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Revisiting constraints to smallholder participation in high-value markets: A best-worst scaling approach

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Abstract

We show how policymakers in developing regions can generate richer insights from using the choice experiment method best-worst scaling (BWS) method when ranking policy priorities on an importance scale. More specifically, we adopt BWS to provide an update on constraints that limit the participation of Kenyan horticultural smallholder farmers in modern agricultural value chains. In addition to traditional constraints posed by input market failures and missing institutions, we considered constraints such as trust and familiarity with buyers shown by recent empirical studies to inform smallholders' market choices. Ascertaining the relevance of these constraints highlights our contribution to the existing literature. We find that farmers consistently rate access to high-quality inputs as their main constraint followed by concerns about access to credit, the high cost of meeting food standards, missing cooperatives, and exploitative intermediaries. Respondents considered insufficient labor, small farmlands, and weak tenure rights as the least important constraints. Age, location, gender, household income, and education influence the relative importance various segments of smallholders place on these constraints. For example, constraints are economic rather than personal for low-income farmers. Counterintuitively, rural smallholders are less likely to perceive poor transportation network as a constraint. Smallholders' distrust of buyers they interact with is informed by their location and income. In designing intervention initiatives, policies that focus on segments of smallholders are needed for improving smallholder participation in modern agricultural value chains.

KEYWORDS

best-worst scaling, constraints, high-value market channels, smallholder heterogeneity

JEL CLASSIFICATION

L11, L14, Q12, Q18

1 | INTRODUCTION

Policymakers commonly elicit the opinion of those affected by current or future policy initiatives to better understand preferences for and the importance of these initiatives to guide decision-making and design of such initiatives. Relatedly, in developing countries, policymakers and researchers are interested in promoting the entry of smallholders into modern agricultural value chains (or high-value markets [HVMs]). HVM channels demand high-quality, differentiated products

that meet strict food standards, require more coordination, and have higher entry costs compared to traditional spot markets. These conditions engender various constraints that limit the entry of smallholders into HVMs.

What are smallholders' perceptions of the relative importance (or unimportance) of these constraints? This question is especially relevant, given that entry into HVMs is regarded as a sustainable pathway to improving the welfare of smallholders and promoting rural development (Barrett et al., 2012; Reardon, Barrett, Berdegué, & Swinnen, 2009). Despite efforts by public and private sector policymakers to introduce intervention programs to facilitate HVM entry, these efforts have not had the intended effects, as smallholders still struggle to gain access to HVMs (Fernandez-Stark, Bamber, & Gereffi, 2012; Hernandez, Berdegué, & Reardon, 2015; Swinnen, Colen, & Maertens, 2013). Their struggles suggest an unclear understanding of the importance of constraints smallholders face when entering HVMs and the incentives needed to promote entry.

In the literature, several studies have used household survey data to identify socioeconomic and institutional determinants of HVM participation (see Section 2 for a detailed literature review). While insights from these studies reveal the key determinants crucial to HVM participation, there is little information on the relative importance of the constraints limiting participation. Similarly, researchers commonly employ choice experiments to elicit smallholder preferences for the agricultural contract attributes that facilitate HVM entry. However, it would be misleading to deduce the relative importance of each constraint from contract attribute preferences.[1]

Moreover, previous studies that directly focused on the importance of the constraints limiting smallholder entry into HVMs confine their discussions to constraints stemming from imperfect input and output markets and poor physical infrastructure (see Boselie, Henson, & Weatherspoon, 2003; Henson, Jaffee, Cranfield, Blandon, & Siegel, 2008; Salami, Kamara, & Brixiova, 2010; Swinnen et al., 2013). In the recent empirical literature, "new" constraints related to social dynamics, such as trust and familiarity with buyers, are increasingly discussed as central to HVM participation.[2] The emerging importance placed on these dynamics suggests a need to update knowledge concerning the importance of these constraints. In this study, we address these gaps. We estimate smallholder preferences and perceptions of the relevance of the constraints limiting their entry into HVMs. We offer three contributions to the literature. First, we ascertain the relevance of the constraints to HVM entry on a scale of importance (from most to least) within the horticultural sector context in Kenya. This is important because policy interventions or programs that fail to incentivize or provide zero to minimal benefits are less likely to be adopted by farmers, and such interventions amount to waste of monetary resources. There is also the political aspect of policy interventions. Take, for example, the input subsidy programs in many countries in sub-Saharan Africa: evidence shows that these programs have become political tools for local politicians to curry favor with the electorate (see Jayne & Rashid, 2013). Smallholders' opinions of policies designed to improve their welfare influence how and for whom they vote, which, in turn, informs politicians on what policies to support or introduce. Therefore, understanding the relative importance smallholders attach to entry constraints is critical for identifying and designing beneficial interventions aimed at promoting smallholder participation in HVMs.

Our second contribution is the measurement of the importance of these constraints across various segments of smallholders' information that helps policymakers tailor policy interventions to the right segment of smallholders. Our third contribution relates to our methodology. When conducting research to measure the importance of policy proposals in developing countries, researchers and policymakers usually deploy traditional Likert-scale-type ranking methods. To the best of our knowledge, the only quantitative study to directly measure the relative importance of constraints to entering HVMs employed a Likert-scale method (see Henson et al., 2008).[3] The underlying process guiding traditional ranking methods elicits preferences on an item-by-item basis. However, preferences and choices are made and best measured relative to other choice options (Louviere, Flynn, & Marley, 2015). Consequently, we adopt a choice experiment method: best-worst scaling (BWS) object case. BWS object case possesses several cognitive and methodological advantages over traditional ranking methods (see Section 4 for a description of a BWS experiment). BWS capitalizes on the human inclination to identify extreme options, to significantly reduce the cognitive strain respondents experience when asked to rank items (Marley & Louviere, 2005). The process behind BWS allows respondents to make trade-offs between items present in a choice set and allow for those items to be calculated on individual-level scales and more advanced econometric

[1] For example, contract attributes typically measured include input provision by different actors or different transportation modes. While smallholders might place value on inputs supplied by cooperatives over other actors or favor farmgate pickups over delivery to a centralized collection center, that information reveals nothing about the importance of access to input as a constraint relative to poor transportation means. See Carlsson, Frykblom, and Lagerkvist (2007) and Brooks and Lusk (2012) for warnings against deducing the importance of policy items from preferences for product attribute, including products affected by those policies.

