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Organic vegetables demand in urban area using a count outcome model: case study of Burkina Faso

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Abstract

This paper designs and tests a model for count outcomes to analyse the effective demand for organic vegetables in the city of Ouagadougou, Burkina Faso. From a 'short value chain' perspective, we show that the distance travelled by consumers to organic vegetable production sites primarily managed by women farmers' associations, is a key determinant of organic food demand. Furthermore, the effect of the distance travelled on the demand is stronger for women than for men. In addition, consumers' health awareness and the intended use of these vegetables are significant determinants of their demand. Moreover, social-relational factors affect the purchase decision both ways, including issues of trust and access to market information. Thus, this paper first introduces the socially subjective considerations of the demand for food in the close interaction between producers and consumers of organic food. Second, it contributes to filling the knowledge gap on the factors influencing consumer behaviour in purchasing organic food in urban production sites in developing countries.

Keywords: Organic vegetable, Short value chain, Urban food demand, Distance, Health, Burkina Faso

Background and aim

The global market for organic products continues to grow. Retail sales of organic food and drinks reached USD 80 billion in 2014 according to the Research Institute of Organic Agriculture (FiBL) and the International Federation of Organic Agriculture Movements (IFOAM) (Willer and Lernoud 2016). This expansion of the market for natural and organic products follows a global trend of an increasing demand arising from greater expectations for health and well-being. There is widespread concern about the use of chemicals and pesticides, which may have negative consequences on human health and the natural ecosystem (Dias et al. 2015).

In the scholarly literature, organic food consumption is related to environmental awareness, health, quality, perceived value, and price fairness (Srinieng and Thapa 2018; De Toni et al. 2017; Petrescu et al. 2017; Tsakiridou et al. 2008). However, little is known about organic food production and consumption in developing countries.

Indeed, North America and Europe generate the most organic food product sales, have about one-third of global organic farmlands, and consume over 90% of organic food and drinks (Willer and Lernoud 2016). But surprisingly, much of the organic crops are grown in other regions, especially in Asia, Latin America and Africa, and exported (Sahota 2016). Most literature on organic food markets (supply and demand) is dominated by case studies in the Western world (Orlando 2018; Benedetti et al. 2018; de Toni et al. 2017; Petrescu et al. 2017; Cene and Karaman 2015; Dias et al. 2015; Annett et al. 2008). These cases studies are about organic food production/consumption, certification and traceability within long food chains (with intermediaries and retailers). So far, little is known about the factors that shape local organic food demand in situations where there are no retailers or intermediaries between vegetable producers and consumers. Instead, in these cases, there is a direct linkage between producers and consumers. Such short food chains do exist in organic food production in rich countries, as well as in traditional agricultural and resource-constrained contexts such as peri-urban Burkina Faso. These short food value chains in Burkina Faso largely fall outside national statistics. There is, however, an extensive literature in other parts of the world on organic food. This establishes the key determinants of organic food demand in terms of sensory factors (e.g. food taste) and non-sensory characteristics (e.g. gender) of consumers (Annett et al. 2008; Tsakiridou et al. 2008; Dias et al. 2015; Cene and Karaman 2015; Petrescu et al. 2017; de Toni et al. 2017). Some authors use the concepts of pull and push factors to explain the behaviour of consumers towards organic food (Nandi et al. (2016)): health concerns, environmental awareness, income, price, food availability, education, gender, perception of organic food, taste, and nutrition value, are amongst the factors that shape the demand for organic food found in this literature. Even though these case studies have largely focused on vegetable demand in their approach (Srinieng and Thapa 2018; Nandi et al. 2016), they did not consider the demand of those foods as a dynamic system in which the producers and consumers interact with each other within a 'market place'.

Hence, this research addresses the question: What are the interactive determinants of the effective demand for organic vegetables within the short food chain in the urban context? It empirically tests the significance of these determinants in a case study of Ouagadougou in Burkina Faso. Ouagadougou is an interesting context because consumers are increasingly becoming aware of the benefits of eating fresh organic products and are willing to pay premium prices for it. Also, although a certain internal (local) demand exists, the supply of products in the local market is still quite low: data from the National Council for Organic Agriculture (CNABio) identifies only two production sites of organic vegetables, 3 acres in total, in the Ouagadougou (CNABio 2015). Two women groups produce fresh vegetables in both sites (Women Food Entrepreneurs-WFE project 2015). Such organic food is seen as a new concept in Ouagadougou as there is no formal evidence of the attachment of consumers to organic food within a weak existing system regulating the supply and consumption of this type of food.

