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Household demand for food in the Democratic Republic of Congo. A Quadratic Almost Ideal Demand System

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List of abbreviations

DRC: Democratic Republic of Congo

QUAIDS: Quadratic Almost Ideal Demand System

IAD: Indirect Addilog Demand

AIDS: Almost Ideal Demand System

U_Own: Uncompensated Own Price Elasticity

C_Own: Compensated Own Price Elasticity

Abstract

In recent years, the Democratic Republic of Congo has experienced sustained economic growth. However, this did not translate into improved food security. To generate the evidence required to design and implement effective food policies, this study utilised two rounds of National Household Surveys collected in 2005 and 2012 to estimate the demand elasticities for eight food groups using the QUAIDS model. Overall, the findings are consistent with the demand theory. The estimated income elasticities suggested that most of the food groups were normal goods. In the urban areas, the own-price elasticities suggested that vegetable, milk, meat and fish, main staples and oil were price elastic, while pulses, fruits and sugar were inelastic. In the rural areas, pulses, vegetables, milk and oil were price elastic, whereas the main staples group was not. The results of the cross-price elasticities in both urban and rural areas showed that all the food groups are complements to the main staples and substitutes to meat and fish. Also, the findings revealed that substitution effects induced by price change were insignificant in rural areas. The study recommends policies that target the increase of household's income and multi-stakeholder partnership to improve the food sector of DRC.

Keywords: QUAIDS model, DRC households, price elasticities, income elasticities, food

1. Introduction

Understanding the magnitude and direction of changes in household's food consumption induced by changes in prices and expenditures is critical in the design of strategies to achieve food security and nutrition. In view of this, it is important that each country takes the responsibility of formulating appropriate policies that are geared towards ending food insecurity and malnutrition (African Union, 2003, 2014, 2015; Hendriks, 2018). Regarding the Democratic Republic of Congo (DRC), it relies on the import of cereals, especially maize and rice. In addition to cassava and maize, DRC has diversified food system including palm oil, which is in high consumption and a significant source of income. Fruits, milk and dairy products as well as other livestock products that are scarce and expensive (Ulimwengu *et al.*, 2012; Marivoet, 2016).

Although, there are many factors that affect food choice, income and the price of food are among the most important, especially in developing countries such the DRC. Indeed, in a developing country where the majority of the population are poor and when prices go up or the income decrease, the affordability is reduced and many people, particularly those with low-income experience reduced access to food (Anríquez *et al.*, 2013).

The DRC is a country with outstanding agricultural potentials; however, unable to feed itself. The country ranks high among those with high malnutrition rate in the world. The UNDP ranked the country 176th out of the 189 countries regarding the human development index (Grebmer *et al.*,

2013; Grebmer *et al.*, 2014; Grebmer *et al.*, 2015; Grebmer *et al.*, 2016; Grebmer *et al.*, 2018). About 60 per cent of its population is in rural areas and live under the poverty line. The department of foreign affairs of DRC (2017) and UNICEF (2017) reported that the rate of reduction of malnutrition in DRC is less than the rate of economic growth.

Marivoet *et al.* (2018) found positive progress in poverty alleviation; however, regarding nutrition status, there is no evidence of improvement. Hence, there is a need to understand how the observed economic transformation in the DRC is affecting the household's consumption. Therefore, knowledge of the effect of price and expenditure on household demand for food is vital for designing policies that can influence the consumption of particular food items as well as the development of the local food-based dietary guidelines. This will, in turn, influence healthy living and the nutritional status of consumers. Thus, analysing household demand for food provides significant information on how should be households food security and nutritional status in case of any change in the country economy (Lechene, 2000; Mittal, 2010; Ulimwengu *et al.*, 2012; Haggblade *et al.*, 2016; Babu *et al.*, 2017). Hence, the objective of this study is specifically to generate knowledge and evidence that can better policy in the area of food and nutrition security. The responses of Congolese households to changes in expenditure and price of foods is being studied. To achieve this, elasticities were estimated. The study used data from the National Household Surveys collected in 2005 and 2012. The elasticities will be very important tools for the sustainability of the implementation of food-based dietary guides.

This method was applied by Ulimwengu *et al.* (2012) to study the demand for food in DRC. However, the authors did not disaggregate the study area into urban and the rural areas and the analysis did not capture the temporal aspect, their study used only the 2005 survey. In the current study, urban and rural areas were separately analysed using both the 2005 and 2012 surveys. These two aspects are very important because of the significant difference between urban and rural areas and the demand analysis give an efficient estimate with time-series data.

