stereotypes about the different capabilities of women and men imply that many women shy away from economic activities such as cash cropping or post-harvest processing. Women do participate to some extent in economic life through marketing as owners of small shops or vendors during market days. Even though the government signaled a willingness to mainstream gender as early as in 1997 with its first National Gender Policy, and women are reasonably represented at higher levels of government, norms and customs prevent women in most rural areas of Uganda from participating fully in economic life.

3.2 Sample

Our study area comprises eleven districts in southeastern Uganda, and roughly corresponds to the Busoga Kingdom. We include agro-input dealers located in trading centers and villages as well as smallholder maize farmers that live in the catchment areas of these key market sheds. The dealer sample was obtained by listing all agro-input shops in the area during a census, which resulted in 193 dealers. We collected information on their characteristics in September and October 2020.

After the census, these agro-input shops were grouped in catchment areas based on their location. A catchment area is defined as the area that is served by a dealer, the area where this dealer's customers live. If catchment areas of two or more dealers overlap because these dealers operate in the same town or trading center, they are assigned to the same catchment area. This is done based on their geographical location. Using GPS coordinates of the shops, the haversine function constructs an adjacency matrix, and shops that are less than five kilometers apart are assigned to the same catchment area. The 5-kilometer threshold was selected based on a visual inspection of the map, the size of an average village and the mean reported distance between farmers and dealers. The 193 agro-input dealers in Busoga were assigned to 65 catchment areas. In some catchment areas, there is a high density of shops, while in others there are only one or two dealers. On average, there are 2.7 dealers in an area, with a minimum of one and a maximum of 18.

In each catchment area, we also sampled farmers in proportion to the number of agro-input dealers in the area. We connected shops to villages by asking every dealer where most of his or her customers come from. Enumerators were sent to these villages and instructed to randomly sample ten households that grow maize.[2] In particular, enumerators obtained lists of all households within the village obtained from village health workers or from the village chairman and used systematic sampling to select the ten households (choosing the n-th household where n=(total number of households in village)/10). Consequently, we sampled 1,931 smallholder maize farmers and collected information about their characteristics in April 2021. A second round of ratings by the same farmers of the same agro-dealers was collected in January and February 2022.[3] While these ratings were provided by the same farmers, only 1,893 of them were found during the second wave. These two rounds of surveys constitute the key sources of data for the study. Note that we only include shops in our analysis if the gender of their manager did not change between the first and the second round of rating collections, which led to the removal of 27 agro-input dealers (or 15 % of the sample of agro-input dealers).

Within sampled households, we choose the person that was most knowledgeable about maize farming and takes most of the decisions for the ranking and interviews. In most cases, this was the male household head. However, as in the area where we did the research most maize plots are jointly managed and decisions are taken together (see eg. Lecoutere, Spielman, and Van Campenhout, 2023), we sometimes interviewed the women if the man was unavailable (eg. away from the household for longer term). As such, we think our sample is fairly representative of the population of farmers that interfaces with agro-input dealers.

[2] One may argue that for results to hold for the entire farmer population, sampling should be proportionate to the village size. While this would have been the preferred way, our approach of starting from a complete listing of all agro-dealers is likely to lead to implicit weighting as more densely populated areas are also more likely to have more agro-dealers, leading to relatively more farmers sampled that are connected to these agro-dealers.

[3] This was done to increase the number of rating (as some farmers rated different agro-input dealers in the first and second round and some agro-dealers were rated by different farmers in the first and second round). Furthermore, this also created a subset of repeat ratings (as some farmers rated the same agro-input dealers in both rounds and some agro-dealers were rated by the same farmers in both seasons) which can potentially reduce measurement error. The fact that the latter may be correlated within farmer and/or within agro-dealer is dealt with in Section 4. We confirm that our finding are robust to the decision to pool ratings from different rounds by also estimating equations separately for first and second round ratings. Results are available from authors upon request.

3.3 Descriptive statistics

Table 1 describes the average agro-input dealer included in our study, differentiated by gender of the shop manager. When enumerators approached a shop, they tried to interview the manager, i.e., the person who is most knowledgeable about the day-to-day operations of the business, inventories, sales, and so on. It may be that the shop is owned by one person, but the owner employs another person to manage it. About 60 percent of managers are male. In 63 percent of the cases, the male respondent is also the owner of the shop, while only 47 percent of female managers are also the owner. If the gender of the shop manager is different from the gender of the owner, the question emerges whose gender affects perceptions of the shop as a whole. We feel that the person who manages the shop is most visible and as such most likely to affect perceptions, therefore the gender of the respondent determines if a shop is categorized as female or male-managed in our analyses.

There is substantial heterogeneity across shops. Some are small informal shops located in rural areas, which sell other goods and only stock seed during the planting season. Others are located in towns or trading centers and specialize in farm inputs and tools. The average shop has been in operation for about five to five and a half years. We find differences in the number of customers conditional on the gender of the agro-dealer manager: male managers report serving more than 51 customers a day, female managers serve only 36 customers per day. A shop had on average three maize seed varieties in stock during the last season. We asked more detailed question on the four most common seed types, such as amounts obtained and sold, and prices. Additional statistics describing seed handling and storage practices, efforts, and services of agro-input dealers, are presented in Table 2. We see that female managers do not seem to handle or store seed in less appropriate ways than male managers. In fact, on many measures, female managers appear to do better than male managers.

Table 3 provides descriptive statistics of the farmers included in the study. The average farmer in our sample works on a small farm, with about 3.4 acres of land for crop production. Half of our sampled farmers indicate that they used maize seed of an improved variety, i.e., seed of a hybrid or open-pollinated variety, on at least one plot in the season preceding the survey, and of the farmers that used seed of an improved variety, two-thirds obtained it from an agro-input shop, suggesting reasonable varietal turnover at this level. However, fertilizer use is low. As a result, productivity is also low, with the average farmer harvesting only about 450 kg of maize per acre. Almost 70 percent of farmers believe that maize seed sold at agro-input shops is counterfeit.

3.4 Measuring perceptions

Quantifying perceptions of the quality of services provided by agro-input dealers and of the products they sell—improved maize varieties in particular—is central to our analysis. To do so, we asked farmers to rate agro-input dealers in the catchment area on a range of attributes. We broadly categorized the attributes into two families. A first set of indicators attempts to measure overall quality of agro-input dealers and the services they provide, while a second set of indicators has a narrower focus and asks about maize seed, a particular product sold by the agro-input dealer.

To measure the perceived quality of agro-input dealers, farmers were asked to rate these dealers on a scale of one (worst) to five (best) on their general quality, location (convenience, accessibility, closeness to clients), price (competitive pricing, discounts), seed quality, stock (availability of seed, number of varieties in stock), and reputation (what do other farmers think about the dealer). We also compute an average of these six dealer-level ratings. For these indicators, farmers were asked to rate the shop as a whole.