Determinants of the demand for organic food

Organic food demand is a complex process that involves several stages or steps (Thøgersen and Zhou 2012; Yiridoe et al. 2005). Two approaches to analyse this demand are identified in the literature: the ex-post and ex-ante approach. The ex-post

approach to the demand or effective demand focuses on concepts like continued demand or adoption (Thøgersen and Zhou 2012), organic product purchase decisions (Yiridoe et al. 2005) or repurchase intentions (De Toni et al. 2017). At this stage, the demand is considered as integral to the consumers' habits, meaning that they have integrated consumption of organic food into their consumption behaviour. In contrast, the ex-ante approach to the demand or non-effective demand focuses on the intention or decision to adopt (Thøgersen and Zhou 2012) consumers' preferences and attitudes which is also called perceived demand (Yiridoe et al. 2005) or perceived value (de Toni et al. 2017), or willingness to pay (Gschwandtner 2017; Lim et al. 2014; Hamzaoui-Essoussi and Zahaf 2012).

Whilst many studies have analysed the main determinants of non-effective demand (Srinieng and Thapa 2018; Ricci et al. 2018; Gschwandtner 2017; Drexler et al. 2017; Hasselbach and Roosen 2015; Lim et al. 2014; Henryks et al. 2014; Hamzaoui-Essoussi and Zahaf 2012; Rodríguez 2012; Suh et al. 2012; Chang and Zepeda 2009; Kim et al. 2008; Lodorfos and Dennis 2008; Yiridoe et al. 2005), there is almost no significant distinction between non-effective and effective demand, except that the former is based on perceptions. This justifies our analysis of the effective demand for organic food through the ex-post approach.

Many empirical studies adopt the ex-post approach and identify key explanatory factors to organic food demand (Benedetti et al. 2018; Pham et al. 2018; Petrescu et al. 2017; de Toni et al. 2017; Nandi et al. 2016; Cene and Karaman 2015; Quah and Tan 2009; Tsakiridou et al. 2008; De Magistris and Gracia 2008). They conclude that, first, environmental awareness and health consciousness are found to be the core characteristics of organic food that consumers look for when buying them: consumers[1] are keen to buy organic food products when they have information on the health attributes of such products; hence, access to information is seen as an important step prior to the effective demand for organic food (Pham et al. 2018; Annett et al. 2008). This is the same when consumers seek environment-friendly products (Benedetti et al. 2018; Pham et al. 2018; de Toni et al. 2017; Nandi et al. 2016; Cene and Karaman 2015; Tsakiridou et al. 2008; De Magistris and Gracia 2008).

Second, sensory factors such as colour, shape, texture and the taste of organic food (Pham et al. 2018; Petrescu et al. 2017), nutritional value or benefit seen in organic food (Nandi et al. 2016; Annett et al. 2008), and, more broadly, the quality of these foods (de Toni et al. 2017) are other significant determinants of their demand. Besides these sensory factors, other significant determinants of organic food demand include socio-demographic factors of consumers such as education, gender (Nandi et al. 2016); food safety (Pham et al. 2018; Quah and Tan 2009); presence of a sick friend/member in household, and health-supplement expenditures (Quah and Tan 2009). In addition, human factors such as the desire of consumers to support their local economy is a significant determinant (Nandi et al. 2016). Furthermore, consumers rely on local producers because local food production activities, and thus quality, can be easily checked and traced (Annett et al. 2008).

Third, price and consumer income are significant factors underlying the demand for organic food. Evidence shows that the price of organic food is the most restricting

[1]Consumers' income is found to not have a significant impact on this effective demand.

factor to their demand (Pham et al. 2018; Petrescu et al. 2017; de Toni et al. 2017; Cene and Karaman 2015). This is consistent with classical economic demand theory as organic goods are highly elastic (Yiridoe et al. 2005). In contrast, other authors have found that the price of organic products is not a significant determinant of demand, possibly because organic food is healthy and environmentally sustainable and sought by consumers (Benedetti et al. 2018; Nandi et al. 2016; Annett et al. 2008; Tsakiridou et al. 2008; De Magistris and Gracia 2008). With regard to income, two strands of empirical evidence exist. The first strand considers income as a key determinant of the demand for organic food products in the sense that low-income consumers cannot afford them (Petrescu et al. 2017; Nandi et al. 2016; Cene and Karaman 2015; Quah and Tan 2009; De Magistris and Gracia 2008). As such, organic food can be considered as a normal good because any increase in income in a household willing to consume these healthy and environment-friendly products will also increase the demand for these products (Yiridoe et al. 2005). In the second strand, income is not a significant factor affecting the demand for organic food (Benedetti et al. 2018; Pham et al. 2018; de Toni et al. 2017; Annett et al. 2008; Tsakiridou et al. 2008). Hence, effective demand is not just income centred.

Fourth, other factors such as the availability of organic food (Pham et al. 2018; Petrescu et al. 2017; Cene and Karaman 2015; Quah and Tan 2009), their labelling and the extra time to buy them (Pham et al. 2018) are likely to increase or decrease their demand.

