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

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Abstract

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 wide variety of settings and may be an important reason why some sectors remain dominated by men and gender gaps persist. Using 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. After explicitly controlling for quality differences between male- and female-managed agro-input shops and including fixed-effects to account for farmer-level heterogeneity, 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. Our results show that gender bias in customer perceptions persists and continues to be a severe comparative disadvantage and an important entry barrier for female agro-input dealers, and we conclude that policies and interventions designed to challenge gender norms and customs are needed to correct this bias.

keywords: gender bias, agro-input dealer, perceptions, maize, Uganda

1 Introduction

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

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Agricultural inputs such as inorganic fertilizers or improved seed varieties, which are high yielding cultivars like open-pollinated and hybrid maize varieties, lie somewhere on the continuum between experience goods and credence goods. When farmers inspect goods at the agro-input shop, the quality can only be assessed superficially from readily observable characteristics such as homogeneity of the seed or by checking if the fertilizer package is intact. Even after the commodity has been used and yields can be observed, it may still be difficult for the farmer to learn about the quality of the input, as many other factors in addition to the input affect yield. As such, when farmers decide to acquire agricultural inputs or not, perceptions and emotions often take the upper hand.

In addition to the difficulty of judging quality of agricultural inputs, several studies note that there is considerable heterogeneity in the actual quality of inputs on the market. For instance, in Uganda, Bold et al. (2017) tested agricultural inputs purchased in local markets and found that 30 percent of nutrient is missing in fertilizer, and hybrid maize seed is estimated to contain less than 50 percent authentic seeds. Also in Uganda, Ashour et al. (2019) tested herbicides and found that the average bottle in their sample was 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 due to 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 one of the few options open to women to earn some money independently from their husband. 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 produce 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 is operated and/or managed by women.

However, the same gender norms and customs may also mean that perceptions are 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 assumed to take care of the household food supply (Orr et al., 2016; Dolan, 2001). A case in point is the recent study by Ntakyo and Van Den Berg (2022) which further confirms this traditional stance in the context of smallholder production in Uganda where a significant negative impact of a commercialization program was prominent on women empowerment in crop production and their control over income, clearly showing a power shift to men in rural households of Uganda. As a result, 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 1 to 5, on a range of characteristics. We then make 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 highest when farmers are asked to rate the agro-input dealership in terms of price competitiveness and in terms of reputation. We also find that seed from male-managed agro-input shops is rated higher than seed from shops managed by women. As the differences in ratings persist after explicitly controlling for the quality of the dealerships or 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.

In the remainder of this article, we first situate the research question in the wider literature. We then provide the context for 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 in this study. Next, we lay out the empirical strategy, followed by the results. A final section concludes and offers some policy guidance.

2 Research question and relation to the literature

We aim to test if gender equity bias—behavior that shows favoritism toward one gender over another—is present in the way smallholder maize farmers in southeastern Uganda perceive agro-input dealers in their neighborhood. Gender equity 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.

One area where gender equity 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 between the two. They find that editors largely follow the referees, resulting in

[1] The paper builds on earlier exploratory work published in Van Campenhout and De (2022) 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.

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 (NBER) conferences; Hospido and Sanz (2021) do find a significant advantage for male authors being accepted at three different European conferences. Gender equity 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 regarding male professors is significantly different than their language used in 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 equity bias is studied most in the context of peer review processes such as those mentioned above. However, the same perceptions surface when individuals decide on who to engage with, be it who to work with, who to elect as leaders, or who to consult. Labor markets and hiring decisions involve situations where managers 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 equity bias is also often 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 equity bias in performance appraisals, where (often male) managers' beliefs creep into their evaluations of workers (Correll et al., 2020).

Gender equity bias is also pervasive in politics. Pair et al. (2021) use Natural Language Processing (NLP) 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 earnings gaps. Klein, Shtudiner, and Zwilling (2021) find that a financial adviser's gender is one of the most important factors influencing a customer's choice of investment adviser. Female advisers' gender was found to have a negative effect on the desire to invest, and this negative attitude was found to be significantly higher among male respondents.

Gender bias features so prominently in areas such as scholarly peer review, teaching assessments, or labor markets 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.