2. Literature review

Since the 60s, consumer food demand has been at the centre of many studies. In the 60s and 80s, the double log and semi-log models were mostly used. However, the main issue with using them is that they violate the Engel aggregation condition, which is a serious concern when the complete demand systems are estimated (Zellner, 1962; Ullah and Fatima, 2016). Later on, the Linear Expenditure System was used and was credited with several advantages. However, it has the disadvantage of not permitting goods to be inferior, gross substitutes and demand elastic (De Boer and Paap, 2009; Ullah and Fatima, 2016). Apart from this many other models including the Indirect Addilog Model (IAD), the Rotterdam Model, the Generalized Addilog Demand System Model,

the Almost Ideal Demand System Model as well as the Quadratic Almost Ideal Demand System QUAIDS (Babu *et al.*, 2017) have been used to tackle the previous issues.

The almost Ideal Demand System as proposed by Deaton and Muellbar (1980a) has been used in many studies of consumer demand. This is because it allows an optional first-order estimate for any demand system. It also fulfils the choice axioms, perfectly aggregates over consumers, features a useful form that is according to household budget data and easy to predict and test the true constraints of demand theory (Barnett and Kanyama, 2013; Bilgic and Yen, 2013; Verbič *et al.*, 2014; Babu *et al.*, 2017). It additionally merges the most effective of the theoretical advantages of each the Rotterdam and translog models (Barnett and Kanyama, 2013). However, for this study, the QUAIDS is used because it covered all the advantages of the AIDS in addition, it has attractive proprieties of allowing the characterisation of goods as luxuries at low levels of total expenditure and as necessities at higher levels of expenditure. This has been proven to be empirically important to describe household budget behaviour (Banks *et al.*, 1996, 1997).

3. Materials and methods

This study is conducted through a historical research design which involves exploring, explaining and understanding past phenomenon or events from already available data (Creswell and Creswell, 2017).

The study used secondary data from the National Household Surveys (Enquête 123) collected in 2004-2005 and 2012-2013. For the collection of data, both surveys followed the same methodology called "123 survey" or "Enquête 1-2-3". The numbers represent the phase of the survey: "1" for employment, "2" for the informal sector and "3" for consumption. This study will rely on the data from the third phase (Institut National de la Statistique, 2014; Marivoet *et al.*, 2018). Data on unit prices, local selling units and consumption quantities were obtained from 3,244,982 persons. In total, data on expenditure was collected from 33,490 different households in both years. The sample size covers 12,087 households for the 2005 round and 21,403 households for 2012.

The 123 survey employed stratified, cluster, random and systematic sampling techniques, sampling, with a purpose of seeking representatively per sector (statutory cities, provincial towns and villages) at the provincial level (Institut National de la Statistique, 2014; Marivoet and De Herdt, 2017; Marivoet *et al.*, 2018). In order to correct the weights and cope with sampling problems, Marivoet & De Herdt (2017) added another step to the sampling technique the post-stratification in order to ensure that the population in the sample is equitably represented.

- **Analytical framework**

For the food groups income and prices elasticities the QUAIDS that is derived from a generalisation of the PIGLOG preference starts from an indirect utility function of the form (Banks *et al.*, 1996, 1997):

$$\ln V = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \quad (1)$$

where:

- $(\ln m - \ln a(p))/b(p)$ is the utility function of a demand system with budget shares linear in log total expenditure
- m is the household income
- $a(p), b(p)\ and\ \lambda(p)$ are functions of the vector price

In order to ensure the homogeneity property of the indirect utility function, it requires that $a(p)$ is homogenous of degree one in p, and $b(p)$ and $\lambda(p)$ homogenous of degree zero in p.

We have $\ln a(p)$ has a translog form and $b(p)$ is a simple Cobb-Douglas aggregator.

$$\ln a(p) = \alpha_0 + \sum_j \alpha_j \ln P_j + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \quad (2)$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \quad (3)$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \ where \sum_i \lambda_i = 0 \quad (4)$$

Using Roy's identity to the indirect utility function, the budget shares will be given as:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left[\frac{m}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\}^2 + \varepsilon_i \quad (5)$$

W_i are the estimated budget share of the i[th] food group in the total food expenditure, $\alpha_i, \beta_i, \lambda_i, \partial_{ik}\ and\ \gamma_{ij}$ are parameters, *m* = total expenditure, and p_j are food item j prices.