[2] While the impact of social dynamics has been extensively studied in connection to agricultural technology adoption, researchers are beginning to investigate these dynamics in the context of entry into HVMs.

[3] Their study, however, surveyed value chain practitioners such as nongovernmental organisations (NGOs) and academics not smallholders.

analysis compared to traditional ranking methods (Louviere et al., 2015).

This study is structured as follows. In Section 2, we review the literature on smallholder entry into HVMs. Section 3 outlines the data collection procedure. In Section 4, we introduce the BWS scaling method and explain the experiment, including the design. We also describe the econometric strategy for analyzing the data. Section 5 presents our findings, which we discuss, and conclude in Section 6.

2 | LITERATURE REVIEW

Conceptually, several economic schools of thought—notably New Institutional (NIE), Political Economy, and Collective Action—explain why entering HVMs remains difficult for smallholders. Transaction costs theory from NIE highlights how underdeveloped and weak institutions along with input and output market failures raise the costs of entry and coordination in HVMs (Barrett et al., 2012; Williamson, 1979). Discussions often center on how contracts can alleviate these risks by codifying the frequency of transactions and providing relevant agricultural inputs to correct market failures and enhance smallholders' abilities to comply with strict food standards. Also relevant in these discussions is how to enforce contractual agreements to prevent opportunistic behavior by smallholders and retailers. Political economy theories draw attention to the unequal power relationships between farmers and buyers (or market intermediaries) as a way for buyers to exploit smallholders (Porter & Phillips-Howard, 1997; Singh, 2002). Collective action theories highlight the role of cooperatives in reducing these unequal power relations and generating economies of scale to correct several market failures. Empirical evidence indicates that smallholders who lack access to cooperatives are at a severe disadvantage when competing with their peers, who are cooperative members, to enter HVMs (Hernández, Reardon, & Berdegué, 2007; Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009).

The need to understand the dynamics surrounding HVM entry has motivated a growing body of empirical literature examining the issue from multiple perspectives. One literature strand looks at the economic, demographic, and institutional factors that determine participation in contract farming (see Reardon et al., 2009; Wang, Wang, & Delgado, 2014, for a qualitative review of studies). Results show that male, educated, and asset-endowed farmers are likelier to participate in contract farming relative to female, less-educated and poorer farmers. Another strand of literature uses choice experiments to investigate smallholder preferences for different contract attributes (Abebe, Bijman, Kemp, Omta, & Tsegaye, 2013; Blandon, Henson, & Islam, 2010; Ochieng, Veettil, & Qaim, 2017). These studies show that smallholders place value on contract attributes that provide a guaranteed market for their products without subjective product rejections and agricultural inputs supplied by their buyers. These studies also demonstrate that various demographic and socioeconomic factors drive heterogeneity in preferences for different contract attributes.

A third strand of literature examines smallholders' preferences for different market channels (Gelaw, Speelman, & Van Huylenbroeck, 2016; Schipmann & Qaim, 2011). Schipmann and Qaim (2011) show that smallholders prefer market characteristics synonymous with traditional spot markets. Both Schipmann and Qaim (2011) and Gelaw et al. (2016) argue that trust and familiarity with buyers play an important role in smallholder market preferences. More recently, a fourth strand has emerged, focusing on the social dynamics guiding the behavior of market actors and how this behavior impacts potential contractual relationships and contract enforcement (Fischer & Wollni, 2018; Kunte, Wollni, & Keser, 2016; Michelson et al., 2017; Granja & Wollni, 2019; Rosch & Ortega, 2019; Saenger, Torero, & Qaim, 2014). Findings from these studies suggest that imperfect contract enforcement affects the ability of farmers to enter HVMs and building long-term relationships are essential to prevent contract breach and opportunistic behavior. These studies find that trust, gained either from personal or neighbors' experiences with buyers, significantly informs preferences for contract attributes and smallholders' decisions to enter HVMs.

What is less clear is the extent to which smallholders consider entry constraints to be relatively relevant. Which constraints do smallholders perceive to be very important or unimportant? Moreover, given heterogeneity among smallholders, how do socioeconomic differences influence smallholders' perceptions of these constraints? We address these questions in this study. We note that a variety of HVM channels—for example, export and domestic HVMs (e.g., domestic supermarkets, hotels, restaurants, and schools)—share a common key similarity: the demand for high-quality products, a feature that separates all HVM channels from spot markets. It is on this commonality that we classify the channels under a generic HVM. The constraints we specify in the experiment capture this commonality, as well as other transactions specific to individual HVM channels.

3 | DATA

We use agricultural farming household survey data collected in Kenya from September to November 2018. We purposively selected four counties (Kiambu, Meru, Kakamega, and Siaya), encompassing different geographic regions in Kenya.

Vegetables and other horticultural crops are commonly cultivated for in these four counties for domestic and export HVMs and traditional spot markets (Ngenoh, Kurgat, Bett, Kebede, & Bokelmann, 2019). For each county, we selected the main vegetable-growing subcounties. We used the probability proportional to size technique to estimate the sample size at the county and then subcounty levels based on numbers obtained from county government sources. The sample is representative and consists of 995 farmers drawn randomly from vegetable growing areas within the subcounties. Driven by increased tourism and an expanding middle class, the proliferation of domestic HVMs in Kenya, including in small towns, means that opportunities to sell to HVMs are available to smallholders (see Ngenoh et al., 2019; Rischke, Kimenju, Klasen, & Qaim, 2015).[4] The overall sample comprises farmers supplying export markets, domestic HVMs, and traditional spot markets. The questionnaire covered the socioeconomic characteristics of smallholders, farm production, and marketing activities of smallholders and the BWS choice experiment.