Such misperception 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 in turn will reinforce gender stereotypes and the view that women are less able to perform particular tasks. It is therefore important to be aware of gender bias in this context, and to design policies to increase participation of women in sectors that are affected by this bias.

3 Context and data

3.1 Study context

Our study was carried out in Uganda. As in many traditional agricultural societies, women's roles in Uganda are largely domestic, including housekeeping, child rearing, fetching water, cooking, and tending to community needs. Strong gendered norms and stereotypes about the different capabilities of women and men means that women shy away from many economic activities such as cash cropping or post-harvest processing. Women do tend to participate to some extent in economic life through marketing as owners of small shops or vendors during market days. While the government already 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 in government, norms and customs still prevent women from participating in economic life in most of the rural areas in Uganda.

3.2 Sample

Our study area comprises 11 districts in southeastern Uganda, which 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 348 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, street or right next to each other, they are assigned to the same catchment area. This is done based on geographical location. Using GPS coordinates of the input dealers, the haversine function is used to construct an adjacency matrix, and shops that are less than 5 kilometers apart are assigned to the same catchment area. The 5-kilometer threshold was selected based on visual inspection of the map, the size of an average village and reported distance between farmers and dealers. The 348 agro-input dealers in Busoga were assigned to 130 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 1 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/her customers come from.[2] Enumerators were sent to these villages and instructed to randomly sample ten households that grow maize. Consequently, we sampled about 3500 smallholder maize farmers and collected information about their characteristics in April 2021.

It is important to note that only farmers in half of the catchment areas rated dealers.[3] This means that 1931 farmers rated 193 dealers in April 2021. To have enough ratings, a second round was collected in January and February 2022. While these ratings were provided by the same farmers, only 1893 of them were found during the second wave. These two rounds of surveys constitute the key sources of data for the study.

3.3 Descriptive statistics

Table 1 describes the average agro-input dealer included in our study. There is substantial heterogeneity across shops. Some are small informal shops located in rural areas, that 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. About 60 percent of agro-input shop managers are male. The average shop has been in operation for about five years and serves about 40 customers a day, half of whom come to buy maize seed. A shop stocks on average three maize seed varieties. More statistics describing seed handling and storage practices, efforts, and services of agro-input dealers, are presented in the appendix in Table 12.

Table 2 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 improved maize seed on at least one plot in the season preceding the survey, and of the farmers that used improved seed, two-thirds obtained this seed from an agro-input shop. However, fertilizer use is very low. As a result, productivity is also low, with the average farmer harvesting only about 500 kg of maize per acre. Almost 70 percent of farmers are of the opinion that maize seed sold at agro-input shops is counterfeit.

[2] If this village was already named by another dealer, the village with the second most customers was chosen.

[3] These ratings are part of the intervention of a different study, where a computer algorithm allocated the rating treatment randomly at the level of the catchment area.

Table 1: Descriptive agro-input dealer statistics

	mean	min	max	SD	nobs
Dealer's age in years	31.46	15	59	10.02	193
Dealer is male	0.591	0	1	0.493	193
Dealer finished secondary education	0.388	0	1	0.489	188
Dealer owns shop	0.565	0	1	0.497	193
Dealer received training on maize seed handling/storage	0.580	0	1	0.495	193
Shop's distance to nearest tarmac road in km	5.850	0	40	9.20	192
Distance between farmer and shop in km	5.214	0.19	12.561	3.21	193
Shop only sells farm inputs	0.751	0	1	0.433	193
Number of customers per day	44.55	2	300	48.34	192
Number of customers per day buying maize seed	23.01	0	250	28.25	192
Number of years since shop's establishment	5.430	0	33	6.106	193
Number of maize varieties in stock	3.057	0	10	1.948	193
Number of hybrid maize varieties in stock	1.803	0	8	1.476	193
Number of OPV maize varieties in stock	1.301	0	5	0.717	193
Sales price of maize seed (UGX/kg)	4353.674	2500	12000	1291.825	186
Cost of maize seed for dealer (UGX/kg)	3522.765	2000	8500	959.380	179
Amount of maize seed dealer bought (in kg)	969.978	0	52500	4683.849	184
Shop's cleanness/professionality rating by enumerator	3.503	1	5	1.142	193
Shop received seed-related complaint from customer	0.674	0	1	0.470	193
Shop is registered with UNADA	0.489	0	1	0.501	182
Shop has trading license from local government	0.789	0	1	0.409	190