α_i intercept capturing the demographic variables.

γ_{ij} shows the effects of a 1% change in the prices of item j on the budget of group *i*,

β_i illustrates whether goods are luxuries or necessities,

λ_i determines the effects of quadratic term,

ε_i is the error term.

The coefficients of the quadratic term must be price dependent.

For theoretical consistency,

$$\sum \alpha_i = 1; \sum \beta_i = 0; \sum \gamma_{ij} = 0 \; and \; \gamma_{ij} = \gamma_{ji} \tag{6}$$

where j represents the food groups in the demand system and therefore we will have $J - 1 = 7$ expenditure share equations. In our system of food demand, we have eight commodity groups and therefore five equations. The parameters of the eighth commodity group are derived by imposing the following constraints.

The expression (6) represents the theoretical constraints of addition, homogeneity and symmetry. Moreover, that should remain for the QUAIDS model to indicate a system of demand equations, which sum up to the total expenditure$\sum w_i = 1$, satisfy Slutsky symmetry and are homogeneous to degree zero in total expenditure and prices.

The demographic effects through the intercept in equation (5) is given as:

$$\alpha_i = \rho_{i0} + \sum_j \rho_{ij} d_j \tag{7}$$

where d_j is the j^{th} the demographic variable of which there are J.

To calculate the QUAIDS model elasticities, we differentiate equation (5) with respect to $\ln m$ and $\ln p_j$, respectively to obtain:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\} \tag{8}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i \left(\alpha_j + \sum_k \gamma_{jk} \ln p_k \right) - \frac{\lambda_i \beta_j}{b(p)} \left\{ \ln \left[\frac{m}{a(p)} \right] \right\}^2 \tag{9}$$

The elasticities can be computed as:

$$\eta_{im} = \frac{\mu_i}{w_i} + 1 \tag{10}$$

$$\eta_{ij}^M = \frac{\mu_{ij}}{w_i} - \delta_{ij} \tag{11}$$

Using the Slutsky equation, we have:

$$\eta_{ij}^h = \eta_{ij}^M + \eta_{im} w_i \tag{12}$$

Where:

η_{im} is the Expenditure elasticities, η_{ij}^M represents the Marshallian elasticities, η^h represents the Hicksian elasticities, $\delta_{ij}$is the Kronecker delta.

The QUAIDS model allows for the estimation of the expenditure elasticity (see equation 8) which represents the relative change of demand with respect to the relative change in expenditure. Own price elasticity, on the other hand, is the measure of the percentage change in the quantity

demanded of good *"i"* from a one per cent change in the price of good *"j"* (ceteris paribus). If *"i"* and *"j"* are the same, about it is own-price elasticity and, otherwise, it is cross-price elasticities. The uncompensated (Marshallian) elasticity deals with how demand changes when price changes, holding money income constant. While the compensated (Hicksian) elasticity deals with how demand changes when price changes, holding "real income" or utility constant.

In order to assess the household demand, we categorised food items into eight food groups commonly used by the World Food Program. The eight foods groups were main staples, pulses, vegetables, fruits, fish and meat, milk, sugar, oil.

Table 1: Food groups and food items

	Food groups	Foods Items
1	**Main staples**	Cereals such as rice, maize flour, sorghum, bread, dry corn (husked), etc. Plantains, roots and tubers such as cassava flour, potatoes, etc.
2	**Pulses**	Beans, soya, groundnuts, etc.
3	**Vegetables**	Vegetables, Cassava leaves and others leave
4	**Fruit**	Orange, mango, pineapple, apple, avocado, etc.
5	**Meat and fish**	Pork, poultry, goat, beef, egg, frozen fish (mpiodi), dried/smoke fish, salted fish (Bitoyo), fried sardine (ndakala), etc.
6	**Milk**	Milk, cheese, yoghurt and other dairy product
7	**Sugar**	Sweets, honey and sugar products
8	**Oil**	Palm oil, butter, fats, oils

Source: Authors adapted from the World Food Programme (2008)

The food items represented in Table 1 are the food items that are usually consumed in the DRC.

4. Estimation Results and discussion

- Income and own-price elasticities

The expenditure elasticity, as well as the own prices elasticities for urban and rural areas, are presented in

Table 2.