We held focus group discussions and conducted a pilot survey to ensure that the language in the questionnaire was clear. Using a structured questionnaire, well-trained enumerators collected data through face-to-face interviews conducted in Swahili with the household head or another household member familiar with the household farm production and marketing activities.

We also conducted expert interviews with the experienced farmers, supermarket procurement managers, and intermediaries active in the horticultural value chain. The purpose of the expert interviews was to understand the various activities in the horticultural value chain, as well as the chain's weaknesses and opportunities, and contextualize our quantitative findings. We asked questions related to our respondents' production and marketing activities, nature and degree of interactions with other actors in the horticultural value chains, and challenges to and opportunities of entering HVMs.

4 | METHODS

4.1 | Best-worst scaling

BWS is a discrete choice experiment (DCE) method that requires respondents to make decisions about items they deem important or unimportant from a list of items in a choice set. BWS is common in health economics and has been used in food economics to investigate the importance of food values to consumers (see Lusk & Briggeman, 2009). BWS is categorized into three cases: object case, profile case, and multiprofile case. The latter two cases require respondents to assess levels of an attribute in a manner reminiscent of traditional DCE methods (Louviere et al., 2015). We selected the BWS object case because it asks respondents to evaluate the relative importance to an individual of items provided on a list. Even though BWS object case resembles ranking methods, it is regarded as a choice experiment method because its underlying process allows respondents to make trade-offs. To the best of our knowledge, this method has not been applied previously in agricultural development literature. Items could be objects, policy alternatives, statements, or product features a researcher is interested in measuring on a common scale of importance. Items in the context of our article refer to HVM-entry constraints, the importance of which we are interested in measuring. In BWS object case, a single choice set containing different combinations of items is presented to respondents. Respondents then select items they perceive to be the best, or worst, from the choice sets. The expression "best" and "worst" can be changed to reflect the research questions a researcher is investigating. In this article, we compiled a list of constraints and asked smallholders to select their biggest and smallest constraints to participating in HVMs.

4.2 | Constraints

We extensively reviewed both empirical and theoretical literature on smallholder participation in HVMs to identify constraints preventing smallholders from entering HVMs. We identified 12 distinct constraints from the literature. The constraints are typical in developing countries. During focus group discussions with smallholders, we refined the wording of each constraint to ensure use of terms familiar to smallholders, and to make certain we had not overlooked any constraints.[5] Table 1 outlines and describes these constraints. We pretested the experiment in a pilot survey of 20 smallholder farmers.

4.3 | Experimental design

We used balanced incomplete block design (BIBD) to construct two complementary BIBD comparison blocks (Louviere et al., 2015). BIBD is a tool for an experimental design that creates comparison blocks whose items occur or co-occur equally throughout each block (Louviere et al., 2015). In our case, we had four blocks in total. Respondents

[4] Domestic high-value market channels are common and available in all four counties, albeit more so in Kiambu and Meru. However, all sales to export markets and a plurality of sales to domestic high-value markets involving smallholders in Kenya typically occur through intermediaries (exporters). For example, 30% of respondents in our sample supply high-value markets, with about 80% of those farmers—particularly from Kakamega and Siaya—selling to high-value markets through intermediaries. See Table A5 in the Supporting Information for more summary statistics.

[5] For example, it is common for farmers in Kenya to refer to "wholesale traders and exporters' as 'middlemen." We changed the constraint "exploitative wholesale traders and exporters' to exploitative middlemen."

TABLE 1 List of constraints and description

Constraints	Description
Poor roads and means for transporting farm produce to the market	Refers to the absence of transportation infrastructure or that the existing infrastructure is very poor. This creates an access gap that investments in physical infrastructure must bridge
Distrust of agribusiness firms	Smallholders suspect agribusiness firms operate without considering the interests of farmers, and they distrust those firms. For example, there may be subjective product rejections based on vague grading processes and delayed or late payments
Insufficient labor to help on the farm	Smallholders lack sufficient labor for the planting and necessary postharvest operations needed for horticultural crops. Smallholders are forced to rely on their own labor, which raises opportunity costs.
Weak land rights	Smallholders do not possess complete access to their farmlands, which prevents them from deciding whether to supply HVMs
Missing cooperatives and farmer organizations	Means collective groups such as cooperatives and farmer organizations are absent, and farmers are unable to organize to benefit from the economies of scale provided by collective action
Cost of meeting quality standards required by HVMs	The costs of meeting quality standards are too high. Examples include the cost of certification, cost of reducing the use of agricultural chemicals on farmlands, and the cost of acquiring information about the use of those chemicals
Unaware of efficient cultivation techniques	Poor human capital know-how, exemplified by lack of access to extension services and the latest agronomic techniques needed to cultivate high-quality crops
Poor access to high-quality inputs	Poor access to high-quality seeds, fertilizer, and chemicals
Poor irrigation facilities	Lack of access to irrigation facilities, or existing irrigation facilities that are poor quality and inadequate for maintaining production
Lack of access to credit and capital	Inability to secure loans or insurance to expand business operations, invest in necessary farm equipment, and take more risks
Exploitative middlemen	Market intermediaries, for example, wholesalers, traders or dealers, exploit smallholders, and smallholders are disinclined to trust them
Small farmlands	Smallholders operate on small farmlands inadequate to continually meet the output quantities required by HVMs

were randomly assigned to each block. Each block consists of six columns and six rows, with each row representing a choice set, meaning each respondent was presented with six choice sets. Overall, our design meets the four criteria for optimal experimental design: frequency balance, orthogonality, connectivity, and positional balance (Sawtooth software, 2013).[6] We used the JMP software to construct the blocks.

We described the experiment and the meaning of each constraint to the respondent before starting the experiment. To facilitate further understanding of the choice sets and reduce dependence on memory, we printed the choice sets in Swahili on cards for the respondents to observe. See Tables A2 and A3 and Figure A1 in the Supporting Information for more details on experimental design, a pictorial illustration of choice sets and experiment description.

[6] Frequency balance ensures that each constraint appears equally throughout the design. Orthogonality means constraints are equally paired with each other. Connectivity means constraints are well paired such that it allows inference on the relative importance of each constraint. Positional balance means each constraint occurs equally on the left- and right-hand side of the design. See Supporting Information; Tables A2 and A3 for more information on experimental design.