In summary, the empirical evidence using the ex-post approach has shown factors that influence demand but not clearly identified the interactive factors explaining the close or direct relationship between consumers and organic food producers. To fill this gap, we adopt the short food chain theoretical thinking that focuses on the direct interaction between consumers and producers where good relationships between them are necessary (Marsden et al. 2000). In the short food chain, new quality definitions are associated with the locality/region or spatiality, nature and networks. The short food chain provides the capacity to re-socialise or re-spatialize food and then allows consumers to make value judgements about their desirability based on their own knowledge, experience or perceived imagery. Short food chains are thus perceived as delivering 'more healthy' foods (Marsden et al. 2000). Short food chains also have the potential to shift the production of food commodities out of their industrial mode, to short-circuit the long, complex and rationally organised chain with a small part of the total value captured by the primary producers (Marsden et al. 2000). As such, the short food chain redefines the producer-consumer relationships by giving clear signals about the origin of the food products, that is, their traceability. In this relationship, value and meaning are central elements rather than the exchanged product itself (Marsden et al. 2000).

In this paper, we identify several theoretical factors explaining the demand for organic vegetables. First, the frequency (dependent variable) with which consumers or producers directly exchange organic food can theoretically be a significant proxy of the demand for organic food because it can show the attachment that both actors have to each other, and particularly the intensity with which households consume those food products. Second, consumers' knowledge and information about the market are assumed to influence food production activities and, thus, the demand because, in a close

relationship, consumers can share with producers such knowledge or experience and information on food production and marketing strategies/techniques.

Third, in our approach, organic foods that are characterised by environmental and health awareness can be analogised to natural resources with use and non-use values (Rulleau et al. 2010; Desaigues and Point 1993). Thus, consumers can travel a certain distance from their home to the production sites to buy this organic food, and also express their attachment to these sites. As such, a third new theoretical explanatory factor is the distance from the production site to the household residence.

In addition to these new theoretical determinants, consumers' personal norms, socio-cultural, and economic factors (sensory and non-sensory factors globally, and particularly gender, purchased quantity) can interact to shape the behaviour of consumers over time. Indeed, as gender influences the purchase patterns of food products in the African context, this factor can play a significant role as women are likely to have different transport options (Duchène 2011). As such, we hypothesise that gender interacts with the distance travelled by female consumers as women may not have access to the same means of transportation as men do (Duchène 2011).

Furthermore, we also assume that gender interacts with the amount of purchased food. We assume that household income is not central in this model as, when a consumer travels from his or her home to the site to buy such foods, the consumer has the purchasing power to purchase the organic food. As the model also considers the traceability of organic food products, the labelling system that provides information on certification of organic food and how it is perceived by buyers is assumed to have a significant influence on the demand for those foods. The food price is also worth focusing on according to the previous studies: it can contribute to a better understanding of consumers' attachment to organic food themselves and their production sites, as well as be an indicator of the purchasing power of each consumer. As such, the price is assumed to not restrict the demand for those organic food products. Finally, the perceived quality of organic food is an important determinant as it is a central part of households' consumption behaviour, according to previous studies: it provides additional motivations for consumers to buy organic food from the production site. Thus, the perceived quality of organic food is assumed to significantly increase the demand for these food products. Figure 1 below provides the theoretical model of organic food demand in the short food chain framework.

Data and methods

Data collection

This study was carried out by systematically following up on the marketing activities of fresh vegetables at two production sites in Ouagadougou, Burkina Faso: Amicale des Forestières du Burkina (AMIFOB) and Saisonnière, respectively, in Tampouy and Kossodo district of Ouagadougou. In the period between 2 December 2017 and 20 January 2018, we carried out, on a weekly basis, follow-up activities that consisted of going to the production sites from 6:00 am to 6:00 pm each Saturday. This aimed to conduct a daily census of all the clients that bought organic vegetables at the production site. A semi-structured questionnaire was used to gather the quantitative and qualitative information on the interaction between producers and clients. Based on this exercise, a total

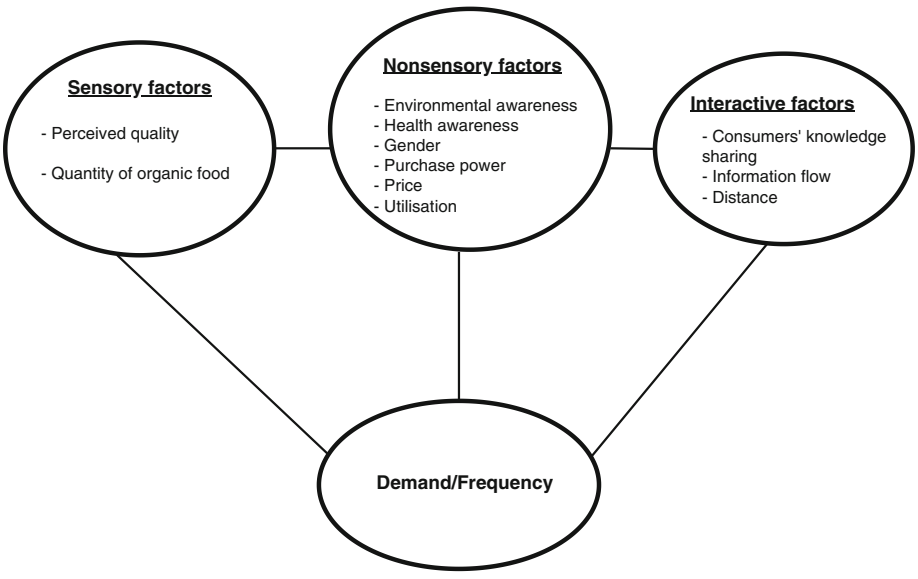

Fig. 1 Organic food demand in a short value chain framework. Groups of factors interacting each to other and determining the demand for organic food (*Source: Authors Design*)

sample of 213 was reached, with some clients repeatedly interviewed, thus, giving us some longitudinal data.[2]