Table 2: DRC urban and rural areas income and own-price elasticities

	Urban areas			Rural areas		
	expenditure elasticity	U_Own price elasticity	C_Own price elasticity	Expenditure elasticity	U_Own price elasticity	C_Own price elasticity
Main staples	0.836***	-1.188***	-2.671***	0.865***	-0.784***	-0.125
Pulses	0.949***	-0.145	0.188	0.803***	-1.578***	-1.898***
Vegetables	0.849***	-1.426***	-2.589***	0.807***	-1.809***	-2.465***
Fruit	0.879***	-0.783***	-0.210***	0.883***	-0.381***	0.032*
Meat and fish	0.867***	-0.904***	1.091***	1.287	-2.885	-2.772
Milk	0.875***	-1.121***	-0.800***	0.875***	-1.058***	-0.744***
Sugar	0.794***	-0.804***	-0.936***	1.312	0.796	0.827
Oil	0.870***	-1.024***	-0.468***	0.871***	-1.384***	-0.938***

Source: Authors. * significant at 10%, ** significant at 5%, *** significant at 1%. Source: Authors' computation from Enquête 1-2-3 data 2005 and 2012. The source remains to be the authors in all the tables and figures that follow.

As shown in

Table 2 expenditure elasticities of all food groups for both urban and rural areas were positive and less than one. The coefficients were between 0.794 and 0.949. This implies that in urban areas one per cent increase in all expenditure leaded to a rise in demand for main staples, pulses, vegetables, fruit, meat and fish, milk, sugar and oil by 0.84%, 0.95%, 0.85%, 0.88%, 0.87%, 0.88%, 0.8% and 0.87% respectively while in rural areas it rise the demand for main staples, pulses, vegetables, fruit, milk and oil by 0.87%, 0.8%, 0.8%, 0.88%, 0.88% and 0.87% respectively. This means that all food groups were found to be necessity goods for urban households while for the rural areas all were necessity goods except sugar, and meat and fish.

For both urban and rural areas, the uncompensated and compensated own-price elasticities for all food groups had the same sign though different magnitude, except for meat and fish in urban areas and fruit in rural areas that had different signs. Moreover, the uncompensated and compensated own-price elasticities for both urban and rural areas had the same signs but different magnitude.

In urban areas, the uncompensated own-price elasticities for vegetables, main staples, fruit, milk, meat and fish, sugar and oil show a negative relation between the quantity demand and the price, same apply for the compensated (the price effect only) except for meat and fish.

This meaning that if the price of main staples, vegetables, fruit, meat and fish, milk, sugar and oil reduces by 10% respectively then the demand for main staples, vegetables, fruit, meat and fish, milk, sugar and oil would rise by 11.9%[1], 14.2%, 7.8%, 9.0%, 11.2%, 8.0% and 10.0% respectively. Of this total increase in demand, 26.7%[2], 25.9%, 2.1%, -10.9%, 8.0%, 9.4% and 4.7% were purely due to price effect (i.e., the substitute effect). The income effect of the price falls accounts for the remaining -14.8%[3], -11.6%, 5.7%, 19.9%, 3.2%, -1.3% and 5.6% respectively for main staples, vegetables, fruit, meat and fish, milk, sugar and oil increase due to the rise in real income, though the absolute amount of money income remains static.

This implies that in the urban areas, the uncompensated and compensated own price elasticities show that oil, milk, meat and fish, vegetable and main staples are price elastic; the percentage change in quantities demanded of items of those food groups was more than the percentage change

[1] The total increase in quantity demanded is the change in price multiplied by the uncompensated price elasticity.
$price = -10\%$ *and uncompensated own price elasticity of main staples is* -1.188.
Total increase in quantity demanded of main staples $= (-10\%)(-1.188) = 11.9\%$
[2] The increase in quantity demanded due to price effect is the change in price multiplied by the compensated price elasticity.
$price = -10\%$ *and compensated own price elasticity of main staples is* -2.671.
Increase in quantity demanded of main staples due to price effect $= (-10\%)(-2.671) = 26.7\%$
[3] The increase in demand due to the income effect is the total increase in demand minus the increase in quantity demanded due to price effect.
Increase in quantity demanded of main staples due to income effect $= 11.9\% - 26.7\% = -14.8\%$ implying that the income effect reduced the quantity demanded of main staples by 14.8% when the price of main staples falls by 10%

in their price. However, pulses, fruits and sugar are inelastic, implying that the percentage change in quantities demanded was less than the percentage changes in their price.