4.4 | Count method

The count method provides a starting point for analyzing BWS data (Louviere et al., 2015). From the count method, we calculated (i) the number of times each constraint was selected as the biggest or smallest constraint across all choice sets; (ii) the difference between the biggest and smallest count for each constraint; (iii) the square root of the ratio of the biggest/smallest count for each constraint; and (iv) the biggest—smallest (B-S) counts for each constraint at the individual level. This served three purposes. (a) We used the difference in the biggest and smallest counts to select the reference constraint in the choice model, which is usually the least-valued constraint. (b) From the square root of the biggest/smallest ratio, we calculated the importance weight of each constraint on a standardized scale. (C) We used the standard deviation obtained from the biggest and smallest counts

for each constraint at the respondent level to observe the preference distribution among the respondents.[7]

4.5 | Econometric analysis

The random utility theory supports the analysis of BWS (Louviere et al., 2015). The underlying assumption is that when presented with a choice set, the B-S pair chosen by a respondent equals the difference between the biggest constraint and the smallest constraint on a scale of importance (Marti, 2012). Assuming a choice set k contains L constraints, there are $L(L-1)$ B-S combinations available for selection. In the database, each set equals $L(L-1)$ lines of observation representing the possible B-S combination. In our case, each set corresponds to 30 lines of observations.[8] The dependent variable is coded 1 for the selected B-S combination and 0 for the other combinations in the choice set. In selecting a B-S combination, it is assumed that respondents will select the combination farthest apart, that is, the distance that maximizes the difference in importance (Lusk & Briggeman, 2009). If a respondent r chooses constraints m and n as the B-S combination, the latent unobservable level of importance between constraint m and n is given by

$$D_{mn} = \delta_{mn} + \varepsilon_{mn}. \tag{1}$$

The random error term is ε_{mn}, and δ_{mn} is the distance between constraint m and n:

$$\delta_{mn} = \beta_m - \beta_n. \tag{2}$$

The probability of respondent r choosing m and n in a choice set k is the probability that the difference between m and n is greater than the distance between all other possible combinations, for example, between constraint i and j in the choice set:

$$P(mn) = P(\delta_{mn} + \varepsilon_{mn} > \delta_{ij} + \varepsilon_{ij}) \text{ for all } m, n \neq i, j \text{ in } k; k = 1, \ldots, K. \tag{3}$$

The error term is assumed to be i.i.d. type 1 extreme, which takes a multinomial logit form:

$$P(mn|k) = \frac{\exp(\delta_{mn})}{\sum_{i=1}^{k}\sum_{j=1}^{k}\exp(\delta_{ij})}, \tag{4}$$

which can be rewritten as:

$$P(mn|k) = \frac{\exp(\beta_m - \beta_n)}{\sum_{i=1}^{k}\sum_{j=1}^{k}\exp(\beta_i - \beta_j)}. \tag{5}$$

We control for error variance to avoid bias in model parameters and study how consistent and certain subgroups of respondents are of their selections (Flynn, Louviere, Peters, & Coast, 2010; Louviere & Eagle, 2006). We allow for heterogeneity in the standard deviation of the random error component of Equation (4) based on four covariates: current participation in HVM, location, possession of irrigation technology, and membership in cooperatives (Vermunt, 2013).[9] We selected the four covariates because we expect farmers in these groups to possess advantages that predispose them to participation in HVMs compared to farmers outside those groups. These advantages provide experience from supplying HVMs that might inform and perhaps lead to more consistency in their selections. This is illustrated as:

$$(mn|k) = \frac{\exp(\lambda_1\delta_{mn})}{\sum_{i=1}^{k}\sum_{j=1}^{k}\exp(\lambda_1\delta_{ij})}, \tag{6}$$

where

$$\lambda_1 = \sigma_{\varepsilon_{r,m,n}} \propto \exp(-w'_r\gamma), \tag{7}$$

where $\sigma_{\varepsilon_{r,m,n}}$ is the random error component; w'_r is a vector of the covariates, γ is the estimated parameter; and $\exp(w'_r\gamma)$ represents the scale factor that is inversely proportional to the standard deviation of the random error component (Vermunt, 2013). We estimate Equation (6) using a heteroskedastic conditional logit framework. The estimated coefficients are interpreted relative to a reference constraint that is removed from the estimation by setting its value to 0 to avoid the dummy trap.

One difficulty in interpreting the estimates from Equation (6) is that they have no natural interpretation. To solve this problem, we calculate a share of preference scores for each constraint. The share of preference scores for each constraint reflects the importance of that constraint on a ratio scale depicting the probability that a selected constraint is more important than another constraint (see Lusk & Briggeman, 2009). For example, a constraint with a score twice that of another constraint is twice as important as that

[7] Our results showed that majority of the constraints were normally distributed. This provided a reason for us to estimate a mixed logit model. See Supporting Information: Figures A2–A13 for a graphical representation of the distribution and Table 8 for the mixed logit model estimates.

[8] This means that there were in total 180 lines of observation for each respondent since each respondent saw six choice sets. Table A5 in the Supporting Information shows an example of the data output.

[9] The nature and complexity of choice task or the employed discrete choice experiment method can also explain heterogeneity in error variance. Due to the focus on the policy implications of our results, we limit our analysis of error variance heterogeneity to covariates linked to personal characteristics of respondents.

other constraint. The share of preference for a constraint m is represented as

$$PS_m = \frac{\exp^{\beta_m}}{\sum_{i=1}^{K} \exp^{\beta_i}}. \quad (8)$$

The multinomial framework outlined in Equation (6) assumes that preferences are homogenous. However, differences in socioeconomics and surrounding characteristics can influence the preferences of farmers. We use latent class modeling (LCM) to account for differences in preferences. LCM creates segments, or classes, of smallholders with similar preferences and characteristics to account for variability in choices (Vermunt & Magidson, 2002).

