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Transaction costs magnitudes, market participation, and smallholder profitability in rural-urban vegetable supply chain

Bensolomon Baraka[a], John Mburu[b], and Beatrice Muriithi[c]

[a]HELP Logistics, program of the Kuehne Foundation, Nairobi, Kenya; [b]Department of Agricultural Economics, University of Nairobi, Nairobi, Kenya; [c]Social Science and Impact Assessment Unit (icipe), International Center of Insect Physiology and Ecology (icipe), Nairobi, Kenya

ABSTRACT

Transaction costs are pervasive barriers in agricultural supply chains as they exclude farmers from profitable markets. Identification of these costs without reliance on proxy variables and their effects on smallholder profitability has not been empirically analyzed. The Heckman 2-step model was used to assess the effects of magnitudes of these costs on farmer profitability. Indirect monitoring and negotiation-related transaction costs had significant, positive, association with selling vegetables directly from urban markets; indirect information transaction costs had a negative association. A positive association between higher indirect information transaction costs and profitability was observed. Better market information systems will improve farmer profitability.

KEYWORDS

Commercialization; direct transaction costs; indirect transaction costs; institutional arrangements

The ability of rural-urban food systems to sustain the nutritional needs of urban populations may not be able to keep pace with rapid urbanization in sub-Saharan Africa (SSA) (Bjorndal et al., 2016; Donavan, 2012). As a result, there is an increased examination of ways to improve farmer productivity to ensure sufficient food reaches urban areas and farmers have better livelihoods as they move toward commercialization.

Smallholder farmer commercialization, driven by liberalized market policies, has not achieved desired levels of success to improve farmer livelihood (Magingxa and Kamara, 2003). This may be due to coordination failure between actors and institutions making markets in SSA prone to market transaction failure (Dorward et al., 2009). Deductive reasoning provides insight into which barriers prevent increased market entry and participation among farmers.

The Coasian approach (Coase, 1937) provides a basis for deductive reasoning on market participation and barriers. This approach recognizes markets are not perfect if left unsupervised due to various factors including imperfect information. Costs are incurred by actors in order to use market mechanisms. Costs that reduce uncertainty, risks, and opportunism of actors in market transactions are termed transaction costs (Arrow, 1970). In SSA agricultural markets, magnitudes of transaction cost incurrence are necessary to overcome market imperfections

CONTACT Bensolomon Baraka bensolomon.baraka@kuehne-stiftung.org HELP Logistics Ltd, P.O Box 2856-00621, Nairobi, Kenya

(Dorward et al., 2009). Those who cannot surmount these costs are rendered unable to participate in the market and move from commercialization to self-sustenance (Donavan, 2012).

Neoclassical, and new institutional, economics postulates the objective of a producer is profit maximization. To achieve this, costs can be reduced as revenue remains constant. In the presence of market barriers, it is critical that production costs and transaction costs be minimized as critical functions of profitability and efficiency of institutional structures. To the best of our knowledge empirical measurement of transaction costs without reliance on proxy variables, and its effects on smallholder profitability is yet to be achieved.

Few studies have measured transaction costs in food supply chains (Kherallah and Kirsten, 2002). This may be because when transaction costs are high in a market exchange, they may prevent the exchange from taking place and costs cannot be empirically captured. Studies on measuring transaction costs have resorted to observable factors, and proxies that explain, or mitigate, transaction costs. These include distance to output market, ownership of transport and communication assets, membership in marketing groups, the intensity of research and development expenditures as a measurement of asset specificity and uncertainty as percent change in farm output supply (Hobbs, 1996; Omamo, 1998).

A more quantitative technique to model transaction cost relies on a methodology that identifies direct transaction costs as cash expenses incurred in sourcing for information, negotiation, monitoring and enforcing contracts in a market exchange, and indirect transaction costs as time spent on those activities which is monetized by assigning a cash value based on opportunity cost of a farmer's time (Irungu, 2007). This work examined indirect, and direct, transaction costs to measure the magnitude of transaction costs; provide an understanding of the role transaction costs play in determining farmer participation in urban markets, and assess effects of these costs on smallholder farmer profitability in urban markets.