Note: "Distance between farmer and shop in km" 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 farmer statistics

	mean	min	max	SD	nobs
Homestead's distance to nearest tarmac road in km	8.850	0	100	9.39	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	3.826	0	52	4.894	1858
Farmer's age in years	48.51	20	97	13.34	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	22.85	0	82	13.00	1931
Farmer is member of (maize) farmer group/association/cooperative	0.132	0	1	0.338	1927
Farmer's land for crop production in acres	3.350	0.25	80	3.980	1915
Yield in kg/acre	504.1	0	28000	842.5	1921
Farmer used improved maize seed (OPV/hybrid) for any field last season	0.499	0	1	0.500	1929
Farmer bought maize seed at agro-input shop (if he/she used improved seed)	0.671	0	1	0.470	932
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 field	0.666	0	1	0.472	1931

Note: "Homestead's distance to nearest agro-input shop in km" is the distance reported by the farmer. Respondents could only report one answer for the nearest agro-input shop.

3.4 Measuring perceptions

Quantifying perceptions of the quality of services provided by agro-input dealers and of the products they sell—improved maize seed varieties in particular—is central to our analysis. To do so, we asked farmers to rate agro-input dealers in their catchment area on a range of attributes. We broadly categorized the attributes into two families of indicators. 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. Note that as agro-input dealers are often clustered in towns and trading centers, farmers often rate several agro-input dealers.

To measure the perceived quality of agro-input dealers, farmers were asked to rate these dealers on a scale of 1 to 5 (5 being the best and 1 being the worst) 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, which also includes the person who operates the shop.[4]

To measure the perceived quality of seed, farmers were asked to rate the improved maize varieties that dealers sell on a scale of 1 to 5 on their general quality, yield, drought tolerance, pest/disease tolerance, crop duration/maturation period, and germination reliability.[5] We also compute an average of these six seed-level ratings. Here, farmers were asked to rate seed, the product itself. 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.

We asked farmers to rate agro-input dealers twice, a first time in April 2021 and a second time in January 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 12 farmers, while one shop received ratings from almost 50 farmers. Table 3 provides descriptive statistics of the ratings used in our study. For example, when assessing the quality of maize seed sold by agro-input dealers in our sample, farmers rate its germination with 3.68 out of 5 on average. Farmers generally rate dimensions related to the dealership better than dimensions related to the product quality. For instance, the mean location rating is 3.81 out of 5.

[4]It may be that the shop is owned by one person, but the owner employs another person to manage the shop. If the gender of the shop manager is different from the gender of the owner, the question emerges who's 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.

[5]Some of these attributes are variety specific. For instance, some hybrid seeds may be particularly drought tolerant, while other seeds may be higher yielding. Therefore, we specifically asked farmers to rate varieties relative to what is advertised for these attributes.

Table 3: Descriptive agro-input dealer ratings

	mean	min	max	SD	1st quartile	3rd quartile	nobs
Dealer's maize seed rating on general quality by farmers	3.799	1	5	0.873	3	4	992
Dealer's maize seed rating on yield by farmers	3.562	1	5	0.921	3	4	972
Dealer's maize seed rating on drought tolerance by farmers	3.018	1	5	0.882	2	4	937
Dealer's maize seed rating on pest/disease tolerance by farmers	2.464	1	5	0.945	2	3	949
Dealer's maize seed rating on speed of maturing by farmers	3.833	1	5	0.738	4	4	952
Dealer's maize seed rating on germination by farmers	3.676	1	5	0.898	3	4	967
Dealer's rating on general quality by farmers	3.734	1	5	1.006	3	4	1022
Dealer's rating on location by farmers	3.811	1	5	1.232	3	5	1022
Dealer's rating on price competitiveness by farmers	3.255	1	5	1.183	3	4	1022
Dealer's rating on seed quality by farmers	3.797	1	5	1.074	3	5	1022
Dealer's rating on seed stock by farmers	3.910	1	5	1.093	3	5	1022
Dealer's rating on reputation by farmers	4.162	1	5	0.937	4	5	1022

Note: The descriptives convey the dyadic nature of the dataset.

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 1 (poor) to 5 (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.