Let the probability that a respondent r selects m and n as the best-worst combination in a choice set k to be represented by the vector α_r:

$$P\left(\alpha_r\right) = \frac{\exp\left(\beta_{mrk} - \beta_{nrk}\right)}{\sum_{i=1}^{K}\sum_{j=1}^{K} \exp\left(\beta_{irk} - \beta_{jrk}\right)}. \quad (9)$$

The parameters are modeled as random draws from a discrete distribution with C latent classes over six choice set scenarios (Yoo & Doiron, 2013). The likelihood of respondent r responses is a function of the frequency of each class C: Υ_c, and the class-specific utility parameters: α_c:

$$L_n\left(\alpha_1, \alpha_2 \ldots \alpha_c; \Upsilon_1, \Upsilon_2, \ldots \Upsilon_c\right) = \sum_{c=1}^{C} \Upsilon_c \prod_{k=1}^{K} P\left(\alpha_c\right) \quad (10)$$

where $?_c = 1 - ?_{(c=1)}^{(C-1)} ?_c$.

We jointly estimate class membership and choice preferences as a function of individual characteristics in a latent class conditional logistic model using the expectation-maximization (EM) algorithm (Pacifico & Yoo, 2013).

5 | RESULTS

5.1 | Individual characteristics

From the original 995 respondents, we dropped three respondents due to missing information resulting in 992 respondents. Since each respondent faced six choice sets, we had 5,952 choice situations. About 68% of the respondents were male, the mean age was 44 years, and the number of years spent in school was nine. About 74% of the respondents resided in villages classified as rural (villages farther from large cities), and 26% resided in peri-urban areas (villages closer to large cities). From the sample, 30% of the respondents were HVM suppliers. See Table A5 in Supporting Information for more detailed summary characteristics.

5.2 | Importance of constraints: Counting scores

The results of the B-S scores, rescaled scores, and standardized importance weights are shown in Table 2. We focus on the standardized importance weights scores (Table2, column 6). About 18% of the respondents rate poor access to high-quality inputs as the biggest constraint. This was followed by missing cooperatives (14%), poor access to credit and capital (13%), high cost of meeting food quality standards (12%), and exploitative middlemen (10%). Nine percent of smallholders in our sample perceived poor transportation networks as a big constraint. On the other end, 4% of the respondents selected small farmlands, insufficient labor, and lack of awareness of farm practices as important constraints. Only 1% of the respondents selected weak land rights as an important constraint.

5.3 | Importance of constraints: Choice models

We estimated a heteroskedastic conditional logit model to show the importance of the constraints. We present the estimated coefficients and share of preference calculated in Equations (6) and (8) in Table 3, columns 1 and 2, respectively. All coefficients were statistically significant at 5% confidence level. Due to each individual contributing several lines of observations, standard errors were adjusted for clustering on individuals.[10] Relative to the reference constraint, poor access to high-quality inputs is the most important constraint, followed by (in order of descending importance): poor access to credit, high cost of meeting food quality standards, missing cooperatives, exploitative middlemen, poor irrigation facilities, and poor transportation networks. Being unaware of efficient farm practices, distrust of agribusiness firms and insufficient labor were the least important constraints. The probability that a constraint is more important than another constraint is reported based on the ratio of each constraint's SP scores (Table 3, column 2) calculated from Equation (8). On average, smallholders rate poor access to high-quality inputs as 1.7 times more important as poor access to credit and high cost of meeting food quality standards and twice as important as missing cooperatives and exploitative intermediaries. On the issue of trust and buyer familiarity, exploitative intermediaries are perceived to be about three times more important than agribusiness firms. The share of preference scores was consistent and similar in magnitude to the weight of importance scores from the count method displayed in Table 2.

[10] We later clustered at the subcounty level to observe and control for possible spatial correlation effects. The clustered coefficients and standard errors at the individual and subcounty level were identical and similar, respectively. See Table A8 in the Supporting Information for standard errors clustered at subcounty level. We continue and present the results from individual clustered standard errors. We thank a reviewer for this suggestion.

TABLE 2 Raw biggest and smallest totals, biggest and smallest scores, and weight importance

Constraint	B	S	B-S	Ratio B/S scores[a]	sqrt(B/S)	Weight importance[b]
Columns	1	2	3	4	5	6
Poor access to high-quality seeds, chemicals, and fertilizer	1,045	153	892	6.830	2.613	18%
Missing cooperatives and farmer organization	688	160	528	4.300	2.074	14%
Poor access to credit and capital	617	181	436	3.409	1.846	13%
Cost of meeting quality standards requirements	756	255	501	2.965	1.722	12%
Exploitative Middlemen	705	336	369	2.098	1.449	10%
Poor transportation networks	782	433	349	1.806	1.344	9%
Poor irrigation facilities	441	472	−31	0.934	0.967	7%
Distrust of agribusiness firms	254	433	−179	0.587	0.766	5%
Unaware of efficient farm practices	223	617	−394	0.361	0.601	4%
Insufficient labor	149	478	−329	0.312	0.558	4%
Small farmlands	246	884	−638	0.278	0.528	4%
Weak land rights	46	1,550	−1,504	0.030	0.172	1%

[a]B-S scores divided by sample size.

[b]Percentage of the sum of each constraint divided by sum of all constraints.

5.4 | Importance of constraints: HVM farmers versus non-HVM farmers

We estimate conditional logit models at a subgroup level to understand how HVM and non-HVM farmers might rank constraints (see Table 3, columns 4–7). Our results reveal some differences in perceptions of the constraints (see Table 3, column 4). HVM farmers rate poor access to high-quality inputs, exploitative middlemen, poor access to credit, high cost of meeting food quality standards, and missing cooperatives as their biggest constraints. From the SP scores, poor access to high-quality inputs was equally rated as important a constraint as exploitative middlemen. Both constraints are 1.5 times as important as poor access to credit and the high cost of meeting food quality standards. Non-HVM farmers rate poor access to high-quality inputs as their biggest constraint. This constraint was 1.6 times as important as the poor access to credit and high cost of meeting quality standards, which were rated as the next most important constraints and about 2.5 times as important as exploitative middlemen.