To measure the perceived quality of seed, farmers were asked to rate seed of improved varieties that dealers sell on a scale of one to five on their general quality, yield, drought tolerance, pest and disease tolerance, crop duration

Table 1: Descriptive agro-input dealer statistics

	Male					Female				
	mean	min	max	SD	obs.	mean	min	max	SD	obs.
Dealer's age in years	32.114	15	59	10.951	114	30.519	18	50	8.474	79
Dealer finished secondary education	0.405	0	1	0.493	111	0.364	0	1	0.484	77
Dealer owns shop	0.632	0	1	0.485	114	0.468	0	1	0.502	79
Dealer received training on seed handling	0.614	0	1	0.489	114	0.532	0	1	0.502	79
Shop's distance to nearest tarmac road in km	5.595	0	39	8.470	114	6.224	0	40	10.225	78
Distance between shop and farmer in km[1]	5.157	0	13	3.300	114	5.297	0	13	3.087	79
Shop only sells farm inputs	0.702	0	1	0.460	114	0.823	0	1	0.384	79
Number of customers per day	50.850	2	300	55.759	113	35.544	2	150	33.443	79
Number of customers buying maize seed per day	25.327	1	250	31.043	113	19.696	0	100	23.485	79
Number of years since shop's establishment	5.684	0	33	6.252	114	5.063	0	25	5.910	79
Number of maize varieties in stock (last season)	3.123	0	10	2.096	114	2.962	0	10	1.720	79
Number of hybrid maize varieties in stock (last season)	1.868	0	8	1.594	114	1.709	0	6	1.293	79
Number of maize OPVs in stock (last season)	1.351	0	5	0.776	114	1.228	0	3	0.619	79
Sales price of maize seed in UGX/kg (last season)	4331.212	2500	10000	1148.673	110	4386.184	2800	12000	1482.227	76
Cost of maize seed for dealer in UGX/kg (last season)	3481.250	2000	8500	886.174	108	3585.915	2200	7750	1064.599	71
Revenue from maize seed in million UGX (last season)	10.290	0	82	18.041	112	6.722	0	81	14.592	79
Amount of maize seed dealer bought from provider in kg (last season)	332.245	0	2500	422.518	102	271.347	10	2000	346.179	72
Amount of maize seed dealer sold in kg (last season)	460.709	0	2453	536.918	103	370.026	0	1700	447.520	76
Shop's cleanliness/professionality rating by enumerator	3.465	1	5	1.191	114	3.557	1	5	1.071	79
Shop received seed-related complaint from customer	0.711	0	1	0.456	114	0.620	0	1	0.488	79
Shop is registered with UNADA	0.486	0	1	0.502	107	0.493	0	1	0.503	75
Shop has trading license from local government	0.830	0	1	0.377	112	0.731	0	1	0.446	78

Note: SD is the standard deviation.
Number of observations: All 193 agro-input dealers are included in this table.
[1]The distance between shop and farmer is calculated using the haversine function based on the GPS coordinates obtained during data collection. Farmers were asked to rate agro-input shops they know (one farmer can rate multiple shops) and these shops are not necessarily located in the immediate vicinity.

Table 2: Descriptive agro-input dealer statistics: Variables in indices

	Male					Female				
	mean	min	max	SD	obs.	mean	min	max	SD	obs.
Capital-intensive seed handling/storage practices observed by enumerator										
Shop has leak-proof roof	0.535	0	1	0.501	114	0.544	0	1	0.501	79
Shop has insulated roof	0.579	0	1	0.496	114	0.671	0	1	0.473	79
Shop has insulated walls	0.807	0	1	0.396	114	0.823	0	1	0.384	79
Shop is ventilated	0.833	0	1	0.374	114	0.835	0	1	0.373	79
Shop displays official certificate	0.500	0	1	0.502	114	0.506	0	1	0.503	79
Shop always handles expired seed correctly	0.935	0	1	0.247	108	0.948	0	1	0.223	77
Labor-intensive seed handling/storage practices observed by enumerator										
Shop stores seed away from other products	0.447	0	1	0.499	114	0.342	0	1	0.477	79
Shop has problem with pests	0.623	0	1	0.487	114	0.658	0	1	0.477	79
Shop's light is ambient (not direct sunlight/dark)	0.842	0	1	0.366	114	0.785	0	1	0.414	79
Shop stores seed on pallets/shelves (not directly on wood/floor/cardboard)	0.642	0	1	0.482	109	0.776	0	1	0.419	76
Shop stores maize seed in open containers	0.211	0	1	0.409	114	0.165	0	1	0.373	79
Shop's cleanliness/professionality rating by enumerator	3.465	1	5	1.191	114	3.557	1	5	1.071	79
Dealer's efforts and services										
Shop always explains to customers how seed should be used	0.561	0	1	0.498	114	0.342	0	1	0.477	79
Shop always recommends complementary inputs to customers	0.614	0	1	0.489	114	0.456	0	1	0.501	79
Shop offers extension/training	0.544	0	1	0.500	114	0.494	0	1	0.503	79
Shop offers discounts for large quantities	0.789	0	1	0.409	114	0.747	0	1	0.438	79
Shop's smallest seed bag is 1 kg (not larger)	0.700	0	1	0.460	110	0.770	0	1	0.424	74
Shop provides seed on credit	0.632	0	1	0.485	114	0.671	0	1	0.473	79
Shop received seed related complaint from customer	0.711	0	1	0.456	114	0.620	0	1	0.488	79
Shop accepts mobile money as payment	0.395	0	1	0.491	114	0.405	0	1	0.494	79

Note: SD is the standard deviation.
Number of observations: All 193 agro-input dealers are included in this table.

Table 3: Descriptive farmer statistics

	mean	min	max	SD	obs.
Homestead's distance to nearest tarmac road in km	8.850	0	100	9.391	1844
Homestead's distance to village headquarters in km	0.744	0	12	0.899	1914
Homestead's distance to nearest agro-input shop in km[1]	3.826	0	52	4.894	1858
Farmer's age in years	48.513	20	97	13.344	1923
Household head is male	0.789	0	1	0.408	1931
Farmer is married	0.881	0	1	0.323	1931
Farmer finished primary education	0.525	0	1	0.500	1913
Number of people in household (incl. respondent)	8.651	1	25	4.029	1931
Years since farmer started growing maize	22.851	0	82	13.004	1931
Farmer is member of farmer group/association/cooperative	0.132	0	1	0.338	1927
Farmer's land for crop production in acres	3.350	0	80	3.980	1915
Yield in kg/acre	456.998	22	2200	341.842	1881
Farmer used improved maize seed varieties for any field last season	0.499	0	1	0.500	1929
Farmer bought this maize seed at agro-input shop	0.324	0	1	0.468	1931
Farmers thinks seed at agro-input shops is counterfeit/adulterated	0.684	0	1	0.465	1512
Farmer is satisfied with maize seed used on plot	0.666	0	1	0.472	1931

Note: SD is the standard deviation.
Number of observations: All 1,931 farmers are included in this table. However, farmers were allowed to indicate that they did not know, sometimes leading to lower response rate on sensitive or harder questions.
[1]The homestead's distance to the nearest agro-input shop is the distance reported by the farmer. Respondents could only report one answer for the nearest shop.

or maturation period, and germination reliability.[4] We also compute an average of these six seed-level ratings. Farmers were also allowed to indicate that they could not rate seed on a particular dimension (for instance, because they never bought seed from the agro-input dealer). Then this dimension was not considered when computing the average.