In modeling for market participation, the Heckman model (Heckman, 1979), or its alternatives of double hurdle and switching regression models have been used (Minot et al., 2000). The Tobit model has also been used to analyze market supply (Woolridge, 2003). However, a drawback of the latter model is that it assumes the same set of parameters and variables determine the probability and intensity of market participation (Ricker-Gilbert et al., 2011).

It may be that a minority of farmers may sell produce given market barriers. However, despite a corner solution such as a Double Hurdle (Ricker-Gilbert et al., 2011) being suitable to capture the value of zero indicating nonparticipation as a valid economic choice, within this study, nonparticipating households were purposefully excluded from the sample as transaction costs would be unobservable. This systematic exclusion increases the likelihood of sample selection bias. Because of this problem, the Heckman model (Heckman, 1979) is the preferred alternative as it accounts for this bias, unlike other variations.

Materials and methods

The study was conducted in Kiambu county, Kenya. Based on pre-survey market visits in formal urban markets in Nairobi, Lari and Juja sub-counties in Kiambu were identified appropriate due to the high volume of vegetables and traders from those regions. This particular vegetable supply chain serves as a representative of rural-urban vegetable supply chains in most of SSA as Kenya shares similar characteristics with most of these countries on matters of high urbanization rates, reliance on smallholder farmers and undernourishment (Bjorndal et al., 2016).

The Cochran formula (Cochran, 1963) was used to determine sample size. The study desired a 95% confidence level and 5% precision level. As variation in vegetable commercialization among the farmer population was not expected to be widespread due to high homogeneity with regards to vegetables cultivated and sold, $P = .1$. Application of this formula resulted in a sample size of 138 potential respondents being selected; not all farmers were available for interviews reducing the number to 111 respondents.

Commercial leafy vegetable farmers were purposively selected. Due to varying population densities, a proportion to size sample was used producing 48 respondents in Lari, and 63 in Juja. During data collection, the main challenge was ascertaining the actual number of farmers in each study site in order to construct the sampling frame. This was because no formal database of leafy vegetable farmers was maintained in the 2 sub-county agricultural offices. Farmers were identified with help from sub-county agricultural extension officers. During data collection, respondents gathered at central locations; easily accessible to farmers.

Primary household-level data were collected using focus group discussions and a semi-structured questionnaire. The data, particularly transaction cost data, were based on farmer market participation in July, August and September 2017. To measure the magnitudes of transaction costs in the supply chain, the Statistical Package for Social Sciences (ver. 21, SPSS, Armonk, NY) was used. Data on cash directly paid, or spent on, searching for market availability, market access, knowing selling price and making contracts, was collected from farmers based on their recollection and calculated as direct transaction costs. Indirect transaction costs were a product of monthly profit accrued from vegetable enterprises disaggregated into profits per minute thereafter multiplied by every minute spent on searching for price information, contracting, negotiation and bargaining on a monthly basis. This captured the opportunity cost of time spent trying to surmount market constraints. Mean estimates of disaggregated transaction cost components along the supply chain, and between market channels, were computed and the resulting data subjected to analysis of variance. This process allowed the determination of magnitudes of transaction costs. To assess the effects of

transaction costs on smallholder farmer profitability, the first stage of the Heckman model estimated the probability of participating in the vegetable supply chain through directly selling from the urban market or selling at farmgate. Those who participate in urban markets using the former arrangement are hypothesized to incur higher transaction costs compared to the latter. This is due to the expectation that the presence of market failure will result in this group of farmers incurring more costs and spending more time searching for preferable urban markets, negotiating with transporters and monitoring other urban market for prices. All these activities are expected to increase transaction costs. Once the effect of transaction costs on market channel choice was established from the first step, the Inverse Mills Ratio generated to cater for any sample selection bias was introduced in the second step Ordinary Least Square (OLS) regression. The second step looked at the effects of transaction costs on the profitability of farmers, conditional on them selling directly in the urban market. Profits were expressed using proxy gross margins a farmer receives monthly, i.e., the value resulting from subtracting variable costs from total farm income (Nemes, 2009). The Heckman model equations were estimated using STATA (ver. 14, College Station, TX) to assess probabilities of selecting a particular market channel choice given magnitudes of transaction cost and effects of these costs on farmer profitability.