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 a (potentially unobservable) characteristic of the farmer (for example a poor experience with an agro-input dealer in a previous year), which may affect the ratings received by all agro-input dealers rated by this farmer. 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 a (potentially unobservable) characteristic 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.

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

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 within-cluster error correlation generally leads to standard errors that are biased downward, leading to under-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 agro-input shops to average ratings received by female-managed agro-input 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), identification of the gender equity effect (β) relies on differences between agro-input dealers. As dealer gender is constant for all farmers that rate a 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 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 on average less educated than male agro-input shop managers, and less educated agro-input dealers are rated lower by farmers. In this case, differential ratings are not caused by gender, but rather driven by differences in education. We will control for a range of agro-input dealer-level potential confounders by including them as additional regressors (x_d) in equation (4):

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

As we are interested in explaining gender equity bias in perceptions in different dimensions, the set of control variables used will also differ. For example, when farmers are asked to rate agro-input dealers in terms of price competitiveness, it seems reasonable to include prices charged by 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, such as storage technology, infrastructure such as leak-proof roof or insulation, and so forth. In 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.

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, now imagine that better-educated farmers are more inclined to shop at male-managed agro-input dealerships. This makes it difficult to differentiate a gender equity effect from an effect arising from differences in education of the farmer. 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 will also run a fixed-effects model that, in addition to controlling for farmer heterogeneity through fixed-effects, also controls for dealer-level observable characteristics. We will again do this by 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 4 and 5 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 on the one hand, farmers rated dealerships on a set of general characteristics like location and pricing, and on the other hand, they rated maize seed, a particular product that these dealers sell, on various dimensions like germination and yield.

Looking at general dealerships ratings, called *dealer ratings* in the tables, we find that on all but one dimension, male-managed agro-input shops are rated higher than female-managed shops, and the difference in rating is significant for five out of the seven comparisons (at the 10 percent significance level), see table 4. A small but significant difference is found 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. Similar differences exist when farmers are asked to rate an agro-input dealer in terms of product availability. Here, male-managed agro-input shops receive an average score of almost 4 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 4: 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	3.764	3.738	3.89	3.237	3.878	3.792	4.051
	(0.05)	(0.06)	(0.086)	(0.071)	(0.064)	(0.077)	(0.064)
Dealer is male	0.109^{*}	0.129^{*}	-0.085	0.2^{**}	0.052	0.199^{**}	0.161^{**}
	(0.063)	(0.075)	(0.109)	(0.089)	(0.081)	(0.097)	(0.081)
Number of obs.	152	152	152	152	152	152	152

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the dealer is a dummy variable where 1 is male and 0 is female. The ratings received by the dealers are averaged at the dealer level. Standard errors are presented in ().

Table 5: 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	3.417	3.87	3.592	3.005	2.683	3.716	3.651
	(0.044)	(0.051)	(0.059)	(0.061)	(0.062)	(0.055)	(0.066)
Dealer is male	0.053	0.058	0.066	-0.03	0.011	0.081	0.104
	(0.056)	(0.064)	(0.075)	(0.077)	(0.078)	(0.068)	(0.083)
Number of obs.	152	152	152	150	152	151	152

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the dealer is a dummy variable where 1 is male and 0 is female. The ratings received by the dealers are averaged at the dealer level. Standard errors are presented in ().

Table 5 repeats the between-dealers analysis but compares ratings for quality attributes of maize seed sold by these dealers, called *seed ratings* in the tables. 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 4, where we also failed to find a significant difference when asking about seed quality. This suggests that when farmers are asked to think about a particular product, they make abstraction of the person selling it, and the gender effect becomes less important.

Results of between-dealers regressions with added control variables (see equation (5)) are presented in Table 6 for the more general ratings of characteristics related to the dealership and in Table 7 for ratings directly related to seed quality. In all regressions, we add the age and the 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 the first column of Table 6, we explain the overall dealer rating, an average of the other attributes. We find that, even after controlling for a range of observable indicators for overall quality differences in this regression, male-managed shops are rated significantly higher by farmers.