In rural areas, if the price of main staples, pulses, vegetables, fruit, milk and oil reduces by 10% respectively then the demand for main staples, pulses, vegetables, fruit, milk and oil would rise by 7.8%, 15.8%, 18.1%, 3.9%, 10.6% and 13.8% respectively. Of this total increase in demand 0%, 19.0%, 24.7%, -0.3%, 7.4% and 0.9% were purely due to price effect (i.e., the substitute effect). The income effect of the price falls accounts for the remaining 7.8%, -3.2%, -6.6%, 4.2%, -3.2% and 12.9% respectively for main staples, pulses, vegetables, fruit, milk and oil increase due to the rise in real income, though the absolute amount of money income remains static.

This implies that in rural areas, the uncompensated and compensated own price elasticities revealed that pulse and vegetables were prices elastic; the percentage change in quantities demanded of items of those food groups were more than the percentage change in their price. Moreover, the uncompensated own-price elasticity suggests that milk and oil were price elastic as opposed to main stapes. But, the compensated own-price elasticity suggested that milk and oil were price inelastic. Implying that the percentage changes in quantities demanded was less than the percentage change in their price. It is worth to note that the compensated own-price elasticity suggested that the main staples were perfectly inelastic. Both the uncompensated and compensated price elasticities indicated that meat and fish as well sugar were perfectly inelastic.

Our overall results on expenditure elasticities were in line with findings from Colen *et al.* (2018) for African countries, Abdulai (2002) for Switzerland as well as Mittal (2010) for India who found that almost all food groups were necessity goods for households in rural and urban areas.

In our study expenditure elasticities were found to be similar between the urban and rural areas, opposing the findings of Colen *et al.* (2018), Abdulai (2002) and Mittal (2010) who found that elasticities were lower in urban areas compared to rural areas and argued that the higher the income of the population the lower the elasticities. In DRC, the reason could be that in rural areas, farmers consumed what they produced and sold the surplus to urban areas (Chauvin *et al.*, 2012; Smoes, 2012) hence urban and rural households demand for food changed equally when there is a change in overall household expenditure. Nevertheless, expenditure elasticities in DRC were still high in both urban and rural areas compared to other African countries implying that DRC households have a meagre income compare to other African countries (Colen *et al.*, 2018).

It was worth to note that, in rural areas, the relationship between the change in household expenditure and demand for meat and fish as well as sugar was not significant. This was evident that both products were very scarce and expensive in rural areas. The results were in line with Heinz (1995) who found that in spite of the fact that domesticated animals were reared in rural areas, meat was not often accessible there, as the butchering happened in abattoirs in urban areas. The high price likewise restrained the consumption of meat and fish. Moreover, almost 90% of the rural population lived below the poverty line, usually consuming.

Our findings on main staples in rural areas were in line with the conclusions of the WFP (2007) who found that for poor developing countries, main staples are usually priced inelastic.
However,

Table 2 results showed that in urban areas, staples foods were price elastic opposing the findings from Dorosh & Haggblade (1997), and WFP (2007). The reason of this could be that in urban areas of DRC households do not have strong preferences for different items within the food groups, therefore, they can easily substitute maize flour to cassava flour or sorghum to rice or even cassava tuber to potatoes.

Moreover, the difference between urban and rural areas in DRC could be because households in rural areas do not depend on the market for staples foods instead; the big quantity of staples foods consumed is produced. This is in line with Ulimwengu *et al.* (2012) who found that many households grow their own vegetables, fruits and staples. Only a small quantity of main staples finds its way to the market.

- Compensated and uncompensated cross-price elasticities

The compensated and the uncompensated cross-price elasticities for urban and rural areas of DRC in Table 3 and Table 4.

Our discussion focused on the compensated cross-price elasticities as it best explains the effects of change in price on the quantity demanded.