Results and discussion

Farmers were grouped based on the selling point. These groups were either directly selling from urban markets or farmgate. Findings from this study should only be used for transaction theory propositions but not extended to other diverse food supply chains as the unique characteristics associated with various commodities may result in different outcomes. A minority of farmers sold directly to urban markets, and majority at farmgate. Transaction costs for the two groups differed (Table 1). Farmers who sold vegetables at the urban market incurred more transaction costs. This may be due to their need to surmount barriers related to price information and market access along this market channel, and contractual arrangements with transporters and urban market brokers. This argument is supported by higher, significantly different, direct transaction costs of this group in searching for information and contract negotiation.

The high direct cost for searching for market information signifies the size of a barrier these costs represent for smallholder vegetable farmers. This situation also occurs in other SSA countries (Mmbando, 2014) where high transaction costs imply imperfect knowledge of market opportunities, and together with information asymmetry, leads to increased cost of gathering information. This may provide an explanation of why some vegetable farmers choose the less costly option of selling at the farm-gate.

Table 1. Monthly direct, indirect and total transaction costs (in KES, Kenya Shillings; 1USD = KES101) in 2 marketing channels.

	Farmer-urban market (n = 36)	Farm-gate (n = 75)	
Cause of transaction costs	Mean	Mean	t-test
Direct transaction costs			
Search for market and price information	2254.58	383.13	−2.240**
Contract negotiation	2876.39	293.07	−3.276***
Monitoring transaction	656.67	138.8	2.417***
Indirect transaction costs			
Search for market and price information	4349.72	1701.96	−0.853
Contract negotiation	1498.91	11.43	−1.004
Monitoring transactions	267.96	48.14	2.671***
Total transaction costs (in KES) associated with the participation in the two marketing channels			
Total direct transaction costs	5787.64	815	−4.021**
Total indirect transaction costs	6116.59	1761.53	−1.121
Total transaction costs	11904.23	2576.53	−2.040**

*,**,*** significant at $P < 0.1$, $P < 0.05$, or $P < 0.01$, respectively.

Another significant difference was for costs incurred in contract negotiation. Agricultural contracts are essential in reducing production and marketing risks (Kherallah and Kirsten, 2002). This is through the agreement of specific quality requirements with various intermediaries in the supply chain, and ensuring farmers have an immediate market outlet for their produce. Intermediaries can be exploitative, especially where farmers are highly dependent on them as their final buyer, which reduces the farmer's bargaining power (Mburu and Wale, 2006). Where intermediaries absorb a large portion of market risk they are more likely to impose low buying prices on farmers (Oguoma et al., 2010). Some costs intermediaries incur include transportation, assembling, inventory management, and storage. Contract negotiations, where intermediaries want to buy at low prices and farmers seek higher selling prices incur significant transaction costs as farmers may have to call various intermediaries to get better offers. Farmers who sell at urban markets, and not farmagate, may have to negotiate with various actors along the chain to access urban markets and participate, incurring transaction costs.

For farmers who sold at farmgate, searching for market information incurred different magnitudes of direct and indirect transaction costs. The indirect costs of searching for markets were higher meaning farmers spent more time searching for information on market prices as opposed to directly incurring cash to get this information, e.g., through visiting markets. This would ideally involve them calling or visiting neighboring farmers based on distance apart to determine prevailing prices and different contacts for middlemen who may pay better for leafy vegetables.

Higher values in direct and indirect transaction costs in a farmer-urban market arrangement, can be due to inadequate physical infrastructure that farmers who participate directly in urban markets face when traveling to these markets (Kirsten et al., 2009). Inadequate physical infrastructures, such

as all weather roads leads to higher transportation charges from service providers especially during rainy seasons and more time spent by farmers trying to find cheaper providers and negotiate favorable transport fees.

Another form of direct transaction costs among farmers who take vegetables directly to central markets is incorporated in costs of contracting and negotiation for market access and participation with urban market traders. This group of farmers incurred these costs primarily due to the presence of central market brokers. This particular institution of brokerage established rules acting as barriers to market entry. Farmers cannot sell produce directly in the central market without the assistance of a broker to whom they enter into an informal contract. Under this contractual arrangement, the farmer is obliged to pay a fee to the broker who then sells vegetables in the market on the farmer's behalf.