As mentioned above, we asked farmers to rate agro-input dealers twice, a first time in April 2021 and a second time in January and February 2022. The average farmer in our data set provided ratings for about two agro-input dealers, with some farmers rating up to 15 dealers. The average agro-input shop received ratings from almost twelve farmers, while one shop received ratings from almost 50 farmers. Table 4 provides descriptive statistics of the ratings used in our study. For example, when assessing the quality of maize seed sold by male agro-input dealers, farmers rate its germination with 3.67 out of 5 on average. Farmers generally rate dimensions related to the dealership better than dimensions related to the product. For instance, the mean location rating is 3.91 out of 5 for female agro-input dealers.

As this study explicitly focuses on perceptions, farmers were allowed to rate all agro-dealers in their neighborhood, regardless of their experience with them. However, we collected some data on actual farmer-dealer interaction to get a sense of the degree of personal cognizance. The data suggests that about 26 percent of farmers ever bought seed from the agro-dealer that they rated. Those that did ever buy seed have been a customer for about 4 years. Roughly 44 percent of these farmers also bought seed in the year preceding the study.

4 Empirical strategy

Our empirical strategy exploits the nature of the data, that is, that farmers in our data set rate several agro-input dealers (and dealers are rated by several farmers). A useful starting point is the following specification:

$$y_{f,d} = \alpha + \beta g_d + \varepsilon_{f,d} \tag{1}$$

Here, $y_{f,d}$ represents the rating, on a scale of one (poor) to five (excellent), given by farmer f to agro-input dealer d. g_d is the main variable of interest—the gender of dealer d. α and β are parameters to be estimated, and $\varepsilon_{f,d}$ is a residual.[5]

Because the same farmer may rate several agro-input dealers, we cannot assume that the ratings $y_{f,d}$ in equation (1) are independent. For example, the ratings that a farmer provides may be affected by (potentially unobservable) characteristics of the farmer (for example, a poor experience with an agro-input dealer in a previous year), which may affect the ratings of all agro-input dealers this farmer rates. Furthermore, the same agro-input dealer may be rated by several farmers, leading to interdependence in the other dimension. For example, the ratings that a dealer receives may be affected by (potentially unobservable) characteristics of the dealer (for example, dealer friendliness), which may affect the ratings given by all farmers that rated this dealer. To account for this two-way interdependence in equation (1), we define a composite error term ($\varepsilon_{f,d}$) that can be decomposed into a farmer specific component (ν_f), an agro-input dealer specific component (ω_d), and a residual ($\epsilon_{f,d}$) that varies at the level of the farmer-dealer interaction.[6]

[4] It should be noted that, when asked about particular traits of seed such as yield, drought tolerance or maturation period, we asked farmer to rate in the seed based on how it was advertised. As such, a particular seed may still outperform another seed on a particular trait (eg. yield), but it may still be deemed of poor quality (eg. if yield of a high yielding variety was disappointing).

[5] Note that, as farmers rated agro-input dealers twice, there is also a time dimension in the data. However, to keep notation uncluttered, we omit the time subscript from the equation (see also footnote 6).

[6] In fact, given that we also have a time dimension in the data (see footnote 5), we also have a time specific component which we capture by including a time dummy in all specifications.

Table 4: Descriptive agro-input dealer ratings by farmers

	Male					Female				
	mean	SD	Q_1	Q_3	obs.	mean	SD	Q_1	Q_3	obs.
Dealer's maize seed rating on general quality	3.790	0.903	3	4	629	3.815	0.819	3	4	363
Dealer's maize seed rating on yield	3.583	0.942	3	4	616	3.525	0.883	3	4	356
Dealer's maize seed rating on drought tolerance	3.029	0.877	2	4	594	3.000	0.892	2	4	343
Dealer's maize seed rating on pest/disease tolerance	2.467	0.928	2	3	599	2.457	0.974	2	3	350
Dealer's maize seed rating on speed of maturing	3.847	0.750	4	4	601	3.809	0.718	3.5	4	351
Dealer's maize seed rating on germination	3.673	0.913	3	4	608	3.682	0.875	3	4	359
Dealer's rating on general quality	3.773	0.994	3	5	644	3.667	1.025	3	4	378
Dealer's rating on location	3.755	1.260	3	5	644	3.907	1.176	3	5	378
Dealer's rating on price competitiveness	3.280	1.218	3	4	644	3.214	1.121	3	4	378
Dealer's rating on seed quality	3.781	1.096	3	5	644	3.825	1.036	3	5	378
Dealer's rating on seed stock	3.919	1.058	3	5	644	3.894	1.151	3	5	378
Dealer's rating on reputation	4.182	0.940	4	5	644	4.130	0.934	4	5	378

Note: SD is the standard deviation, Q_1 the 1st quartile, and Q_3 the 3rd quartile.
The minimum rating is 1 and the maximum rating is 5.
Number of observations: All ratings by farmers given to dealers during the first round of collection are included in this table, conveying the dyadic nature of the dataset.

$$\varepsilon_{f,d} = \nu_f + \omega_d + \epsilon_{f,d} \tag{2}$$

Equation (2) shows that the dyadic nature of our data leads to two-way clustering in the error term. If the error term is uncorrelated with the explanatory variable(s) included in equation (1), Ordinary Least Squares (OLS) remains consistent. However, not considering (positive) within-cluster error correlation generally leads to standard errors that are biased downward, leading to over-rejection of the null hypothesis that gender does not affect ratings. In our case, it should be noted that clustering is non-nested. As traditional cluster-robust inference can only deal with clustering in one of the dimensions, our strategy will consist of including sufficient regressors to minimize concerns about error correlation at the agro-input dealer level, and then cluster standard errors at farmer level (Cameron and Miller, 2015).

To test for an agro-input dealer gender effect, we can simply compare average ratings received by male-managed shops and average ratings received by female-managed shops. Equation (3) shows how this can be done using a simple OLS regression on dealer-level averages.

$$\frac{1}{F}\sum_f y_{f,d} = \alpha + \beta\frac{1}{F}\sum_f g_d + \frac{1}{F}\sum_f \nu_f + \frac{1}{F}\sum_f \omega_d + \frac{1}{F}\sum_f \epsilon_{f,d} \tag{3}$$

$$\overline{y}_d = \mu + \gamma g_d + \overline{\varepsilon}_d \tag{4}$$

In equation (3), the identification of the gender effect (β) relies on differences between agro-input dealers. As a dealer's gender is constant for all farmers that rate this dealer, the average g_d is also a binary indicator of the gender of that particular dealer d. The farmer-specific component ν_f is absorbed in the intercept term μ, while the dealer-specific component ω_d is now included in the error term $\overline{\varepsilon}$.

