EFFECTS OF PORTABLE WATER FOR DOMESTIC USE ON FOOD SECURITY IN CAMEROON

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ABSTRACT

Purpose: *This study target as objective to explore the influence of portable water for domestic use and food security in Cameroon and to verify the heterogeneity effect of the food security function by gender.*
Method: *The study used control function model which handles endogeneity, simultaneity and heterogeneity bias concurrently. Data was obtained from 2018 Cameroon household consumption survey collected by the national institute of statistics.*
Results: *Result shows that portable water for domestic use is strongly corroborating with Food Security in Cameroon.*
Originality (novelty): *Considering that there is a growing inter-governmental commitment to supply portable water for domestic use globally, empirically, this study has closed the gap in the literature as it attempted to quantify the link between portable water for domestic use and food security in Cameroon.*
Implications: *The finding suggest that the decision makers should intensify the provision of good portable water for domestic use campaigns to enhance food security in Cameroon.*

Keywords: *Portable Water, Domestic Use, Food Security, control function, Cameroon*

INTRODUCTION

Issues related to portable water for domestic use and food security are top in every policy agenda in the world today. Contaminated source of water use for bathing, washing, drinking as well as in the preparation of food and poor hygienic environment are a major nuance to human health especially child health. A country's productive capacity is strongly determined by the health quality of the population. It is therefore imperative to examine the intricacies, determinants and issues surrounding this area of study (Tambi and Atemnkeng, 2017). Fundamentally, countries located around the equator are heavily characterize by: high irregular rainfall during the wet season; high rate of sun shine in the dry season; many streams, lakes, rivers, stand-water, springs, swamps; forest and savannah zones as well as irregular harmattan winds. All these may either make or mar human health depending on the nature of the environment (Kavoi and Mbeche, 2016).

Cameroon located around the equator and in the heart of Africa seems to suffer from these characteristics. She experiences irregular rainfall that have provoke swamps and stand waters due to heavy runoff and poor infiltration in the forest zones (Martin-Moreau and Ménascé, 2019). These have created an environment that favours the growth of harmful insects (such as mosquitoes, tsetse fly, midges, scorpions, centipedes) and insect-borne diseases (such as flea, tick, mosquito, and louse borne diseases). These have resulted to illnesses such as malaria, river blindness, filariasis, ross river fever, plague, leishmaniasis, dandy fever and chagas diseases to name a few. All these diseases have ultimately reduced human life especially in the forest and coastal lands of Cameroon. In Cameroon the distribution of drinking water in urban areas is carried out by the National Water Company of Cameroon, while the Ministry of Water

and Energy and the non-governmental organizations supply the rural population (Oyegbami and Lawal, 2017).

Human health is continually being affected by the environment in many ways and as a result, sending more people to hospitals every day. This can happen either directly or indirectly. People can directly be affected by environmental hazards when they are expose to harmful gases and substances, or indirectly, by disrupting life-sustaining ecosystems. The consequences of global warming and greenhouse gas emissions increase the number of hospital visits and deaths. Expenditure on Health is essential as it not only helps mankind to survive these hazards but also increases productivity of labour, which further accelerates growth and development. Main sources of environmental degradation and damages are greenhouse gases (in the form of carbon dioxide, methane, nitrous oxide, Chlorofluorocarbon, local air pollutants (CO, NOx, SOx, PM1), Water pollution, soil pollution and noise pollution (Wang et al., 2017). All these have a strong effect on food security across the world.

The UN Conference on Sustainable Development held in June 2012, known as Rio+20, also stressed the importance of the empowerment of women in rural areas as key players for improving agrarian and rural development as well as food and nutritional security (A/CONF.216/L1., 2019).Moreover, the specific UN organizations for the fight against poverty and hunger, namely the (FAO, 2019), the (IFAD, 2019) and the (WFP, 2019), undertake initiatives which specifically highlight the important role of rural women in reducing hunger and poverty. Examples of such measures are the ‘Sourcebook on Gender in Agriculture’ (World Bank, 2020) published by the World Bank, FAO and IFAD along with the FAO report on ‘The State of Food and Agriculture, 2010-2011, focusing on the need to close the gender gap for the benefit of development and underlining that achieving gender equality and empowering women is

not only the right thing to do but also crucial for agricultural development and food security (Mengui et al., 2019).

Hunger is persistently on the rise with food crisis hurting the poor all over the world, hitting the landless and women the hardest. As such, the vast majority of urban and rural households in the developing world rely on food purchases for most of their food and stand to lose from high food prices (Mbangari et al., 2020). The sharpest rise came in 2007 with an increase of 75 million hungry since the period of 2003 to 2005. Asia-Pacific and sub-Saharan Africa accounted for 750 million of the hungry people in the world from 2003 to 2005. As a result of the global food crisis, an additional 41 million people in Asia-Pacific and another 24 million in sub-Saharan Africa have been plunged into hunger (FAO, 2019). But no continent or country has been spared; even in the United States for example, more than 38 million people were struggling to put food on the table as of 2016 (Maue, 2020; Manishimwe, 2019). In this light, development agencies often focus on the availability of food through increased food production and laid emphasis on improving yields and high-potential productive areas to achieve and maintain sufficient food production to feed the growing world population. Such have however been regarded as misguided agricultural and trade policies which contributed to the food crisis, because of the failure to recognise women's crucial roles in agricultural production and household food security (Nanyongo and Bime, 2022).