The questionnaire was structured as follows: The first part addressed the general information on clients/consumers who came to purchase vegetables at the production site. Information included the site where the interview happened, duration of the interview, identity of the client (including gender), residence location and distance between the site and the residence. This part of the questionnaire also addressed the number and type of vegetable crops bought, and the quantity and price of each crop bought. The second part of the questionnaire was composed of both closed and open questions. The open questions supported the closed ones, and were later recoded to redefine new variables to support our analysis. The answers and the coding of their narrative allowed us to have data on all the variables presented in the theoretical model in Fig. 1. In addition, we were able to record the number of clients per day per site during this data collection period. Finally, the interpretation of the meaning of the narratives (to opened questions) of clients has contributed to complementing the quantitative analysis described below.

In regard to the nature of our data, a count outcome regression model, particularly the Poisson distribution was used to estimate the demand for these organic vegetables (Wooldridge 2002; Greene 2002; Long and Freese 2001). Thus, we considered the frequency or the number of times in a month clients bought organic vegetables at a given production site as a dependent variable of 'organic vegetable demand' (see the

[2]In this paper, we did not consider the longitudinal data collected from consumers.

"Empirical model" section). This variable is a discrete one that takes the following values: 1, 2, 3,…. (count data).

As shown above, this dependent variable is theoretically determined by several other explanatory variables: (1) *perceived quality* (*Qual*) of the vegetable by the consumers. This is an ordered variable that takes values ranging from 1 to 4 (1 = fairly good quality to 4 = excellent quality); (2) *quantity* (*Quan*) of purchased vegetables measured in grammes; (3) *price* (*Pri*) of purchased vegetables measured in the local currency (XOF); (4) *number* (*Numb*) of purchased vegetables; (5) *environmental awareness* (*Env*), a binary variable taking the value 1 if yes and 0 if no (consumers claiming yes or no their environmental considerations); (6) *health awareness* (*Health*), a binary variable taking the value 1 if yes and 0 if no (consumers claiming yes or no health considerations); (7) *gender* (*Gend*) of consumers taking the value 1 if female and 0 if male; (8) *purchasing power* (*Pow*) of consumers. This is an ordered variable derived from consumers' perception of the price of vegetables that they bought. As stated above, all consumers who bought such food already had certain purchasing power. The variable then takes values ranging from 1 (if the price is perceived very high) to 3 (if the food is perceived as cheaper); (9) *knowledge* (*market or production techniques*) *sharing* (*Know*) by consumers. This is a binary variable with value 1 if the consumer claims to share his/her knowledge with producers and 0 if the consumer does not; (10) *flow of information* (*Info*) from producers to consumers. This variable is a binary one that takes the value 1 if producers share information on vegetables with consumers and 0 if the producer does not; (11) *distance* (*Dist*) travelled by consumers to the site and from the site to home, measured in kilometre and (12) the utilisation or destination (*Util*) of the purchased vegetable that takes the value 1 if for household/direct consumption and 0 if for reselling. In practice, given the data, we combined the quantity of crops and their price to get the value of the purchased crop (*Val*): value measured in West Africa currency (XOF).

Descriptive statistics

The survey sample of 213 observations was cleaned up to deliver 188 to 202 clear observations[3] depending on the subsets of variables of interest. We used this to compute the descriptive statistics (see Table 1). We conclude that 79.8% of organic vegetable (e.g. lettuce, radish) buyers are females. Furthermore, 98.9% of purchased organic vegetables are for household consumption (including some family social events such as wedding and feasts). The other 1.1% is for retailing. Approximately 53.2% of buyers are motivated by the healthy characteristics of these vegetables and 53.7% buy them because of environmental considerations: they are perceived to be of good quality according to 87.8% of buyers. In total, only 1.6% of buyers find these organic vegetables as fairly good quality (acceptable quality). In addition, few buyers (4.3%) buy such vegetables just to support women involved in this activity. Interestingly, in regard to purchasing power, 67.6% of buyers have a middle income whereas 23.4% have a high income; only 9.0% of buyers have a low income. Finally, in terms of the interaction between producers and consumers, only 34.0% of buyers admit to sharing any information at

[3]This loss in the sample is mainly due to the non-responses to some questions, which were not applicable to those interviewed consumers.