Table 3: DRC urban and rural areas compensated cross-price elasticities

	Price							
Urban areas	**Main staples**	**Pulses**	**Vegetables**	**Fruit**	**Meat and fish**	**Milk**	**Sugar**	**Oil**
Main staples	**-2.671*** **	0.380***	-1.172***	0.607***	2.066***	0.336***	-0.131	0.584***
Pulses	-1.923***	**0.188**	-2.115***	0.542***	2.280***	0.399***	-0.074	0.702***
Vegetables	-1.518***	0.542***	**-2.589*** **	0.627***	2.116***	0.337***	-0.129	0.614***
Fruit	-1.652***	0.292***	-1.319***	**-0.210*** **	2.145***	0.363***	-0.166*	0.547***
Meat and fish	-1.593***	0.348***	-1.260***	0.607***	**1.091*** **	0.343***	-0.143	0.606***
Milk	-1.626***	0.381***	-1.256***	0.645***	2.153***	**-0.800*** **	-0.131	0.634***
Sugar	-1.399***	0.156	-1.063***	0.651***	1.975***	0.289***	**-0.936*** **	0.327*
Oil	-1.619***	0.385***	-1.315***	0.557***	2.181***	0.364***	-0.085	**-0.468*** **
Rural areas								
Main staples	**-0.125**	-0.454***	-0.774***	0.405***	0.164	0.335***	-0.037	0.485***
Pulses	0.868***	**-1.898*** **	0.163	0.580***	-0.009	0.295***	-0.096	0.096
Vegetables	0.726***	0.08	**-2.465*** **	0.501***	0.101	0.324***	0.249***	0.486***
Fruit	0.661***	-0.495***	-0.873***	**0.032***	0.076	0.300***	-0.025	0.324***
Meat and fish	1.416	0.039	-0.928*	0.402	**-2.772**	0.436	0.525	0.881
Milk	0.714***	-0.328***	-0.735***	0.391***	0.107	**-0.744*** **	0.05	0.544***
Sugar	-1.16	1.594	-8.4	-0.481	1.926	0.748	**0.827**	4.946
Oil	0.723***	-0.075	-0.772***	0.295***	0.152	0.381***	0.233***	**-0.938*** **

Source: Authors. Standard errors in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1%

Table 4: DRC urban and rural areas uncompensated cross-price elasticities

	Price							
Urban areas	**Main staples**	**Pulses**	**Vegetables**	**Fruit**	**Meat and fish**	**Milk**	**Sugar**	**Oil**
Main staples	**-1.188*** **	0.087***	-0.027	0.062*	0.143***	0.030**	0.008	0.049**
Pulses	-0.239***	**-0.145**	-0.814***	-0.076	0.096***	0.050*	0.084**	0.095**
Vegetables	-0.011	0.244***	**-1.426*** **	0.074*	0.162***	0.025	0.012	0.071***
Fruit	-0.093***	-0.016*	-0.115***	**-0.783*** **	0.123***	0.041***	-0.020***	-0.015*
Meat and fish	-0.055***	0.043***	-0.072***	0.042*	**-0.904*** **	0.025**	0.001	0.052***
Milk	-0.075***	0.074***	-0.058***	0.075***	0.141***	**-1.121*** **	0.015**	0.075***
Sugar	0.01	-0.122	0.025	0.133	0.149***	-0.003	**-0.804*** **	-0.181
Oil	-0.075***	0.080***	-0.123***	-0.01	0.178***	0.044***	0.060***	**-1.024*** **
Rural areas								
Main staples	**-0.784*** **	-0.109**	-0.071**	0.001	0.088***	0.026	-0.057*	0.043
Pulses	0.256***	**-1.578*** **	0.816***	0.205***	-0.080**	0.007	-0.116***	-0.315***
Vegetables	0.111***	0.401***	**-1.809*** **	0.124*	0.029*	0.035	0.229***	0.073
Fruit	-0.012	-0.143***	-0.155***	**-0.381*** **	-0.002	-0.016	-0.046***	-0.128***
Meat and fish	0.434	0.552	0.119	-0.198	**-2.885**	-0.025	0.494	0.222
Milk	0.047***	0.020***	-0.023**	-0.017***	0.030***	**-1.058*** **	0.029***	0.097***
Sugar	-2.16	2.116	-7.333	-1.093	1.81	0.278	**0.796**	4.275
Oil	0.058***	0.272***	-0.063***	-0.111***	0.075***	0.069***	0.212***	**-1.384*** **

Source: Authors. Standard errors in parentheses, * significant at 10%, ** significant at 5%, *** significant at 1%

The cross-price elasticities (Table 3 and Table 4) indicate that when the price of main staples increased, households reduced the quantities demanded for pulses, fruit, meat and fish, milk as well as oil. This implies that these food groups were complements to the main staples. In rural areas, Table 3 and Table 4 show that the situation was completely different. When the price of main staples increases, households increase the quantities demanded for pulses, vegetables, milk and oil; making them substitute goods compared to the main staples.