The second column of Table 6 corresponds to the second column of Table 4, which compares average general quality ratings given to male- versus female-managed agro-input shops. We have three relatively objective observable proxies for general dealership quality. First, we asked enumerators to provide an overall cleanness 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.[6] 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/training to clients on how to use improved seed varieties; 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 the appendix in Table 12. Third, we asked enumerators to carefully observe and note down a range of capital-intensive seed handling and storage practices, which were 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 association, and so forth). Also for these variables which constitute the capital-intensive practices index, descriptive statistics are shown in the appendix in Table 12. 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

[6] Indices were constructed by weighing each component by the inverse covariance matrix following Anderson (2008).

better on this index also receive higher scores on general dealership quality.[7]

When farmers were asked to assess agro-input dealers in terms of their location, the average distance between dealers and their customers,[8] capturing some indication of centrality of the dealer, provides an obvious candidate as a control variable (third column in Table 6). We do not find a gender equity effect on ratings concerning location in Table 4, nor do we find a difference after controlling for centrality. It should also be noted here that the control variable is significant in the expected direction, as dealers for whom the average distance between dealer and customer is higher (or centrality is lower) also are scored lower in terms of location.

In the fourth column of Table 6, we look at price competitiveness again. 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 between these shops, we control for the average price charged by the dealer, as well as for the cost at which the dealer obtains seed (which is 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 is not due to actual price differences. The gender equity effect is similar in size to the one found without controlling for actual price differences in Table 4. 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.

In the fifth column of Table 6, 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 open containers. This index also includes the shop's overall cleanness 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 the appendix in Table 12. As in column 5 of Table 4, we do not find a gender equity effect regarding the seed quality rating after controlling for observable quality indicators.

In the sixth column, 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 4).

[7]However, caution should be taken when interpreting control variables, as control variables 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).

[8]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. This formula then calculates the distances between these paired latitudes and longitudes in meters, following which we obtain the distances in kilometers and standardize the variable.

The analysis regarding reputation 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 4).

Table 7 repeats the between-dealers analysis for quality attributes of maize seed sold by the agro-input shops reported in Table 5, but controls for practices that are expected to improve seed quality. As all ratings in Table 5 concern quality, we include the same control 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 6. Recall from Table 5 that we did not find a gender equity effect for any seed-quality-related dimensions, and adding the index to control for quality does not change this. Note that the index is generally positively correlated with the rating, but only significantly so when farmers are asked to assess the seed's yield.

Overall, comparing Table 6 to Table 4 and Table 7 to Table 5, we notice that results, both in terms of parameter estimates for β and their significance, are very similar. This suggests that differences between male- and female-managed agro-input shops reflect structural differences in perception of the two genders, rather than actual differences in the dimension being rated (quality, price competitiveness, stock, and reputation).

Table 6: 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	3.79	3.77	3.939	3.326	3.822	3.647	3.921
	(0.134)	(0.227)	(0.185)	(0.169)	(0.15)	(0.204)	(0.156)
Dealer is male	0.157**	0.161**	−0.048	0.219**	0.057	0.183*	0.158*
	(0.063)	(0.071)	(0.1)	(0.091)	(0.081)	(0.097)	(0.082)
Dealer's age in years	−0.003	−0.003	−0.002	−0.003	−0.001	−0.001	0
	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
Dealer finished secondary education	0.11	0.144	−0.001	−0.01	0.198**	0.092	0.15
	(0.078)	(0.088)	(0.122)	(0.108)	(0.098)	(0.122)	(0.1)
Shop's cleanness/professionality rating by enumerator		−0.005					
		(0.047)					
Index of dealer's efforts and services	0.181*	0.152					
	(0.1)	(0.11)					
Index of capital-intensive seed handling/storage practices observed by enumerator		0.29***					
		(0.079)					
Standardized distance between farmer and shop	−0.089**		−0.302***				
	(0.04)		(0.051)				
Standardized sales price of maize seed	−0.098*			−0.176**			
	(0.052)			(0.074)			
Standardized cost of maize seed for dealer	0.057			0.085			
	(0.052)			(0.072)			
Index of all seed handling/storage practices observed by enumerator	0.093				0.184		
	(0.103)				(0.118)		
Number of hybrid maize varieties in stock	−0.02					0.07*	
	(0.03)					(0.038)	
Standardized amount of maize seed dealer bought	−0.013					0.062	
	(0.028)					(0.041)	
Number of years since shop's establishment	0						0.002
	(0.006)						(0.007)
Shop's UNADA registration	0.151						0.113
	(0.097)						(0.103)
Number of obs.	149	151	152	151	151	152	152

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the dealer is a dummy variable where 1 is male and 0 is female. The ratings received by the dealers are averaged at the dealer level. Standard errors are presented in ().