5.5 | Consistency in choice selections

Three covariates significantly explain scale or error variance heterogeneity: the location of the farmers, possession of irrigation facilities, and membership in a cooperative. Estimating the exponent of the parameters (λ_1 sign in Equation (6)) from the heteroskedastic models reveals the degree of consistency in choice selections. Results reveal that cooperative members and rural farmers were 0.88 and 0.77 times less consistent in their choices compared to noncooperative members and peri-urban farmers. This implies that noncooperative members and peri-urban farmers are more secure in their knowledge of which constraints are relevant to their participation in HVMs. Farmers possessing irrigation facilities were 1.18 times more consistent in their choice selections compared to farmers without irrigation facilities. The covariate indicating participation in HVMs was not statistically significant.

5.6 | Heterogeneity in selections

We estimated heterogeneity in preferences using LCM. We selected the optimal latent classes based on two criteria: how well the model predicts choice behavior and interpretability of the coefficients. We estimated the former by obtaining the mean highest posterior probability of class membership across all respondents (Pacifico & Yoo, 2013). Our results showed that mean posterior probabilities were highest in classes 4 and 5 (88.4% and 88.1%, respectively). Interpretability of coefficients was easier in class 5 relative to class 4, and consequently, we chose class 5.

Table 4 shows the coefficients of the constraints, class shares, and covariates predicting class memberships, while Table 5 shows the share of preference scores for the constraints in each class. We report the results based on the share of preferences scores in Table 5.

Smallholders in class 1 account for about 23% of the sample (Table 5, column 1). This group of farmers finds poor access to high-quality inputs and credit (31% and 23%, respectively) to be most important. These farmers rate both exploitative intermediaries and missing cooperatives as equally important (10% each), but about two to three times less important than poor access to high-quality inputs and credit. In

TABLE 3 Heteroskedastic conditional logit models

Constraints	MNL HET	SP	HVM farmers	SP	Non HVM farmers	SP
Column	1	2	3	4	5	6
Poor access to high-quality inputs	3.21	0.224	2.700	0.172	2.832	0.213
	(0.222)		(0.133)		(0.081)	
Poor access to credit and capital	2.642	0.127	2.317	0.117	2.362	0.133
	(0.189)		(0.113)		(0.071)	
High cost of meeting quality standards	2.637	0.126	2.268	0.111	2.277	0.122
	(0.184)		(0.121)		(0.084)	
Missing cooperatives	2.47	0.107	2.149	0.099	2.131	0.106
	(0.175)		(0.114)		(0.076)	
Exploitative middlemen	2.458	0.105	2.629	0.160	1.912	0.085
	(0.170)		(0.124)		(0.072)	
Poor irrigation facilities	2.189	0.081	1.867	0.075	1.949	0.088
	(0.158)		(0.121)		(0.078)	
Poor roads and transport means	2.199	0.081	2.026	0.087	1.862	0.081
	(0.159)		(0.145)		(0.091)	
Unaware of efficient farm practices	1.634	0.046	1.883	0.076	1.227	0.043
	(0.119)		(0.109)		(0.064)	
Distrust of agribusiness firms	1.432	0.038	1.165	0.037	1.248	0.044
	(0.105)		(0.111)		(0.064)	
Small farmlands	1.132	0.028	0.848	0.027	1.072	0.037
	(0.099)		(0.091)		(0.063)	
Insufficient labor to help on the farm	1.147	0.028	0.872	0.028	1.049	0.036
	(0.091)		(0.089)		(0.056)	
Weak land rights	0	0.009	0	0.012	0	0.013
Scale factors[a]						
HVM farmers	0.008					
	(0.054)					
Cooperative members	−0.127***					
(noncooperative members)	(0.049)					
Farmers with irrigation facilities	0.164***					
	(0.055)					
Rural farmers	−0.264***					
(peri-urban farmers)	(0.055)					
No. of observations	178,560		53,460		125,100	
No. of respondents	992		297		695	
No. of groups	5,952					
Log-likelihood	−17,686.5		−5,237.7		−12,408	

Standard errors clustered at individual level.
[a]Reference groups in brackets.
***$p < .01$,
**$p < .05$,
*$p < 0.1$.

terms of socioeconomic characteristics, farmers in class 1 belong to low-income households and are less experienced in agriculture.

Class 2 smallholders constitute 19% of the sample (column 2). This class rates equally poor access to high-quality inputs and credit (18% each) as their most important constraints. The next two biggest constraints for farmers in this class are the high cost of meeting food quality standards (14%) and missing cooperatives (13%). Interestingly, both constraints that capture trust and familiarity with buyers:

TABLE 4 Latent class model

Constraints	Class 1	Class 2	Class 3	Class 4	Class 5	Weighted average
Poor transportation networks	0.092	2.622***	8.007***	0.671***	4.785***	2.620
	(0.142)	(0.208)	(0.439)	(0.123)	(0.189)	–
Distrust agribusiness firms	1.081***	0.714***	7.680***	0.494***	2.134***	1.785
	(0.152)	(0.137)	(0.456)	(0.116)	(0.149)	–
Insufficient labor	0.816***	1.201***	3.025***	0.340***	1.531***	1.164
	(0.125)	(0.144)	(0.282)	(0.106)	(0.120)	–
Missing cooperatives	2.812***	2.790***	5.462***	0.582***	4.137***	2.834
	(0.191)	(0.199)	(0.460)	(0.116)	(0.177)	–
High cost of food standards	2.509***	2.908***	8.634***	0.909***	3.558***	3.056
	(0.163)	(0.179)	(0.429)	(0.141)	(0.182)	–
Unaware of efficient farm practices	2.643***	0.508***	3.206***	0.703***	2.587***	1.800
	(0.172)	(0.125)	(0.310)	(0.125)	(0.158)	–
Poor access to high-quality inputs	3.979***	3.131***	7.734***	1.191***	4.601***	3.655
	(0.185)	(0.176)	(0.423)	(0.158)	(0.168)	–
Poor irrigation facilities	2.383***	2.412***	6.131***	1.723***	1.791***	2.472
	(0.202)	(0.203)	(0.428)	(0.167)	(0.142)	–
Poor access to credit	3.678***	3.109***	5.163***	1.096***	3.280***	2.988
	(0.186)	(0.162)	(0.380)	(0.165)	(0.168)	–
Exploitative middlemen	2.812***	0.909***	6.004***	1.648***	4.337***	2.842
	(0.187)	(0.144)	(0.434)	(0.136)	(0.176)	–
Small farmlands	0.842***	2.451***	1.040***	0.467***	1.230***	1.166
	(0.153)	(0.196)	(0.214)	(0.114)	(0.125)	–
Class share	23%	19%	10%	25%	23%	
Class Membership[a]						
Gender (Male)	0.055	−0.421	−0.100	0.830***	–	–
	(0.249)	(0.261)	(0.295)	(0.259)		
Age (Years)	0.014	0.006	0.034**	0.0176	–	–
	(0.012)	(0.014)	(0.014)	(0.0118)		
Education (Years)	0.038	0.046	−0.259***	0.019	–	–
	(0.038)	(0.042)	(0.048)	(0.034)		
Income (ln)	−0.817***	−1.220***	0.487***	−0.106	–	–
	(0.141)	(0.157)	(0.170)	(0.138)		
Farm Experience (Years)	−0.025*	−0.015	−0.060***	−0.004	–	–
	(0.015)	(0.016)	(0.019)	(0.013)		
Location (Rural)	0.381	−0.120	−0.317	0.641**	–	–
	(0.290)	(0.285)	(0.290)	(0.252)		
Constant	8.840***	14.08***	−4.939**	−0.637	–	–
	(1.766)	(1.897)	(2.123)	(1.761)		
Observations[b]	178,380	178,380	178,380	178,380	178,380	178,380

Standard errors in parentheses

***$p < .01$,

**$p < .05$,

*$p < .1$.

[a]Class 5 is the reference class.

[b] We removed one respondent with missing income value.

TABLE 5 Relative importance of constraints in percent by class

Constraints	Class 1	Class 2	Class 3	Class 4	Class 5
Covariate membership	*Low-income farmers Little experience in agriculture*	*Low-income farmers*	*High-income farmers*	*Rural farmers Male farmers*	
Column	(1)	(2)	(3)	(4)	(5)
Poor transportation networks	0.6	10.8	20.9	6.3	26.3
Distrust agribusiness firms	1.7	1.6	15.0	5.3	1.9
Insufficient labor	1.3	2.6	0.1	4.5	1.0
Missing cooperatives	9.6	12.8	1.6	5.8	13.7
High cost of food standards	7.1	14.4	39.0	8.0	7.7
Unaware of efficient farm practices	8.1	1.3	0.2	6.5	2.9
Poor access to high-quality inputs	30.9	18.0	15.9	10.6	21.8
Poor irrigation facilities	6.3	8.8	3.2	18.1	1.3
Poor access to credit	22.9	17.6	1.2	9.7	5.8
Exploitative middlemen	9.3	2.0	2.8	16.8	16.8
Small farmlands	1.3	9.1	0.0	5.2	0.8
Weak land rights	0.6	0.8	0.0	3.2	0.2

distrust of agribusiness firms and exploitative intermediaries and insufficient labor were relatively unimportant to farmers in this class. Constraints limiting entry into HVMs are more economic than personal for this group of farmers. Income was a significant predictor of class membership, with this group of farmers belonging to low-income households.

Class 3 farmers account for 10% of the sample (column 3). About 39% of these farmers rate the high-cost of meeting food standards as the most important constraint. While poor transportation network and poor access to high-quality inputs are regarded as big constraints, the high cost of meeting food standards is almost twice as important. Farmers in this class are likely to be older and belong to high-income households.

About 25% of the sample belongs to class 4 (column 4). These smallholders view poor irrigation facilities and exploitative intermediaries equally as their biggest constraints to entering HVMs. Both constraints are about 1.7 times as important as poor access to high-quality inputs and credit, and about two to three times as important as poor transportation networks, high cost of meeting food quality standards and missing cooperatives. Gender and location are predictors of class membership, since members are likely to be male and dwell in rural villages.

The remaining 23% of the respondents are in class 5 (column 5). About 26% of these farmers rate poor transportation networks as the biggest constraint, followed by poor access to high-quality inputs and exploitative intermediaries (22% and 17%, respectively). Less than 5% of these farmers selected small farms, distrust of agribusiness firms, and insufficient labor or weak land rights as important constraints.

We compare parameters from a mixed logit model with the weighted average from the latent class models. Mixed logit models have been shown to provide estimates that accommodate error variance heterogeneity (Hess & Train, 2017). We found that weighted averages of class estimates from the latent class models are closely identical to estimates from the mixed logit model that validates estimates from our latent class model (see Table A6 in Suppoprting Information for the mixed logit model).

6 | DISCUSSION AND CONCLUSION

A significant number of studies have been devoted to understanding the constraints limiting smallholder entry into HVMs. Such studies have typically focused on which socioeconomic factors determine participation in HVMs, how different contract attributes mitigate the costs posed by various constraints, or how the behavior and experiences of smallholders and buyers might constitute a constraint. However, the relative degree to which these constraints are important when compared on a most-to-least scale remains unclear in the literature.

In this article, we exploit a choice experiment method, BWS object case, to examine how smallholders rate different constraints limiting their ability to enter HVMs. In addition to constraints brought about by imperfect markets, we investigate the relevance of additional constraints, such as trust, in encouraging/discouraging entry into HVMs. We explore how different segments of smallholders might perceive the relevance of these constraints. Our approach represents an attempt

to understand how smallholders perceive one constraint to be more important than another. We demonstrate in this article that the BWS object case offers a simple way to rank items of interest to researchers and policymakers, provides valid statistical estimates, and yields more information than ranking methods. This would especially be useful in sub-Saharan Africa where researchers and policymakers tend to employ traditional ranking methods to estimate and rate health, agriculture, or development policy priorities.