Table 1 Descriptive statistics of the nominal and categorical variables

Variables	Values	*N*	Percent
Gender of client	Male	38	20.2
	Female	150	79.8
	Total	**188**	**100.0**
Utilisation	Selling	2	1.1
	Consumption	186	98.9
	Total	**188**	**100.0**
Health awareness	No	88	46.8
	Yes	100	53.2
	Total	**188**	**100.0**
Environmental awareness	No	87	46.3
	Yes	101	53.7
	Total	188	100.0
Supporting women group	No	180	95.7
	Yes	8	4.3
	Total	**188**	**100.0**
Perceived quality	Fairly good	3	1.6
	Good	165	87.8
	Very good	16	8.5
	Excellent	4	2.1
	Total	**188**	**100.0**
Purchase power	Low	17	9.0
	Middle	127	67.6
	High	44	23.4
	Total	**188**	**100.0**
Information sharing by consumer	No	124	66.0
	Yes	64	34.0
	Total	**188**	**100.0**
Knowledge sharing by consumer	No	163	86.7
	Yes	25	13.3
	Total	**188**	**100.0**

Source: Field survey Ouagadougou, 2017-2018

their disposal with producers, and 13.3% of clients share their knowledge or experience with producers.

Moreover, data in Table 2 shows that, on average, a purchaser goes to the organic vegetable production site 7.36 times per month whilst a few go every day, or 30 times a month. A client buys, on average, 1.24 crops and a maximum of 6 crops per purchase

Table 2 Descriptive statistics of continues variables

Variables	*N*	Min	Max	Mean	Std. deviation
Frequency	188	1.00	30.00	7.36	5.41
Number of crops	188	1	6	1.24	0.85
Distance	188	0.01	60.00	4.81	8.94
Purchase value	188	50	15,000	960.64	2112.10

Source: Field survey Ouagadougou, 2017-2018

Table 3 Classes of distance travelled by consumers

Distance (km)	Number	Percent (%)
< = 0.5	43	20.19
[0.5; 5]	124	58.22
[5; 10]	26	12.21
[10; 15]	2	0.94
[15; 20]	3	1.41
> 20	15	7.04
Total	**213**	**100.00**

Source: Field survey Ouagadougou, 2017-2018

time. In addition, a purchaser travels 4.81 km per round-trip from the point of residence to the production site. The distance ranged between 10 m and 60 km. Finally, the purchase value is about XOF 960.64 (US$ 1.70) per client and per time, with a maximum of XOF 15000 (US$ 26.55) per time.

In addition, Table 3 categorises consumers on the basis of the distance they travel to the production sites. It shows that more than 20% of the consumers live in the neighbourhood (less than 0.5 km) of vegetable production sites. The most important proportion of consumers (more than 58%) live between 0.5 and 5 km from the sites. And more than 7% of consumers in the sample travel at least 20 km to the production sites.

Finally, Table 4 shows that, on average, a female purchaser travels 4.96 kilometres per round-trip to the production site compared to men (4.38 km). The standard deviation is higher for female buyers than male ones (respectively 9.27 and 7.49). And, the maximum travelled distance for female clients is also higher than for male clients (respectively 60 and 36 km). All these data show that female buyers travel a slightly higher distance than male buyers do, to purchase the food at the production sites.

With regards to the purchase frequency, a male client goes to the site 7.24 times per month on average compared to a female client (7.17 times per month). The standard deviation is higher for male than for female clients (respectively 6.39 and 5.51). It stands out that there is a relatively higher variability of the frequency in favour of male clients compared to female clients.

Empirical model

Following the introduction of the theoretical count outcome model in the data collection section, the empirical model can be presented as follows:

Table 4 Frequency and travelled distance in regards to the gender

		Mean	Std. Dev	Min	Max
Frequency	Male	7.24	6.39	1	30
	Female	7.17	5.51	1	30
Distance	Male	4.38	7.49	0.2	36
	Female	4.96	9.27	0.01	60

Source: Field survey Ouagadougou, 2017-2018

$$Demand = f(Qual, Quan, Pri, Numb, Env, Health, Gend, Pow, Know, Info, Dist,) \tag{1}$$

where $f(.)$ is a function whose mathematical form is to be specified.

Since the dependent variable (*Demand = Frequency or Freq*) is the number of times or frequency with which consumers who purchase organic vegetables at the production sites over a month, this count variable fulfils the conditions of the Poisson distribution (Chesneau 2018; Wooldridge 2002; Greene 2002). That is,

$$\text{Demand} \sim P(\lambda(x)), \text{where } \lambda(x) = E(Demand|\{X = x\}); \tag{2}$$

$$\text{where } X = (Qual, Quan, Pri, Numb, Env, Health, Gend, Pow, Know, Info, Dist),$$

the set of the explanatory variables of organic vegetables demand. However, we replace the price and quantity of the purchased crops by their value as: Value = Price×Quantity (see Eq. 4) where Val = value of purchased food.