Table 7: 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	3.416	3.768	3.584	3.128	2.779	3.644	3.612
	(0.105)	(0.12)	(0.139)	(0.147)	(0.147)	(0.131)	(0.157)
Dealer is male	0.053	0.047	0.066	−0.019	0.023	0.075	0.104
	(0.057)	(0.065)	(0.075)	(0.079)	(0.079)	(0.07)	(0.085)
Dealer's age in years	−0.002	0.002	−0.001	−0.005	−0.005	0.002	−0.001
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Dealer finished secondary education	0.125^{*}	0.122	0.118	0.058	0.188^{*}	0.052	0.175^{*}
	(0.069)	(0.079)	(0.091)	(0.096)	(0.096)	(0.085)	(0.103)
Index of all seed handling/storage practices observed by enumerator	0.061	0.139	0.194^{*}	0.064	−0.089	0.083	−0.016
	(0.083)	(0.095)	(0.11)	(0.115)	(0.115)	(0.102)	(0.124)
Number of obs.	151	151	151	149	151	150	151

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the dealer is a dummy variable where 1 is male and 0 is female. The ratings received by the dealers are averaged at the dealer level. Standard errors are presented in ().

5.2 Farmer fixed-effects models

In order to clarify whether the bias persists after accounting for farmer-level heterogeneity, 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 characteristics by including farmer fixed-effects.

Tables 8 and 9 show parameters, estimated with a model that includes farmer fixed-effects (using the within transformation of equation (6)).[9] In Table 8, we use the general agro-input dealer ratings as outcome variables, similar to Table 4. Table 9 estimates the same model, but now for the more specific seed-quality-related ratings, similar to Table 5.

Table 8 shows that male-managed agro-input outlets receive significantly higher ratings in the areas of quality in general, price competitiveness, stock, and reputation. The average rating also shows a significant difference between male and female dealers. Comparing Table 8 to Table 4, 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.

[9] As errors are also correlated within agro-input dealers, we report standard errors that are robust to clustering in this dimension.

Table 8: 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	0.116^{***}	0.176^{***}	0.023	0.188^{***}	0.049	0.082^{*}	0.18^{***}
	(0.029)	(0.05)	(0.048)	(0.047)	(0.043)	(0.05)	(0.048)
Number of obs.	3562	3562	3562	3562	3562	3562	3562

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the input dealer is a dummy variable carrying the value of either 0 or 1. Fixed-effects or within estimation has been used at the farmer level. Cluster-robust SE are obtained by clustering at the dealer level (presented in ()).

Table 9: 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	0.073^{***}	0.075^{*}	0.047	0.053	0.041	0.079^{*}	0.11^{***}
	(0.027)	(0.038)	(0.043)	(0.042)	(0.044)	(0.039)	(0.04)
Number of obs.	3520	3496	3442	3356	3384	3398	3428

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the input dealer is a dummy variable carrying the value of either 0 or 1. Fixed-effects or within estimation has been used at the farmer level. Cluster-robust SE are obtained by clustering at the dealer level (presented in ()).

For seed-quality-specific ratings, comparing Table 9 to Table 5, we see that, after controlling for farmer-level heterogeneity, some of the differences between male and female dealers turn significant. 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. We further find signs of gender effects when farmers are asked to rate seed quality in general and whether seed maturity is as advertised. The gender equity bias in these dimensions is also reflected in a significant difference in the average seed rating between male- and female-managed agro-input shops (column 1).

The fact that we do find gender equity 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 5 and 7, gender equity 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 owned 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 6 and 7. Table 10 presents the more general dealer ratings, and Table 11 presents the seed quality ratings. We find that controlling for observable characteristics at the dealer level does not change findings for the first set of ratings, which evaluate the agro-input dealer. The largest gender equity effects are found when farmers are asked to rate agro-input dealer reputation (column 7) and price competitiveness (column 4). In both cases male-managed agro-input shops are rated about 0.2 points higher. The difference in ratings between male- and female-managed agro-input shops for the stock attribute has become indistinguishable from zero.