It is important to note that in equation (4), the dealer-specific error component $\frac{1}{F}\sum_f \omega_d$ in the error term $\overline{\varepsilon}_d$ may be correlated with the independent variable g_d. This would be the case if, for example, female agro-input shop managers are less educated on average than male agro-input shop managers, and less educated dealers get lower ratings by farmers. In this case, differential ratings are not caused by gender, but rather driven by differences in education. Therefore, in all regressions, we control for the education level of the shop manager, and add an additional regressor (x_d) to equation (4). A similar argument can be made for the age of the agro-input shop manager, which is a characteristic that is also easily observable and likely to affect perceptions:

$$\overline{y}_d = \mu + \gamma g_d + \varphi x_d + \overline{\varepsilon}_d \tag{5}$$

One may wonder if controlling for age and education is sufficient, as causal inference using regressions based on observational data often suffers from unobservable heterogeneity. It is important to note that this is likely to be less of a problem in our setting, because the dependent variable is derived from observations made by farmers while the characteristics included on the right hand side are collected from agro-input shop managers (which is different from the standard case where both dependent and independent variables are obtained from the same actors). For example, it is unlikely that an unobserved characteristic such as the motivation of the agro-input manager directly affects perceptions of farmers, unless this is reflected in the attribute that the farmer is assessing. That is why we also add control variables that differ depending on the attribute that is being rated. For example, when farmers are asked to rate agro-input dealers in terms of price competitiveness, it seems reasonable to include prices charged by these dealers as controls. Similarly, for perceptions related to the quality of seed sold, we are particularly interested in testing if the coefficient on the gender of the agro-input dealer changes after adjusting for various observable dealer characteristics that are directly related to quality, like the storage technology, the infrastructure such as a leak-proof roofing or insulation, and so forth. This way, we attempt to differentiate between situations where farmers perceive female-managed agro-input shops less favorably and situations where differences in ratings reflect real differences between male- and female-managed shops.[7]

Farmer-level characteristics could also confound the relationship between an agro-input dealer's gender and the rating that the farmer provides. For example, it may be that farmers who are better educated generally provide higher ratings. At the same time, imagine that better-educated farmers are more inclined to shop at male-managed agro-input dealerships. This would make it difficult to differentiate a gender effect from an effect arising from differences in farmer education. Fortunately, we often have instances where the same farmer rates both male- and female-managed agro-input shops. This allows us to exploit within-farmer variation for identification in equation (6). While we would be able to control for a farmer's education level by simply including it in an OLS regression, a within-farmer transformation also controls for characteristics that would be difficult or impossible to measure and to control for, like motivation, kindness, locus of control, norms, and values, and so forth. In other words, the within-farmer (fixed-effects) estimator removes all farmer-level heterogeneity.

$$y_{f,d} - \frac{1}{D}\sum_d y_{f,d} = \beta\left(g_{f,d} - \frac{1}{D}\sum_d g_{fd}\right) + \left(\varepsilon_{f,d} - \frac{1}{D}\sum_d \varepsilon_{f,d}\right) \tag{6}$$

$$y_{f,d} - \overline{y}_f = \gamma\left(g_{f,d} - \overline{g}_f\right) + \varepsilon_{f,d} \tag{7}$$

Finally, we also run a fixed-effects model that, in addition to controlling for farmer heterogeneity, also controls for dealer-level observable characteristics. We do so by again including additional regressors (x_d) in equation (7), which leads to:

$$y_{f,d} - \overline{y}_f = \gamma\left(g_{f,d} - \overline{g}_f\right) + \varphi\left(x_{f,d} - \overline{x}_f\right) + \varepsilon_{f,d} \tag{8}$$

5 Results

5.1 Between-dealers models

Tables 5 and 6 report perceived differences between male- and female-managed agro-input shops using an OLS regression based on equation (4). The difference between the two tables is that in the first table, farmers rate dealerships on a set of general characteristics like location and pricing, while in the second table, they rate maize seed, a particular product that these dealers sell, on various dimensions like germination and yield.

Looking at general dealership ratings in Table 5, we find that on all but one dimension, male-managed agro-input shops are rated higher than female-managed shops, and that the difference in ratings is significant for five out of the seven comparisons. We find a particularly large difference when farmers are asked to rate price competitiveness. Here, female-managed agro-input shops are scored only 3.24 out of 5, while male-managed agro-input shops receive a score of 3.44 out of 5. While these effects may seem small, it should be noted that ratings generally lie within a small range (of approximately 2.5 to 4). Thus, even a small coefficient estimate may reflect a considerable bias. Similar differences exist when farmers are asked to rate an agro-input dealer in terms of stock. Here, male-managed

[7]Deciding which control variables to include is not always straightforward, especially for seed quality, which is difficult to verify objectively (which is why farmers are likely to rely on perceptions and potential gender differences in perceptions of agro-input shop managers are particularly alarming). The decision on what controls to use is based on focus group discussions and expert interviews with different stakeholders (including extension staff, agronomists, seed inspectors, and so forth).

agro-input shops receive an average score of 3.99 out of 5, while female dealers get 3.79. Interestingly, female-managed agro-input shops are not rated significantly worse with regards to the quality of seed sold. They also appear to be equally rated with respect to location.

Table 6 repeats the between-dealers analysis but compares ratings for quality attributes of maize seed sold by these dealers. While we still find that on most characteristics, male-managed agro-input shops get a higher rating than female-managed shops, the differences are never significant. Note that these results are consistent with what was found in Table 5, where one of the few non-significant differences was related to perceived seed quality. This suggests that when farmers are asked to think about a particular product and the gender effect becomes less important.

Results of the between-dealers regressions with added control variables (see equation (5)) are presented in Table 7 for the more general ratings related to the dealership and in Table 8 for the more specific ratings related to seed quality. In all regressions, we add the age and education of the dealer as general control variables as they are considered proxies for quality, and additional controls depending on the attribute being rated.

In column (1) of Table 7, we investigate the overall dealer rating, an average of the other attributes. We find that, even after controlling for a range of observable indicators of overall quality in this regression, male-managed shops are rated significantly higher by farmers.