As such, for any $k \in \mathbb{N}$, the probability:

$$P(Demand = k|\{X = x\}) \text{ is } P_k(x) = \exp(-\lambda(x))\frac{(\lambda(x))^k}{k!} \tag{3}$$

In line with the sample size, equation (Eq. 1) can be rewritten for a consumer i as follows:

$$Demand_i = f(Qual_i, Val_i, Numb_i, Env_i, Health_i, Gend_i, Pow_i, Know_i, Info_i, Dist_i) \tag{4}$$

with $i = 1, 2, \ldots, n$, *n being the sample size, that is,* 202 *consumers.*

Equation (2) can be rewritten as follow:

$$\ln(\lambda(x)) = \beta_0 + \beta_1 \text{Qual} + \beta_2 \text{Val} + \beta_3 \text{Numb} + \beta_4 \text{Env} + \beta_5 \text{Health} + \beta_6 \text{Gend} + \beta_7 \text{Pow} + \beta_8 \text{Know} + \beta_9 \text{Info} + \beta_{10} \text{Dist} \tag{5}$$

That means:

$$\lambda(x) = \exp(\beta_0 + \beta_1 \text{Qual} + \beta_2 \text{Val} + \beta_3 \text{Numb} + \beta_4 \text{Env} + \beta_5 \text{Health} + \beta_6 \text{Gend} + \beta_7 \text{Pow} + \beta_8 \text{Know} + \beta_9 \text{Info} + \beta_{10} \text{Dist}) \tag{6}$$

As assumed in the theory above, interaction variables were introduced in the model to control for the effect of gender on the value of the purchased food and the distance travelled by consumers to the production sites. The underlying reason for this is that female consumers are likely to have a different budget than male consumers, and female/male mobility may be gender biassed as well. Thus, equation (Eq. 6) is rewritten as follows:

$$\lambda(x) = \exp(\beta_0 + \beta_1 \text{Qual} + \beta_2 \text{Val} + \beta_3 \text{Numb} + \beta_4 \text{Env} + \beta_5 \text{Health} + \beta_6 \text{Gend} + \beta_7 \text{Pow} + \beta_8 \text{Know} + \beta_9 \text{Info} + \beta_{10} \text{Dist} + \beta_{11} \text{Val}*\text{Gend} + \beta_{12} \text{Dist}*\text{Gend}) \tag{7}$$

The aim is to estimate the β_0, β_1, ...β_{12} from our data set, that means estimating $\lambda(x)$ and $P_k(x)$ by substitution. Therefore, we used the conditional maximum likelihood method for that purpose (see Wooldridge 2002).

[4]We exclude the variable "Know" and "Qual" from the list of explanatory variables because the models do not have a good fit with them.

Table 5 Poisson and negative binomial models

Frequency	Poisson (PRM)	Negative binomial (NBRM)
Health	0.1805846 (3.31)***	0.2229538 (2.05)**
Distance	−0.0495767 (−4.00)***	−0.0575186 (−2.75)***
Utilisation	−0.8727124 (−5.89)***	−0.9575999 (−2.38)**
Environ	0.0431457 (0.78)	0.0686963 (0.62)
Support	−0.2043093 (−1.33)	−0.2126473 (−0.78)
Value	0.1625952 (1.86)*	0.1670796 (0.97)
Number of crop	−0.0188148 (−0.46)	−0.0150279 (−0.20)
Power	0.0779047 (1.60)	0.0768872 (0.79)
Gender	0.9387853 (1.71)*	1.064793 (1.00)
Gend*Val	−0.1829558 (−1.99)	−0.2094394 (−1.16)
Gend*Dist	0.0308516 (2.39)**	0.0397297 (1.83)*
Constant	1.835343 (3.35)***	1.88481 (1.71)*
Lnalpha		−0.9359292
Alpha		0.3922212
	Log likelihood = −725.74641	Log likelihood = −584.76611
	Observations: 202	Observations: 202

Source: Field survey Ouagadougou, 2017-2018

Model estimation technique and goodness-of-fit

The Poisson regression model (PRM) was run using the method of conditional maximum likelihood estimation (CMLE) (Wooldridge 2002) as it provides consistent estimated parameters of the models. However, as Poisson regression, in practice, rarely fits with data because of the problem of over-dispersion often occurring (Long and Freese 2001), the negative binomial regression model (NBRM) was also run to test the over dispersion. This has led to Table 5[4] below. Indeed, the PRM and NBRM have the same mean structure (Long and Freese 2001), and must be ran to detect the problem of over dispersion. That is, if the assumptions of the NBRM are correct, the expected rate for a given level of the independent variables will be the same in both models. However, the standard errors in the PRM will be biassed downward, resulting in spuriously large z values and spuriously small p values (Cameron and Trivedi 1986).