Comparing Tables 9 and 11, the significant differences between male- and female-managed agro-input shops with respect to the seed maturity rating (column 6), germination rating (column 7), and general seed quality ratings (column 2) found in Table 9 persist after controlling for observable dealer-level differences in seed quality.

Table 10: 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	0.119^{***}	0.149^{**}	0.028	0.2^{***}	0.03	0.082	0.201^{***}
	(0.034)	(0.058)	(0.049)	(0.05)	(0.047)	(0.051)	(0.048)
Dealer's age in years	0.003^{***}	0.001	0	0.003^{**}	0.004^{***}	0.004^{***}	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dealer finished secondary	0.016	0.043	0.032	−0.034	0.037	−0.007	−0.003
education	(0.025)	(0.036)	(0.035)	(0.036)	(0.037)	(0.036)	(0.032)
Shop's cleanness/professionality		0.021					
rating by enumerator		(0.015)					
Index of dealer's efforts	0.01	−0.004					
and services	(0.029)	(0.043)					
Index of capital-intensive seed handling/storage		0.057^{*}					
practices observed by enumerator		(0.031)					
Standardized distance between	−0.02		−0.025				
farmer and shop	(0.016)		(0.026)				
Standardized sales price	-0.024^{*}			0.009			
of maize seed	(0.013)			(0.02)			
Standardized cost of maize	0.022			−0.009			
seed for dealer	(0.014)			(0.02)			
Index of all seed handling/storage	−0.006				0.072^{*}		
practices observed by enumerator	(0.023)				(0.04)		
Number of hybrid maize	−0.008					0.001	
varieties in stock	(0.008)					(0.011)	
Standardized amount of maize	−0.002					0.013	
seed dealer bought	(0.009)					(0.013)	
Number of years since	0.005^{**}						0.015^{***}
shop's establishment	(0.002)						(0.003)
Shop's UNADA	−0.026						0.002
registration	(0.027)						(0.031)
Number of obs.	2779	3014	3433	3302	3149	3356	3433

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the input dealer is a dummy variable carrying the value of either 0 or 1. Fixed-effects or within estimation has been used at the farmer level. Cluster-robust SE are obtained by clustering at the dealer level (presented in ()).

Table 11: 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	0.073^{**}	0.073^{*}	0.07	0.032	0.044	0.087^{*}	0.084^{*}
	(0.029)	(0.041)	(0.046)	(0.044)	(0.049)	(0.042)	(0.043)
Dealer's age in years	0.001	0.003^{**}	0.004^{***}	-0.001	-0.001	0	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dealer finished secondary education	-0.022	-0.023	-0.029	0.009	0.011	-0.084^{***}	0.011
	(0.02)	(0.029)	(0.032)	(0.031)	(0.033)	(0.028)	(0.032)
Index of all seed handling/storage practices observed by enumerator	0.023	0.051	0.062^{*}	-0.009	-0.029	0.035	0.033
	(0.022)	(0.033)	(0.035)	(0.033)	(0.035)	(0.03)	(0.033)
Number of obs.	3109	3088	3038	2965	2988	3000	3026

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Note: Here, the gender of the input dealer is a dummy variable carrying the value of either 0 or 1. Fixed-effects or within estimation has been used at the farmer level. Cluster-robust SE are obtained by clustering at the dealer level (presented in ()).

6 Conclusion and policy implications

Using survey data from smallholder farmers and agro-input dealers in southeastern Uganda, we tested if farmers perceive female-managed shops differently than male-managed shops. To do so, we asked a random sample of farmers to rate agro-input dealers in their neighborhood on a scale ranging from 1 (poor) to 5 (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.

Using simple comparisons of average ratings given to male- and female-managed agro-input shops, we found that female-managed shops are generally rated lower than their male-managed counterparts. However, when farmers were asked to focus on a specific product, the difference became insignificant. When adding controls for agro-input dealer-level observable characteristics, parameter estimates and significance remained similar, suggesting that differences in ratings between male- and female-managed agro-input shops reflect structural differences in perceptions rather than actual differences in quality.