Column (2) of Table 7 corresponds to column (2) of Table 5, which compares general quality ratings given to male- versus female-managed agro-input shops. We include three relatively objectively observable proxies for general dealership quality. First, we asked enumerators to provide an overall cleanliness and professionality rating for the agro-input shop for which they collected data. Second, we construct an index that measures dealer effort and a range of services that dealers offer to clients. All indices were constructed by weighing each component by the inverse covariance matrix following Anderson (2008). In particular, this index accounts for whether an agro-input dealer 1) always explains how seed should be used (seed spacing, seed rate, complementary inputs); 2) always recommends complementary inputs such as fertilizers and chemicals; 3) provides extension or training on how to use seed of an improved variety to clients; 4) provides discounts to clients who buy large quantities of seed; 5) sells small quantities; 6) provides seed on credit; 7) has received a seed-related complaint from a customer; and 8) accepts mobile money as a payment modality. Descriptive statistics for the variables which constitute this effort and service index are shown in Table 2. Third, we asked enumerators to carefully observe and note down a range of capital-intensive seed handling and storage practices, which we also summarized in an index. In this index, we account for whether 1) the roof is leak-proof; 2) the roof is insulated to keep the heat out; 3) the walls are insulated to keep the heat out; 4) the area where seed is stored is properly ventilated; 5) any official certificates are on display in the shop (for example, inspection certificates, training certificates, registration with an association, and so forth). Also for these variables which constitute the capital-intensive practices index, descriptive statistics are shown in Table 2. We see that after controlling for these three groups of variables, the male premium on general quality ratings increases from 0.13 to 0.16. Note that the index of capital-intensive seed handling and storage practices observed by the enumerator is significant and has the expected sign, as input dealers who score better on this index also receive higher scores on general dealership quality.[8]

When farmers were asked to assess agro-input dealers in terms of their location, the average distance between dealers and their customers,[9] an indication of dealer centrality, provides an obvious candidate as a control variable

[8]However, caution should be taken when interpreting control variables, as they do not necessarily have a structural interpretation. For instance, it may be that the relationship between the control variable and the outcome variable is confounded by a third (potentially unobservable) variable (Hünermund and Louw, 2020).

[9]The haversine formula calculating the arc distance between two points is used. The latitudes and longitudes are extracted from the GPS coordinates for both farmers and agro-input shops and inserted as paired values in the haversine formula. The formula then calculates the distances between these paired latitudes and longitudes.

Table 5: Between-dealers model focusing on dealer ratings (control variables not included)

	Dependent variable: Average rating received by dealer						
	Average dealer rating	Dealer's general quality	Dealer's location	Dealer's price	Dealer's seed quality	Dealer's stock	Dealer's reputation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	3.711	3.676	3.914	3.101	3.771	3.744	4.058
	(0.049)	(0.062)	(0.088)	(0.072)	(0.069)	(0.081)	(0.066)
Dealer is male	0.083	0.119*	−0.072	0.207***	0.019	0.124	0.101
	(0.053)	(0.066)	(0.095)	(0.078)	(0.074)	(0.087)	(0.071)
Number of obs.	283	283	283	283	283	283	283

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the farmer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: The ratings by farmers given to dealers are averaged at the dealer level while also averaging across rating collection rounds. Max. 152 shops are included in this table as the gender of their manager did not change between rounds.

Table 6: Between-dealers model focusing on seed ratings (control variables not included)

	Dependent variable: Average rating received by dealer						
	Average seed rating	Seed's general quality	Seed's yield	Seed's drought tolerance	Seed's pest/disease tolerance	Seed's speed of maturing	Seed's germination
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	3.405	3.735	3.553	2.973	2.385	3.882	3.670
	(0.050)	(0.063)	(0.071)	(0.081)	(0.075)	(0.062)	(0.072)
Dealer is male	0.065	0.056	0.057	−0.037	0.044	−0.019	0.055
	(0.053)	(0.066)	(0.075)	(0.084)	(0.079)	(0.065)	(0.076)
Number of obs.	264	255	229	204	212	219	228

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the farmer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: The ratings by farmers given to dealers are averaged at the dealer level while also averaging across rating collection rounds. Max. 152 shops are included in this table as the gender of their manager did not change between rounds.

(column (3) in Table 7). We do not find a gender effect on ratings concerning location in Table 5, nor do we find a difference after controlling for centrality. It should also be noted that the control variable is significant in the expected direction, as dealers for whom the average distance between dealer and customer is larger (or centrality is lower) also are scored lower in terms of location.

In column (4) of Table 7, we look at price competitiveness. To account for the possibility that the difference in price ratings between male- and female-managed agro-input shops is driven by actual price differences, we control for the average price the dealer charges for improved maize seed varieties, as well as for the cost at which the dealer obtains seed, an important determinant of the price. The analysis confirms that there is a difference in perception of male and female dealers, and that this difference cannot be explained by actual price differences. The gender effect is larger than the one found without controlling for actual price differences in Table 5. Note again that one of the control variables is significant and suggests that dealers who charge higher prices also receive significantly lower price competitiveness ratings, as expected.

When investigating seed quality ratings in column (5) of Table 7, we control for another index, one that reflects *all* seed handling and storage practices observed by the enumerator. This index includes the five capital-intensive practices mentioned above, but also accounts for whether the agro-input dealer 1) destroys seed that has exceeded shelf-life; 2) stores seed in a dedicated area, away from other merchandise; 3) has no problem with rats, insects, or other infestations; 4) stores seed in ambient light conditions as recommended; 5) stores seed on pallets or shelves; and 6) does not store seed in open bags or containers. This index also includes the shop's overall cleanliness and professionality rating provided by the enumerator. Descriptive statistics for the variables which constitute this (capital- and labor-intensive) practices index can be found in Table 2. As in column (5) of Table 5, we do not find a gender effect regarding the seed quality rating after controlling for observable quality indicators.

In column (6), we repeat the analysis for perceptions related to a dealers' stock, now controlling for the number of hybrid maize varieties that this dealer has in stock and the quantity bought by the dealer from seed producers or wholesalers, the former being significant and having the expected sign. The male premium on the rating persists, although the effect becomes slightly weaker as compared to a regression without controls (column (6) in Table 5).

The analysis regarding the reputation rating is repeated in column (7), now controlling for the number of years the shop has been in business, and whether the shop is registered with the Uganda National Agro-input Dealer Association (UNADA), as we expect both to have an impact on a dealer's reputation. Here we also see that male dealers receive higher scores, but that the effect is slightly weaker after controlling for experience and UNADA registration (as compared to column (7) in Table 5).

Table 8 repeats the between-dealers analysis for quality attributes of maize seed sold by the agro-input shops as reported in Table 6, but controls for practices that are expected to improve seed quality. As all ratings in this table concern quality, we include the same controls in all regressions. We use the most elaborate index of all seed handling and storage practices as observed by the enumerator that was also used in model (5) of Table 7. Recall from Table 6 that we did not find a gender effect for any seed-quality-related dimension, and adding the index to control for quality does not change this. Note that the index is generally positively correlated with the ratings, but only significantly so when farmers are asked to assess the yield of seed that agro-input shops sell.

Overall, comparing Table 7 to Table 5 and Table 8 to Table 6, we notice that results, both in terms of parameter estimates for β and their significance, are very similar. This suggests that differences in ratings between male- and female-managed agro-input shops reflect differences in perception of the two genders, rather than actual differences in the dimension being rated (general quality, price competitiveness, stock, and reputation).