Estimates of the corresponding parameters from the PRM and NBRM are close, but the z-values for NBRM are consistently smaller than those of PRM. This is the expected consequence of over dispersion. Thus, the over-dispersion test using the one by Long and Freese (2001) is run as follows: the test of G^2 = 2(lnLNBRM−lnLPRM) with lnL of each model indicated at the bottom of Table 4. The computed value of G^2 is 281.96. It is identical to the value of chibar2(01) LR testing the significance of Lnalpha of the negative binomial regression model. As the associated p value to chibar2(01) is 0.0000, this means that the negative binomial regression model is the adequate model as it fits well with the data. Therefore, instead of using Poisson regression, the negative binomial model was adequate to analyse the causal effects of the demand for organic vegetables in Ouagadougou.

Table 6 Estimate of negative binomial regression model

Frequency	Coefficient	*z*	*p* > *z*
Health	0.2229538**	2.05	0.041
Distance	−0.0575186***	−2.75	0.006
Utilisation	−0.9575999**	−2.38	0.017
Environ	0.0686963	0.62	0.533
Support	−0.2126473	−0.78	0.437
Value	0.1670796	0.97	0.330
Number of crop	−0.0150279	−0.20	0.842
Power	0.0768872	0.79	0.431
Gender	1.064793	1.00	0.317
Gend*Val	−0.2094394	−1.16	0.246
Gend*Dist	0.0397297*	1.83	0.067
Constant	1.88481*	1.71	0.088
Lnalpha	0.2229538		
Alpha	−0.0575186		

LR chi2 (11) = 24.65; prob > chi2 = 0.0103
Log likelihood (non-restricted) = −584.76611
Log likelihood (restricted) = −614.4008
LR test of alpha = 0: chibar2 (01) = 281.96; prob > = chibar2 = 0.000
Level of significance: ***(1%); **(5%); *(10%)
Source: Field survey Ouagadougou, 2017-2018

Results and discussion

Table 6 below shows the results of the negative regression binomial model used to analyse the determinants of the demand for organic vegetables.

In Ouagadougou, the demand for organic vegetables increases if consumers prioritise their health. Indeed, the health awareness of consumers significantly increases the probability that they buy organic vegetables frequently at the production sites. In other words, consumers who care more about the healthy attributes of food for consumption are more likely to be motivated to frequently buy organic food at their production sites. This result confirms those of the several studies reviewed above (Benedetti et al. 2018; Pham et al. 2018; de Toni et al. 2017; Nandi et al. 2016; Cene and Karaman 2015; Tsakiridou et al. 2008; De Magistris and Gracia 2008). The difference between this result and the results of previous studies on the effective demand for organic food found in the literature is that consumers are able to appreciate by themselves the production techniques of the vegetables they purchase in situ, with the possibility for them to ask questions to the food producers for more information. This result also confirms the overall approach of the short food chain theoretical perspective because the traceability of the organic food consumers purchase is guaranteed, giving them more trust in eating such food. For instance, a client asserts: “I only consume vegetable products (such as lettuce) from this site because of its cleanliness, high quality, and healthiness. And in case of non-availability, I do not consume lettuce at home until it becomes available at the site”. This sheds light on the trust he or she expresses towards such food at this site. Finally, this can also justify why more than 9% of the clients in the sample travel at least 10 km from their home to the production sites (see Table 3).

The distance travelled by consumers to purchase organic vegetables at the production sites significantly decreases the demand for such food in Ouagadougou. Indeed, when

this distance increases, consumers of organic food are less likely to be motivated to demand organic vegetables. This can be seen as logical since economic agents who are supposed to be rational see high transaction costs in a longer travel distance to purchase such food. As such, this result is in line with the transaction costs theory within the broad paradigm of institutional economics (Williamson 1989) and may explain why more than 78% of consumers in the sample live between 0.01 and 5 km (in a round trip). However, as the distance is an interest variable, it is worth paying attention to the motivations of the 9% of consumers who travel between 10 to 60 km to purchase organic food at the production sites. Indeed, amongst those 19 consumers who live at this distance, 4 come weekly to the production site to buy organic vegetables. The main reason they give is the healthy attributes of such food as well as the clean water used to irrigate the crops and the hygiene surrounding the production process. That is, those consumers are not guided by the price or the costs related to their travel to the site, but the intrinsic or real value that they attach to those sites. For instance, purchasers say: "I consume this product because they do not use chemicals in the production process, they use clean water and the products are organic" or because " the products are produced in a clean way". This sheds light on the attachment of the consumers to the sites. Compared to the other consumers that perceive the same attributes in such food, we can deduce that the attachment of the former to the site activities is greater when considering the effort they put into the process. In particular, by linking the long distance travelled by these consumers with their appreciation of the price, the number of times they frequent the sites and the potential transportation costs (which is an additional cost to the price), it stands out that this type of consumer is much more attached to the sites than others. From an anthropological perspective, the behaviour of consumers who live far from the production sites is not irrational, but socially valuable as they have integrated several social considerations into their behaviour that contributes to social and environmental sustainability, and their own well-being (health).