There is not much difference between the compensated and the uncompensated cross-price elasticities in term of coefficient signs. However, the values of the coefficient of compensated cross-price elasticities are bigger than the uncompensated cross-price elasticities in absolute value. This implies that the income effect significantly affects the choice of food items.

For both uncompensated and compensated, the cross-price elasticities in rural areas were significant; however; their low degree suggested limited complement or substitution possibilities for all food groups. As explained earlier, the reason could be that rural households did not depend highly on the market for food. This is in line with the findings of Huq & Arshad (2010) and Abdulai (2002) substitution effects of price were not quite strong due to the low magnitude of coefficient in poor communities.

However, households in urban areas highly depend on the market for main staples. Moreover, the main staples are very important in the diet composition of households. the results for main staple food in urban areas were in line with the findings of Ulimwengu *et al.* (2012) who found that in case of a rise in the price of staple foods, the household would instead reduce the quantity consumed for other food groups in order to maximize the consumption of main staples.

In the urban areas, when the price of pulses increased, households increased the quantities demanded for all food groups except sugar; making them substitutes goods compared to pulses as opposed to fruits. While in rural areas, pulses were complement as compared to main staples, fruit and milk.

From Table 3 it can be observed that vegetables were complements as compared to other food groups for both areas. This is in line with Blisard *et al.* (2004) who find that vegetables are is considered as complement food in low-income communities. Furthermore, when the price of meat and fish increased, households significantly increased the quantities demanded for all food groups meaning that all the food groups are substitutes as compared to fish and meat. In contrast, in rural areas, the change in the price of meat and fish did not affect the demand of other food groups.

Fruit, milk and oil had a similar pattern in urban areas. In case of a price increase, the quantity demand for all food groups increases as well. Implying that they are substitutes when compared to other food groups. The same applied for rural areas. The results corroborated the one Green *et al.* (2013) who reported that in low-income areas if the price of food items such as fruit, milk or vegetables are high if their price increases, households substitute them with others affordable food items.

Conclusion and recommendation

This study was motivated by the necessity to provide accurate information about changes in household food consumption as a result of changes in price and income. The complete demand system for 8 food groups, were analysed using the two rounds of the household budget surveys collected in 2005 and 2012. The QUAIDS model was employed in the analysis of the complete demand system. The QUAIDS explained the household behaviour towards food demand in case of economic changes.

The expenditure elasticities suggest that the quantity demand for almost all food group rise with income. This implied the potential growth of the food sector with an increase in income of the population.

The own-price elasticities are higher than the expenditure elasticities. This implies that households are more sensitive to changes in price than changes in income. This show that price policies are good agricultural policy instrument, in other words, price policies is very important to stimulate agricultural production. Accordingly, there is a necessity to diminish the gap between the domestic supply of food commodities and demand by considerably increasing local production. This will prevent food price variation.

In the same angle, the cross-price elasticities show that meat and fish can be easily substituted in urban areas. This means that government price interventions for those food items can lead to significant consequences in the economy and the nutrition of the population; hence, there is a need to ensure a fixed price for those commodities. The same applies to the main staples in rural areas. However, overall as the cross-price elasticities were very low especially in rural areas, suggesting he limited possibility of substitution, and price intervention will not affect the entire rural economy as opposed to living standards intervention.

This study used a different approach compared to (Ulimwengu *et al.*, 2012) and (Akakpo *et al.*, 2014). This study explained how households in DRC food demand respond to variation in the economic factors by differentiating urban and rural area and considering two different periods.

Nevertheless, a more disaggregated approach can be a significant adding value to this study as it will highlight the heterogeneity that exists between and within provinces. Moreover, further study

could also desegregate the food groups and analyses the demand for food items within the food groups. This will permit to understand how household behaves regarding food item having similar characteristics. Moreover, it will help to understand the relationships that exist between the quantity and the quality of food items.

Overall findings, the elasticity's analysed via the QUAIDS model is counted for the evidence to be used by policymakers in DRC to plan demand for food across time and income groups. These results would similarly support living standards interventions and the design of price policies that turn as incentives to the farmers and likewise the indication for the household food basket. Hence, it has a significant consequence of household food and nutrition security status.

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