Table 7: Between-dealers model focusing on dealer ratings (control variables included)

	Dependent variable: Average rating received by dealer						
	Average dealer rating	Dealer's general quality	Dealer's location	Dealer's price	Dealer's seed quality	Dealer's stock	Dealer's reputation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	3.689	3.797	3.921	3.082	3.737	3.531	3.948
	(0.109)	(0.176)	(0.148)	(0.130)	(0.132)	(0.160)	(0.122)
Dealer is male	0.059	0.109	−0.037	0.180**	−0.014	0.079	0.099
	(0.058)	(0.070)	(0.090)	(0.079)	(0.080)	(0.089)	(0.072)
Dealer's age in years	−0.001	−0.002	−0.001	0.000	0.000	0.002	0.002
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)
Dealer finished secondary education	0.119**	0.129*	0.014	0.104	0.124	0.096	0.061
	(0.059)	(0.069)	(0.090)	(0.078)	(0.078)	(0.088)	(0.071)
Shop's cleanliness/professionality rating by enumerator		−0.030					
		(0.034)					
Index of dealer's efforts and services	0.158**	0.127					
	(0.078)	(0.090)					
Index of capital-intensive seed handling/storage practices observed by enumerator		0.164***					
		(0.063)					
Standardized distance between farmer and shop	−0.069**		−0.277***				
	(0.031)		(0.043)				
Standardized sales price of maize seed	−0.065*			−0.129***			
	(0.036)			(0.048)			
Standardized cost of maize seed for dealer	0.054			0.043			
	(0.038)			(0.051)			
Index of all seed handling/storage practices observed by enumerator	−0.049				−0.049		
	(0.075)				(0.097)		
Number of hybrid maize varieties in stock	−0.009					0.062**	
	(0.022)					(0.030)	
Standardized amount of maize seed dealer bought	−0.004					0.032	
	(0.020)					(0.031)	
Number of years since shop's establishment	−0.004						−0.003
	(0.005)						(0.006)
Shop's UNADA registration	0.104						0.142*
	(0.068)						(0.074)
Number of obs.	230	253	283	269	261	273	283

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the farmer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: The ratings by farmers given to dealers are averaged at the dealer level while also averaging across rating collection rounds. Max. 152 shops are included in this table as the gender of their manager did not change between rounds.

Table 8: Between-dealers model focusing on seed ratings (control variables included)

	Dependent variable: Average rating received by dealer						
	Average seed rating	Seed's general quality	Seed's yield	Seed's drought tolerance	Seed's pest/disease tolerance	Seed's speed of maturing	Seed's germination
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	3.436	3.718	3.665	3.052	2.378	3.822	3.710
	(0.094)	(0.117)	(0.136)	(0.151)	(0.142)	(0.118)	(0.133)
Dealer is male	0.043	0.035	0.039	−0.055	0.012	−0.032	0.015
	(0.057)	(0.070)	(0.079)	(0.089)	(0.083)	(0.070)	(0.081)
Dealer's age in years	−0.001	0.000	−0.004	−0.003	−0.002	0.002	−0.002
	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Dealer finished secondary	0.037	0.060	0.084	0.082	0.189^{**}	0.006	0.160^{**}
education	(0.056)	(0.069)	(0.080)	(0.089)	(0.083)	(0.069)	(0.080)
Index of all seed	0.051	0.103	0.103	0.057	−0.058	0.127	−0.033
handling/storage practices	(0.070)	(0.086)	(0.099)	(0.112)	(0.104)	(0.089)	(0.102)
observed by enumerator							
Number of obs.	242	234	210	187	192	198	207

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the farmer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: The ratings by farmers given to dealers are averaged at the dealer level while also averaging across rating collection rounds. Max. 152 shops are included in this table as the gender of their manager did not change between rounds.

5.2 Farmer fixed-effects models

In order to test whether the male bias persists after accounting for farmer-level heterogeneity, we exploit the fact that farmers generally rated more than one agro-input dealer. If the same farmer rates both male and female-managed agro-input shops, we can exploit this within-farmer variation and control for farmer specific observable and unobservable characteristics by including farmer fixed-effects.

Tables 9 and 10 show parameter estimates using a model that includes farmer fixed-effects, i.e., the within transformation of equation (6). As errors are also correlated within agro-input dealers, we report standard errors that are robust to clustering in this dimension. In Table 9, we use the general agro-input dealer ratings as outcome variables, similar to Table 5; Table 10 estimates the same model, but now for the more specific seed-quality-related ratings, similar to Table 6. In the previous subsection, the dependent variable was the *average* rating received by dealers, leading to a sample size of about 150 with one observation per rated dealer. In the following farmer fixed-effects analyses however, the dependent variable is the rating of a particular farmer given to a particular dealer. The number of observations now represents the total number of ratings given by all farmers to all dealers with one observation per farmer-dealer combination, leading to a much larger sample size.

Table 9 shows that male-managed agro-input outlets receive significantly higher ratings in the areas of general quality, price competitiveness, and reputation. The average dealer rating also significantly differs between male and female dealers. Comparing Table 9 to Table 5, the largest difference can still be found for price competitiveness, even though the magnitude of the effect decreased somewhat. The effect of gender on ratings related to stocks reduced sharply after controlling for farmer-level heterogeneity.

For seed-quality-specific ratings, comparing Table 10 to Table 6, we see that some of the differences between ratings of male and female dealers turn significant after controlling for farmer-level heterogeneity. For perceptions related to seed germination, male-managed agro-input shops receive a score that is on average 0.11 higher than the germination rating female-managed shops receive. The gender bias in this dimension is also reflected in a significant difference in the average seed rating between male- and female-managed agro-input shops in column (1).

The fact that we do find gender bias when farmers are asked to assess seed quality if we control for farmer fixed-effects suggests that, in the between-dealers regressions of Tables 6 and 8, gender bias is obscured by farmer-level confounders. For instance, it could be that farmers that are higher educated also provide higher ratings and that these higher-educated farmers are also more likely to shop at female-managed dealerships. Not controlling for differences in education levels of farmers may then lead to an underestimation of discrimination against female-managed agro-input shops.

Finally, we run a fixed-effects model that, in addition to controlling for farmer heterogeneity, also controls for dealer-level observable characteristics (see equation (8)), similar to Tables 7 and 8. Table 11 presents the more general agro-input dealer ratings, and Table 12 presents the more specific seed ratings. We find that controlling for observable characteristics at the dealer level does not change the findings for the first set of ratings, which evaluate the dealership. The largest gender effects are found when farmers rate price competitiveness in column (4) and agro-input dealer reputation in column (7). In both cases, male-managed agro-input shops are rated about 0.22 points higher. The difference in ratings between male- and female-managed agro-input shops for the stock attribute has become indistinguishable from zero.

Finally, comparing Tables 10 and 12, the significant difference between male- and female-managed agro-input shops with respect to the average seed rating persists after controlling for observable dealer-level differences in seed quality. The difference in germination ratings in column (7) becomes insignificant but we now find a significant male premium for the general seed quality ratings in column (2).