High indirect costs for farmers who sell directly at urban markets could be due to glut as the central markets receive vegetables from other locations. In order to ensure sales and profits margins are not affected, this group of farmers incurs transaction costs spending time searching for other markets to serve as alternative outlets for their produce.

Assessing the influence of transaction cost on the choice of market channel (Table 2) involved disaggregating these costs into direct and indirect information, negotiation and monitoring costs. Due to a high correlation among some of these transaction costs variables, only indirect costs of searching for information, monitoring, and directs costs involved in negotiation were included in the final analysis.

Indirect costs associated with searching for information had a significant, negative, association with market channel choice. Farmers would prefer to sell from the farm gate to avoid spending time searching for market information and prevailing market prices (Mmbando, 2014). Further, indirect costs associated with monitoring transactions had a significant, positive, association with market channel choice. This meant that the likelihood of a respondent chosing to sell directly from the urban market would increase if the respondent spent more time monitoring the viability of market transactions. This may be the case because more time spent monitoring market transactions may result in a farmer being more aware and certain of market dynamics thus ability to make less risky decisions when participating in urban markets.

Direct costs from contractual negotiations had a significant, positive, association with market channel choice. The more direct costs incurred negotiating contracts along the supply chain, the higher the farmer's probability of directly selling vegetables at the urban market. Like indirect costs associated with monitoring, this effect could have been positive because as farmers hope to maximize their utility they incur transaction costs making contracts with other actors to reduce risks of opportunism due to market imperfections.

Using market brokers had a significant, positive, association with selling at the urban market. Farmers who sold directly at urban markets had a higher

Table 2. Factors influencing choice of leafy vegetable market arrangement.

Dep. Var = MCC[a] (1 = Farmer selling to urban market, 0 = otherwise)					
Independent Variables	Coef.	Rob.Std. Err	z	P > z	dy/dx[b]
Constant	−2.76	1.30	−2.13**	0.033	
Sex	−0.12	0.48	−0.25	0.805	−0.05885
Age	0.05	0.02	2.33**	0.02	0.009548
Total number of years in school	−0.01	0.00	−1.72*	0.086	−0.00135
Vegetable share farm size	0.2	0.14	1.41	0.158	0.06174
Experience selling vegetables	−0.001	0	−1.59	0.112	−0.00036
Use of middlemen	−1.25	0.50	−2.52**	0.012	−0.44322
Interaction with other farmers	−0.27	0.51	−0.53	0.597	−0.12458
Information indirect cost	−3.3E-05	1.57E-05	−2.10**	0.036	−1.00E-05
Monitoring indirect cost	0.004	0.00	2.68***	0.007	0.001124
Negotiation direct cost	0.000355	0.00	3.51***	0.000	0.000106
Mode of transport	−0.73	0.65	−1.12	0.264	−0.18194
Nature of sales	−1.98	0.79	−2.52**	0.012	−0.3564
Vegetable farm size to total farm size	1.62	0.81	2.00**	0.046	0.443758
Use of market brokers	0.76	0.43	1.77*	0.077	0.211767
Number of obs = 111					
Pseudo R^2 = 0.5250					
Wald Chi-Sq = 108.20***					

*,**,*** significant at $P < 0.1$, $P < 0.05$, or $P < 0.01$, respectively.
[a]MCC = Market channel choice.
[b]Marginal effects.

likelihood of selling through market brokers. This can be due to the institutional environment of the particular market arrangement. Farmers preferred urban market brokers as they had their own clients in their respective markets and using them increased their chances of earning more.

Nature of sales based on buyer information had a significant, negative, association with market channel choice participation. A farmer who sold vegetables based on exact buyer requests had a higher probability of selling vegetables at farmgate than directly from urban markets.

Using middlemen to sell vegetables had a negative association with the choice of market channel. A farmer who used middlemen to sell vegetables at farmgate preferred not to travel directly to the urban market. The marginal effect of this variable indicated that the presence of middlemen reduced the probability of selling directly in urban markets. This may be related to the risk-averse nature of some farmers who would prefer not to incur costs selling in distant markets. Perceptions among farmers, where the existence of intermediaries is viewed as a beneficial market arrangement that overcomes problems of transaction costs and imperfect information have been observed in other parts of SSA (Oguoma et al., 2010).