The foreseen utilisation of the purchased vegetables importantly determines their demand. Specifically, the probability that the clients demand this food item decreases when they are destined for selling. This result explains why more 98% of the clients of such food items are direct consumers, and not resellers or intermediaries in Ouagadougou. This shows that consumers are aware and value the quality and traceability of the food they eat. For instance, consumers assert: "here, it is better because the products are directly harvested and sold at the farms compared to the market place" or "it is because of the good quality of the food compared to what is sold at the market place as it is difficult to know if the food there is organic or not". This confirms the theoretical understanding of the demand for a good in the short value chain (Marsden et al. 2000) and thus contributes to the existing empirical literature.

Finally, the interaction between the distance and gender significantly determines the demand for organic food. In fact, this interaction is supposed to amplify the effect of the distance travelled on food demand in regards to the client's gender. Results show that the distance that consumers need to travel to purchase organic vegetables at the production sites affects the frequency with which female clients visit these sites in comparison with male clients. The probable reason is that women do not have equal access to transportation means as men and because women are poorer than men (cf. Duchène 2011; Peters 1999).

These results do not imply a rejection of the entire conceptual framework. Indeed, evidence shows that the results of the negative binomial regression model leads to a rejection of two of the hypotheses related to the interactive variables (knowledge and information sharing). The model results also imply a rejection of the hypotheses on all the sensory variables included in our theoretical model: perceived quality and quantity of purchased vegetables do not significantly explain the demand for organic vegetables. Furthermore, the model rejects the hypotheses on four out of the six non-sensory factors that theoretically determine the demand for organic vegetables: environmental awareness, gender, purchasing power and the price do not have a significant effect on the demand. In addition, the model rejects one of the two hypotheses on the interaction between our interactive factors and non-sensory ones: gender and purchase value. However, and interestingly, the results confirm the need to focus on the interactive factors of the demand under the short value chain perspective, particularly the distance travelled seen as reflecting the attachment consumers or clients have to the food/production sites they buy/go to. Results also validate the importance of the health attributes, and utilisation of the purchased crop in the demand habits, as well as the control variable that catches the interaction between gender and distance. However, in the last case, the field research confirms the existence of an ineffective policy framework regulating the actors involved in organic food production: the state authorities are in charge of the certification of production, but a rigorous control and monitoring system is lacking.

Conclusion

The distance travelled by consumers and the expected utilisation of food are two major determinants of the demand for organic vegetables in Ouagadougou. First, the distance is a factor that negatively affects demand especially for women who are poorer and have fewer transport options than men. However, there is a social value as consumers appear to be attached to the production sites. Second, the traceability and the possibility of interaction with the producers at the sites increase the likelihood of demand for consumers. In addition, the health awareness of consumers is another significant driver of the demand for organic vegetables. Although variables such as information and knowledge sharing and the desire to support women group's activities are not statistically significant, they still make sense from an anthropological perspective and call for more integration with anthropological approaches.

In terms of implication, this research is informative at two levels. First, at the producer-level, producers should be aware that most of their clients prefer quality (i.e. the healthiness of the product, the hygienic nature of the area where production takes place, the types of inputs used in food production—whether chemical or organic) products. Therefore, producers should consider such information to continuously meet these quality conditions. Second, at the policy level, since there is an increase in demand for organic food, the quality control authorities should pay attention to producers who claim to provide organic food to the population, by frequently testing the food in order to deliver periodic certification and share the information with consumers through the media.

The main limit of this paper lies in the interpretation of the meaning of the narratives provided by interviewees to both recoding and discussing the relationships between the explanatory and non-explanatory variables. This could have been avoided by first conducting a pilot test of the semi-structural questionnaire, and second, integrating the full recoded variables to a closed questionnaire for the survey.

Endnotes

The questions included, amongst others: What is the destination or utilisation foreseen for each crop? What are the motivations for the client to buy these vegetable crops? What is the client's perception of the crop's quality they bought? What is the frequency or number of times in the week or month the client purchased these vegetable crops? What is the client appreciation of the purchasing price of each vegetable crop? Does the client make comments/remarks towards vegetable producers? And why? Does the client share with the vegetable producers his/her knowledge related to the set of activities (production, marketing)? And how?

Abbreviations

AMIFOB: Amicale des forestières du Burkina; CMLE: Conditional maximum likelihood estimation; CNABio: National Council for Organic Agriculture; FiBL: Research Institute of Organic Agriculture; IFOAM: International Federation of Organic Agriculture Movements; NBRM: Negative binomial regression model; PRM: Poisson regression model; WFE: Women food entrepreneurs; XOF: Franc de la Communauté Financière Africaine (FCFA)

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Authors' contributions

JK wrote the first full draft of the paper under the supervision of NP and JG: literature review, data collection and analysis, writing up. NP reviewed the paper and gave comments, tips and suggestions to improve the paper. JG reviewed and edited the paper, gave comments, tips and suggestions to improve the paper. The author(s) read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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