Table 9: Farmer fixed-effects model focusing on dealer ratings (control variables not included)

	Dependent variable: Rating of a particular farmer given to a particular dealer						
	Average dealer rating	Dealer's general quality	Dealer's location	Dealer's price	Dealer's seed quality	Dealer's stock	Dealer's reputation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dealer is male	0.113^{***}	0.171^{**}	0.024	0.183^{***}	0.045	0.077	0.180^{***}
	(0.040)	(0.070)	(0.067)	(0.066)	(0.060)	(0.070)	(0.067)
Number of obs.	1781	1781	1781	1781	1781	1781	1781

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the dealer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: We first stack all ratings by farmers given to dealers of both rounds of collection, then exclude ratings of shops if the gender of their manager changed between rounds. E.g., for Dealer's location, we collected 837 ratings in the first round and 944 in the second round, leading to 1,781 observations included in this table, conveying the dyadic nature of the dataset.

Table 10: Farmer fixed-effects model focusing on seed ratings (control variables not included)

	Dependent variable: Rating of a particular farmer given to a particular dealer						
	Average seed rating	Seed's general quality	Seed's yield	Seed's drought tolerance	Seed's pest/disease tolerance	Seed's speed of maturing	Seed's germination
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dealer is male	0.071*	0.070	0.044	0.055	0.034	0.080	0.106*
	(0.038)	(0.053)	(0.060)	(0.059)	(0.063)	(0.055)	(0.056)
Number of obs.	1760	1748	1721	1678	1692	1699	1714

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the dealer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: We first stack all ratings by farmers given to dealers of both rounds of collection, then exclude ratings of shops if the gender of their manager changed between rounds. E.g., for Seed's yield, we collected 797 ratings in the first round and 924 in the second round, leading to 1,721 observations included in this table, conveying the dyadic nature of the dataset.

Table 11: Farmer fixed-effects model focusing on dealer ratings (control variables included)

	Dependent variable: Rating of a particular farmer given to a particular dealer						
	Average dealer rating	Dealer's general quality	Dealer's location	Dealer's price	Dealer's seed quality	Dealer's stock	Dealer's reputation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dealer is male	0.150***	0.180**	0.010	0.208***	0.001	0.077	0.217***
	(0.047)	(0.081)	(0.070)	(0.071)	(0.067)	(0.072)	(0.069)
Dealer's age in years	0.004**	0.002	0.001	0.003	0.005*	0.007***	0.000
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Dealer finished secondary education	0.009	0.080	0.047	−0.015	0.037	−0.057	−0.106*
	(0.042)	(0.063)	(0.064)	(0.062)	(0.062)	(0.059)	(0.055)
Shop's cleanliness/professionality rating by enumerator		−0.016					
		(0.029)					
Index of dealer's efforts and services	0.116**	0.095					
	(0.052)	(0.077)					
Index of capital-intensive seed handling/storage practices observed by enumerator		0.043					
		(0.059)					
Standardized distance between farmer and shop	−0.064**		0.016				
	(0.028)		(0.048)				
Standardized sales price of maize seed	−0.056**			−0.047			
	(0.027)			(0.041)			
Standardized cost of maize seed for dealer	0.084***			0.035			
	(0.028)			(0.041)			
Index of all seed handling/storage practices observed by enumerator	−0.073				−0.017		
	(0.047)				(0.076)		
Number of hybrid maize varieties in stock	−0.007					0.009	
	(0.016)					(0.025)	
Standardized amount of maize seed dealer bought	−0.010					0.000	
	(0.016)					(0.022)	
Number of years since shop's establishment	0.003						0.017***
	(0.003)						(0.005)
Shop's UNADA registration	−0.060						−0.030
	(0.048)						(0.055)
Number of obs.	1374	1496	1706	1649	1541	1674	1706

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the dealer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: We first stack all ratings by farmers given to dealers of both rounds of collection, then exclude ratings of shops if the gender of their manager changed between rounds. E.g., for Dealer's location, we collected 837 ratings in the first round and 944 in the second round, but for 75 observations control variables were missing, leading to 1,706 observations being included in this table.

Table 12: Farmer fixed-effects model focusing on seed ratings (control variables included)

	Dependent variable: Rating of a particular farmer given to a particular dealer						
	Average seed rating	Seed's general quality	Seed's yield	Seed's drought tolerance	Seed's pest/disease tolerance	Seed's speed of maturing	Seed's germination
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dealer is male	0.074*	0.089	0.086	0.022	0.036	0.075	0.086
	(0.041)	(0.059)	(0.064)	(0.062)	(0.070)	(0.058)	(0.062)
Dealer's age in years	0.000	0.004*	0.001	−0.001	0.000	−0.001	0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Dealer finished secondary	−0.035	−0.053	−0.035	0.040	0.070	−0.122***	−0.032
education	(0.035)	(0.048)	(0.055)	(0.054)	(0.057)	(0.047)	(0.052)
Index of all seed	0.110***	0.126**	0.177***	0.095	0.104*	0.091	0.048
handling/storage practices	(0.042)	(0.061)	(0.068)	(0.060)	(0.061)	(0.055)	(0.060)
observed by enumerator							
Number of obs.	1520	1509	1485	1447	1460	1467	1480

Note: The gender of the dealer is a dummy variable where 1 is male and 0 is female.
***, **, and * denote significance at the 1, 5 and 10% levels.
Standard errors are clustered at the dealer level and presented in parentheses, and a time dummy was included in all specifications.
Number of observations: We first stack all ratings by farmers given to dealers of both rounds of collection, then exclude ratings of shops if the gender of their manager changed between rounds. E.g., for Seed's yield, we collected 797 ratings in the first round and 924 in the second round, but for 236 observations control variables were missing, leading to 1,485 observations being included in this table.

6 Conclusion and policy implications

Using survey data from smallholder maize farmers and agro-input dealers in southeastern Uganda, we test if farmers perceive female-managed shops differently than male-managed shops. To do so, we asked farmers to rate agro-input dealers in their neighborhood on a scale ranging from one (poor) to five (excellent). Farmers rated dealers on a set of general characteristics such as accessibility and price competitiveness. They also rated maize seed, a particular product that these dealers sell, on various dimensions like germination, yield, and so forth.

Simply comparing average ratings given to male- and female-managed agro-input shops, we find that shops managed by women are generally rated lower than their male-managed competitors. However, when farmers were asked to focus on a specific product, the difference was insignificant. After adding controls for agro-input dealer-level observable characteristics, parameter estimates and significance remain similar, suggesting that differences in ratings between male- and female-managed agro-input shops reflect differences in perceptions rather than actual differences in the attributes being rated.

Furthermore, ratings of agro-input dealers provided by farmers may also be influenced by farmer characteristics. To control for farmer heterogeneity, we exploit the fact that farmers often rated several agro-input dealers of different genders and ran farmer fixed-effects models. Doing so, we confirm the existence of gender bias when farmers were asked to rate general characteristics of agro-input dealers, but also find differences in ratings of different dimensions of seed quality sold by dealers of different genders.