Farmer age was positively, and significantly, associated with choosing to sell directly in urban markets. They attributed this to the ability of older farmers to better engage in negotiating for better market terms (Makhura, 2001). Farm size is essential in prompting smallholder market participation (Gebremedhin et al., 2009). The amount of land under vegetable production to total farm size was

significantly, and positively, associated with selling directly in urban markets. Marginal effects for this variable indicated a unit increase in the amount of land would increase the probability of selling vegetables in urban markets. The larger the farm size, the more it allowed a household to have surplus production and participate in distant markets (Mmbando, 2014).

Education had a significant, negative, association with choosing to sell directly at urban markets. This could be explained due to highly educated respondents having other non-farm forms of employment and they did not have time to interact, negotiate with various actors and sell vegetables from urban markets.

From the second step OLS regression of the Heckman Model (Table 3), five variables including the Inverse Mills Ratio, had a significant association with farmer profitability. This indicates the data had a selection bias problem and using the Heckman model was essential to correct the issue.

For variables associated with transaction costs, time spent searching for information had a significant, positive, association with profitability. This indicates farmers who sold directly in urban markets, and spent considerable time finding reliable actors to transact with, and avoid opportunistic behavior, would have a high likelihood of increasing profitability. Effective institutional environments and arrangements are best suited to reduce transaction costs and risks (Morrison et al., 2000). This means an appropriate institutional mechanism is necessary to replace the time-consuming process spent in searching for information by ensuring perfect market information reaches farmers. In such a scenario, leafy vegetable farmers would be expected to incur minimal transaction costs of this type as they endeavor to reduce risks and maximize utility. Contract negotiation and monitoring, albeit positive, did not have a significant relationship with profitability for participants in this channel.

Table 3. Factors affecting leafy vegetable farmers profitability.

Ln. Profits (n = 36)	Coef.	Rob.Std. Err.	z
Constant	10.24	1.35	9.53***
Sex	0.50	0.69	1.38
Age	0.006	0.20	0.52
Total number of years in school	−0.0008	0.00	−0.36
Vegetable farm size to total farm size ration	1.13	0.84	1.72*
Vegetable share farm size	0.23	0.13	1.33
Mode of transport	1.60	0.55	2.02**
Use of market brokers	−0.6	0.43	−1.05
Information time indirect cost	0.19	0.11	2.06**
Monitoring time indirect cost	0.1	0.20	1.31
Negotiation direct cost	0.19	0.12	0.35
Nature of sales	−1.79	0.72	−0.44
Interaction with other farmers	0.5	0.54	1.69*
Experience selling vegetables	0.002	0.01	0.43
Mills Ratio = −0.6572*			
Prob> Chi-Sq = 0.0000			
Log likelihood = −53.529172			

*, **, *** significant at $P < 0.1$, $P < 0.05$, or $P < 0.01$, respectively.

Ownership of an asset is an essential step in improving household income and welfare (Carter and Barrett, 2006). Ownership of a transportation asset, or ability to hire one, had a positive, significant, association with increasing profitability for farmers selling directly at urban markets. Ownership of bicycles, or motorized vehicles, increased the likelihood of market participation and higher revenue conditional on farmer participation (Boughton et al., 2007).

The vegetable farm size to total farm size ratio had a positive, significant, association with farmer profitability. Land holdings of farmers positively influenced their intensity of market supply (Mmbando, 2014). Increased land holdings resulted in increased production surplus and quantity sold. With other conditions being constant, these farmers had higher profit margins with an increase in sale volumes.

There was a significant, positive, association between frequency of interactions among farmers, as a measure of their social capital, selling in urban markets and an increase in profitability. Social capital among farmers is an essential pathway to improved livelihood (Kirsten et al., 2009). Through sharing mode of transportation and market information; farmers assist each other in reducing the uncertainty of market exchange, cost of market access, and participation allowing for improved profit. This cooperation is essential in reducing transaction costs as it gives farmers higher bargaining power when interacting with other stakeholders.

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