Furthermore, ratings of agro-input dealers provided by farmers may also be influenced by farmer characteristics. To control for farmer heterogeneity, we exploited the fact that farmers often rated several agro-input dealers of different genders and ran farmer fixed-effects models. In doing so, we confirmed the existence of gender equity bias when farmers were asked to rate general characteristics of agro-input dealers, but also found 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 equity bias when farmers were asked to rate agro-input dealers in terms of price competitiveness. Furthermore, and especially after controlling for farmer-level heterogeneity, we find male-managed agro-input shops to have a significantly better reputation than female shops. This difference 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 equity bias was largest when farmers were asked to assess seed germination rates and whether the seed being rated had the advertised maturing period.

Even though a surprisingly large share of Ugandan agro-input shops is operated and/or managed by women, our findings imply that these women face severe comparative disadvantages with potentially large implications for their daily business. Female-managed shops which are perceived to perform worse than their male competitors are likely to have less customers and sell less products, leading to lower revenues and profits. Next to the direct implications for the success of these shops managed by women, fewer earnings will lead to fewer investments. In the long run, female-managed shops will have less capital to invest, for example in a leak-proof roof or to stock sufficient improved seed varieties, turning a disadvantage that initially only exists in the perceptions of the customers into a real quality differences.

Finding this bias in the context of a developing country in a particular sub-sector which has experienced more female entrants in the recent years, is a notable contribution to the gender bias literature, and has important policy 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, the current scenario shows the need for policies addressing the lack of acceptance or integration that still prevails. If these perceptions cannot be corrected, the future may see withdrawal of women from these sub-sectors in larger numbers due to women's awareness about the higher likelihood of restricted growth and difficulties faced in business. We restrict ourselves to three areas where we see scope for policy action.

First, even though we find no evidence of actual differences in quality between male- and female-managed agro-input 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. Ensuring that women entrepreneurs have access to training should be an important policy priority. The effectiveness and inclusiveness of training programs depend on many attributes of the program. This includes more obvious aspects such as the content of what is taught in the training and who is targeted, but also less obvious attributes such as the gender of who provides the training, timings of training, and so forth (Lecoutere, Spielman, and Van Campenhout, 2020). However, 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 posted in the shops, and so forth, such that equal capacity between male- and female-managed agro-input shops becomes more apparent to clients.

Second, in a variety of contexts, female role models have been shown effective in increasing female participation on 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 staff, and leadership of professional associations such as UNADA. This will not only motivate more women but also bring forth wider acceptance across the value chain or agricultural markets. For public sector positions, quotas may be considered, since research suggests that quotas may 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 prices objectively verifiable, and customers will need to depend less on perceptions and the use of mental shortcuts that are prone to gender equity bias.

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Appendix

Table 12: Descriptive agro-input dealer statistics: Variables in indices

	mean	min	max	SD	nobs
Capital-intensive seed handling/storage practices observed by enumerator					
Shop has leak-proof roof	0.539	0	1	0.500	193
Shop has insulated roof	0.617	0	1	0.487	193
Shop has insulated walls	0.813	0	1	0.391	193
Shop is ventilated	0.834	0	1	0.373	193
Shop displays official certificate	0.503	0	1	0.501	193
Shop always handles expired seed correctly	0.941	0	1	0.237	185
Labor-intensive seed handling/storage practices observed by enumerator					
Shop stores seed away from other products	0.404	0	1	0.492	193
Shop has problem with pests	0.637	0	1	0.482	193
Shop's light is ambient (not direct sunlight/dark)	0.819	0	1	0.386	193
Shop stores seed on pallets/shelves (not directly on wood/floor/cardboard)	0.697	0	1	0.461	185
Shop stores maize seed in open containers	0.192	0	1	0.395	193
Shop's cleanness/professionality rating by enumerator	3.503	1	5	1.142	193
Dealer's efforts and services					
Shop always explains to customers how seed should be used	0.472	0	1	0.500	193
Shop always recommends complementary inputs to customers	0.549	0	1	0.499	193
Shop offers extension/training	0.523	0	1	0.501	193
Shop offers discounts for large quantities	0.772	0	1	0.421	193
Shop's smallest seed bag is 1 kg (not larger)	0.728	0	1	0.446	184
Shop provides seed on credit	0.648	0	1	0.479	193
Shop received seed related complaint from customer	0.674	0	1	0.470	193
Shop accepts mobile money as payment	0.399	0	1	0.491	193