Looking into the individual dimensions that were rated, we find particularly strong gender bias when farmers rated agro-input dealers in terms of price competitiveness. Furthermore, and especially after controlling for farmer-level heterogeneity, we find that male-managed agro-input shops have a significantly better reputation than female-managed shops. This contrast in reputation is also reflected in a significant difference between male and female dealers in the general quality rating. On the other hand, we do not find that male- and female-managed agro-input shops were rated differently when farmers were asked to consider location. This may be because location is easier to assess objectively. For attributes related to the quality of seed sold by agro-input dealers, gender bias was only persistently found for the average seed rating after controlling for farmer-level heterogeneity.

Despite this gender bias favoring men, 40 percent of Ugandan agro-input shops are managed by women, raising the question how this surprisingly large share of female dealers remains in the market. We see that they are on average younger, less educated, and less trained than their male competitors, and that their shops have been established more recently, but perhaps these women have another competitive advantage at their disposal that attracts at least some customers. It cannot be better prices as we saw that farmers discriminate most on this dimension. Seeing that location is the only general dealership characteristic for which female-managed shops receive better ratings than male-managed shops (see Table 5), we investigate whether these shops are located better. However, apparently these shops are further away from roads and customers, implying that location is not the competitive advantage that keeps female dealers in the market. It is however possible that there is less competition in these more remote areas, which could explain why even discriminated dealers are not driven out of the market. Alternatively, shops managed by women may provide better products than their male competitors. We see for example that female-managed shops are more likely to be specialized stores that only sell farm inputs and that they are cleaner, according to enumerators. These shops also have better roofing, walls, and ventilation, and are more likely to store seed on pallets or shelves, instead of in open containers. All this could lead to woman selling better seed, as Barriga and Fiala (2020) document how handling and storage practices affect seed quality. Open air storage of bags can lower the quality of seeds (Bold et al., 2017), temperature control after the seed leaves the breeders is crucial (Barriga and Fiala, 2020), and storage in moist conditions or in direct sunlight further reduces seed quality (Govender, Aveling, and Kritzinger, 2008; Curzi, Nota, and Di Falco, 2022). In line with this, we see that shops managed by women receive less seed-related complaints from customers and appear more professional: on average, they are more likely to display official certificates, to be registered with UNADA, and to have a trading license from the local government. If customers realize that these female dealers sell better seed, this will result in a comparative advantage and explain why 40 percent of Ugandan agro-input shops are managed by women, even though perceptions are stacked against them. An alternative but complementary explanation is that many women simply have no other opportunity to earn money. While men may compare their earnings through agro-input dealing with a lucrative outside option, women may have to compare it with earning nothing. This would explain why they do not leave the market, even though they earn significantly less than their male competitors, pointing to a more structural bias in the economy.

Finding that farmers are discriminating against shops managed by women is troubling for a variety of reasons. Their biased perceptions can influence real purchase decisions which may have long-run implications for agro-input shops. Table 1 indicates that an average female-managed agro-input shop in our sample receives only about 36 customers per day while an average male-managed agro-input shop receives about 51 customers per day. The amount of maize seed sold and the revenue from these sales earned by an average female-managed shop are also lower than the amount sold and revenue of an average male-managed agro-input shop. Farmers' biased perceptions can be particularly damaging in traditional agricultural societies with strong norms and customs. In these societies, women's opportunities are already severely restricted, and gender bias may further restrain women from entering productive activities. This will in turn reinforce gender stereotypes and the view that women are less able to perform particular tasks.

However, gender bias does not only directly impact women's capabilities, aspirations, and their empowerment in agri-food systems (Jayachandran, 2021). It is also likely to affect future generations, as women tend to invest more of their income than men in healthcare, nutrition, and education of their children (Thomas, 1990). But there are consequences that go beyond the household. Almost half of the agro-input shops in our sample are managed by women. If farmers do not trust these shops, this may pose challenges for varietal turnover at more aggregate levels: in a village where only women manage shops, farmers may be less likely to buy commercial seed from the market, and instead use farmer-saved seed obtained through informal channels, hindering agricultural productivity and rural transformation.

Our finding has important implications. It underscores the importance of customs and norms in rural and more traditional societies. Interventions and initiatives that focus solely on increasing women's empowerment are unlikely to be sufficient and may in some cases even backfire (Ntakyo and Van Den Berg, 2022). It will be important to challenge gender stereotypes and role congruence and such interventions should not focus on only one gender.

Our study serves to draw specific lessons for policy. Over the years, policymakers have encouraged women to enter business domains which were traditionally dominated by men, with women striving towards new opportunities and ways to earn for their livelihoods or families. However, our findings show the need for policies addressing the lack of acceptance or integration that still prevails. If these biased perceptions cannot be corrected, we may see a withdrawal of many women from these sub-sectors in the future as they become increasingly aware about the difficulties and the higher likelihood of restricted growth. We restrict ourselves to three areas where we see scope for policy action.

First, even though we do not find evidence of male-managed agro-input shops actually providing better quality than female-managed shops, existing training and advisory services for agro-input dealers are also likely to be biased toward men, and this may indirectly influence perceptions related to the abilities of female managers (Catherine Ragasa and Taffesse, 2013). Ensuring that women entrepreneurs have access to training should be a policy priority. The effectiveness and inclusiveness of training programs depend on many attributes of the program. This includes more obvious aspects such as the training content and who is targeted, but also less obvious attributes such as the gender of who provides the training, the timing of training, and so forth (Lecoutere, Spielman, and Van Campenhout, 2023). At the same time, it is also important to change the perception that female-managed agro-input shops are likely to receive less training. This could be achieved by making training attendance publicly visible, perhaps through a register of trained agro-input dealers, through certificates that are displayed in the shops, and so forth, such that equal capacity between male- and female-managed agro-input shops becomes more apparent to clients.

Second, female role models have been shown effective in increasing female participation in a variety of otherwise male-dominated sectors (Porter and Serra, 2020; Riley, 2022). Considering this, perceptions may evolve in line with the presence of women among agro-input dealers, inspectors, extension providers, and leaders of professional associations such as UNADA. This will not only motivate more women to enter the market but also bring forth wider acceptance across the value chain and in agricultural markets. For public sector positions, quotas may be considered, since research suggests that they can be an effective way to challenge gender stereotypes held by men (Beaman et al., 2009).

Finally, we find that biased perceptions exist especially with respect to prices charged by female agro-input dealers. Simply advertising prices may be sufficient to make them objectively verifiable, and customers will need to depend less on perceptions and the use of mental shortcuts that are prone to gender bias.

Our research also has implications for integrated seed system development. As the bias we uncover is partly related to the formal nature of the maize value chain—with increasing engagement in input and output markets disadvantaging women—more informal seed systems may provide more scope for equitable development. Seed for food crops in which the private sector is less interested, such as sweet potato or beans, are often perceived as more in the female domain than crops that are also grown for cash. Furthermore, alternative forms of certification which are less stringent than existing regulatory frameworks, such as quality declared seed, may also provide more room for women (Mastenbroek, Otim, and Ntare, 2021). In sum, to increase food and nutrition security, we agree with Puskur et al. (2021) on the importance of applying gender analysis to improve seed systems and reduce/overcome existing biases.

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