Returning to our results, in the pooled sample, respondents consistently ranked poor access to high-quality inputs as their biggest constraint. Several studies have documented the link between the use of high-quality inputs and increased productivity and profitability (e.g., see Duflo, Kremer, & Robinson, 2008; McArthur & McCord, 2017). However, discussions in the literature tend to focus more on the adoption rates of agricultural inputs by smallholders, with minimal attention devoted to the quality of those inputs (Bold, Kaizzi, Svensson, & Yanagizawa-Drott, 2017; Sheahan & Barrett, 2017). A seminal study by Bold et al. (2017) showed that fertilizers and seeds sold in local markets in SSA are missing key nutrients, which is responsible for low yields on smallholder farms. The authors showed that farmers had difficulty discerning the quality of inputs sold in the input markets and the effect of input quality on profitability. The authors argued that the substandard inputs might explain low uptake of agricultural inputs among smallholders. Our finding also contextualizes the findings from the previous literature that show that farmers prefer contract configurations that specify the provision of seeds and other essential agricultural inputs.

Our results also show that poor access to credit, high cost of meeting food quality standards, and missing cooperatives were the next most important constraints. Poor access to credit affects smallholders' ability to invest in farm equipment. The cost of meeting food quality standards includes acquiring the technical knowledge needed to comply with quality requirements and the necessary farm equipment (Swinnen et al., 2013). Missing cooperatives means limited opportunities for farmers to organize collectively in order to enjoy economies of scale (Henson et al., 2008). We discovered from our interviews that, despite the existence of vibrant tea, coffee, and dairy cooperatives, very few cooperatives cater to horticultural crops. It was therefore unsurprising that respondents view missing cooperatives as a significant constraint to their participation in HVMs. The fifth highest ranked constraint is exploitative behavior exhibited by intermediaries. The exploitative behavior by intermediaries is ranked especially high among farmers currently supplying HVMs. Anecdotal evidence collected during the interviews with farmers reveals intermediaries form cartels to discourage competition and offer low prices to smallholders.

At the tail end of the rankings, we find that respondents consider insufficient labor on the farm, small farmland area, and weak tenure rights as the smallest constraints. The low importance placed on insufficient labor is interesting and surprising, considering that horticultural crops demand a significant amount of labor, especially for postharvest operations (Andersson, Chege, Rao, & Qaim, 2015). Results from our subgroup analysis reveal that HVM farmers share the view that insufficient labor poses a small constraint to HVM participation.

Our findings from preference heterogeneity provide additional insights into how different segments of smallholders view the constraints. The location where smallholders reside influences how different segments of smallholders perceive these constraints. Much has been said in the literature about how poor transportation networks can exclude smallholders from HVMs by discouraging retailers from sourcing from smallholders residing in rural areas. Interestingly, we find that rural farmers are less likely to perceive a poor transportation network as important compared to peri-urban farmers. A possible explanation could be that smallholders are unaffected by poor road networks since they mostly sell at the farmgate to market intermediaries. Our summary statistics show that about 76% of the respondents sell at the farmgate to intermediaries, who, in turn, sell either to HVM retailers or at wholesale traditional markets. Findings from our interviews with procurement managers for HVM retailers, farmers, and intermediaries shed more light on this issue. HVM retailers often purchase supplies from intermediaries who source in bulk on specified weekdays from smallholders in remote villages. Intermediaries, not farmers, therefore bear the transportation costs and risks, including damages to horticultural crops from poor roads.

Income was also a significant predictor of heterogeneity in choices. For example, constraints to HVM participation are economic, rather than personal, for farmers from low-income households. These farmers rank constraints related to inputs and credit market failures as the most concerning, and they rate constraints brought about by distrust of agribusiness firms and middlemen as unimportant. This finding supports the hypothesis by Barrett et al. (2012) that anticipated welfare gains might motivate participation in HVMs even if terms of the agreement between smallholders and retailers are unfair. High-income smallholders rate the high cost of meeting food quality standards, poor transportation networks, and distrust of agribusiness firms as their biggest constraints, suggesting perhaps some prior or current experience with supplying HVMs.

Based on our major findings, we offer some policy recommendations for public and private sector practitioners with interest in the horticultural sector in Kenya. First, our results show that the inability of smallholders to access high-quality inputs is the biggest constraint to HMV participation. While buyers in export markets sometimes provide inputs to their suppliers, this practice is uncommon in domestic HVMs,

and the majority of smallholders do not participate in export markets. Current public sector programs in sub-Saharan Africa often aim to provide inputs to farmers. However, common critiques leveled at these programs concern their crowding-out effect on the private input markets; huge budgetary demands and inefficiency; vulnerability to political change; and inability to reach poorer households (Jayne & Rashid, 2013). A more sustainable intervention could aim at reforming the private input markets to curtail the sale of substandard inputs and improve the quality of inputs available to farmers.

Second, in the short term, the presence of intermediaries might mitigate constraints created by poor transportation networks. It is therefore understandable that intermediaries will extract rent to compensate for transportation risks. In the long term, however, improvements in physical infrastructure are needed to directly connect smallholders to buyers and reduce smallholder reliance on and exploitation by intermediaries. Formation of cooperatives can also reduce the bargaining power of intermediaries and provide needed services to smallholders. Given the weak state of horticultural cooperatives, a major concern is how to develop and maintain horticultural crop cooperatives. The success of cash crops and dairy cooperatives in the vicinity can offer pointers for policymakers interested in establishing horticultural crop cooperatives.

With regard to future research, more studies examining the quality of agricultural inputs available to smallholders in sub-Saharan Africa are needed. Understanding the economic impacts and behavioral effects of input quality on smallholders could inform more effective support strategies aimed at increasing agricultural productivity, thus improving food security and alleviating poverty. It would also be interesting to observe the importance placed on these constraints by farmers supplying export HVMs, where resource-providing agreements are common, or domestic HVMs where marketing contracts are prevalent. Given our results show that the high cost of meeting food quality standards is a major constraint, an analysis of these costs across various HVM channels could yield insights into which HVM channels might be conducive for specific segments of smallholders. For example, such an approach might reveal which HVM channel would be less costly and more effective for different segments of smallholders, rather than the current efforts that mostly focus on improving access to export HVM channels.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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