FAO (2021) noted that Middle East and North Africa (MENA) region is the largest importer of food in the World and the development and growth of any of its agricultural sectors contributes to improved food security. As FAO revealed, the production of poultry meat and eggs in the MENA region has been increasing steadily and moving to a highly sophisticated industry since the 1960's. In this study, data were collected on production of eggs, chicken meat and turkey meat from 1961-2016 for 20 MENA countries (9

countries in the Near East, 5 in North Africa and 6 Gulf countries). Production of eggs, chicken and turkey meat increased significantly from 1961 to 2016 with increases in chicken meat more so than for eggs and turkey meat. Significant correlations were observed between production and population growth in all MENA regions except in the Gulf where production increased at a faster rate than population growth (Maue, 2020). The FAO researchers observed that the mean percent animal protein of total protein increased by 10% from 1961 to 2016 in North Africa, while the increase was only 5% in the Near east and 6% in the Gulf. Increases in egg protein consumption as % of total protein were only significant in North Africa during the 1980's, whilst increases in poultry meat protein consumption were significant in North Africa in the 1980's and 1990's and in the Gulf from 1970 to 2010. Analysis showed largest significant increases in contribution of poultry products in the Gulf compared to the other two regions.

Assuming (2018) explained that producing products that are safe for consumers has long been a basic requirement for food companies. In recent years, as conversations about climate change take center stage and awareness of the food industry's impact on the environment increases, food companies have taken meaningful steps to reduce their operations' impact on the planet. Food safety and sustainability initiatives go hand in hand, as both center on risk management and harm prevention. Both require a science-based approach and must be incorporated into all aspects of the supply chain to achieve successful results. Therefore, for poultry production, food safety begins on farms and is initially achieved through biosecurity measures (Maue, 2020). These strict procedures help ensure bird health, as well as human health, by reducing the number of pathogens that enter the supply chain. Without attention to food safety, it is impossible for a company to prevent waste

of valuable resources. In fact, healthier chicken requires less electricity, water, feed, and other resources to grow to a market weight. A successful company will have both food safety and sustainability as core tenets of its corporate responsibility programs. These are the cornerstones of Sanderson Farms' approach to food production.

Agriculture remains the bedrock of the Cameroonian economy to ensure food security. It accounted for 27% of the GDP in 1991 and employed 59.3% of the labour force in 1992 according to Food and Agriculture Organization and women have been seen to bring most of the input to this sector. Past and current literatures about Cameroon have consistently point out the all-important role of women in food crop production. For instance, Kassem (2021) holds that women constituted 88.6% of the active labour force in the food crop sector, producing 90% of total production. Mengui et al (2019) observes that female food crop entrepreneurs in Cameroon form an essential distribution link in ensuring food security in big cities and towns. These data demonstrate the importance of female food entrepreneurs and portray them as a key group for agricultural sustainability, food security and economic growth in Cameroon (Mengui et al., 2019).

The Concepts of food security have evolved in the last thirty years to reflect changes in official policy thinking (MoFA, 2017). The term first originated in the mid-1970s, FA0 (2019) defined food security in terms of food supply - assuring the availability and price stability of basic foodstuffs at the international and national level: "Availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". World Bank (2020) definition reinforces the multidimensional nature of food security and includes food access, availability, food use and stability. It has enabled policy responses focused on the promotion and recovery of

livelihood options. Initially made popular by academics such as Khan et al (2019), livelihood approaches are now fundamental to international organizations' development programs. They are increasingly applied in emergency contexts and include the concepts of vulnerability, risk coping and risk management. In short, as the link between food security, starvation and crop failure becomes a thing of the past, the analysis of food insecurity as a social and political construct has emerged (Adams and Ohene-Yankyera, 2018).

More recently, the ethical and human rights dimension of food security has come into focus. The Right to Food is not a new concept, and was first recognized in the UN Declaration of Human Rights in 1948. In 1996, the formal adoption of the Right to Adequate Food marked a milestone achievement by World Food Summit delegates. It pointed the way towards the possibility of a rights based approach to food security. Currently over 40 countries have the right to food enshrined in their constitution and FAO estimates that the right to food could be judicial in some 54 countries (Ntouda et al, 2021). In 2004, a set of voluntary guidelines supporting the progressive realization of the right to adequate food in the context of national food security were elaborated by an Intergovernmental Working Group under the auspices of the FAO Council. Food security is defined in four dimension which are, availability, access, utilization and stability. This study attempt to explore the influence of portable water for domestic use on food security in Cameroon and to verify the heterogeneity effect of the food security function by gender.

METHOD

This objective focuses on determining the effect of portable water for domestic use on food security (FS) in Cameroon using DHS 2018. This relationship has been

hinted by the human capital theory as applied by Tambi and Bime (2019) and this forms the basis for the present study. Food security denoted as FS can fall or increase if portable water for domestic use also varies. It is noted that portable water for domestic use (PWDU) is very useful in exhibiting changes that occur in food security of a household. This linkage can be expressed in an econometrical model as in equation (1) thus:

$$FS = \phi\Upsilon + \omega PWDU + \mu \quad (1)$$

FS represents food security defined as the outcome variable. PWDU stands for portable water for domestic use and is an endogenous explanatory variable in the food security function. It is captured as households that have availability of water for domestic use from protected sources as defined by world health organization (WHO). The correlate Υ is a vector of other exogenous variables that jointly affect FS, ϕ and ω are the coefficients to be estimated in the model while μ captures the errors in the model (Tambi and Bime, 2019, Fambon and Baye, 2017).

Food security is captured as an index using the multiple correspondence analyses (MCA). The choice for this is because all the categories used to construct the index are binary in nature. The categories used in constructing this index include; grain consumption, meat fruits tuber cereals milk and proteins consumption. In constructing this index FOAC is respected where only the yes items are used. The index is normalized to ensure negative signs do not interfere in the interpretation of the various components of the index. Hence in this case FS becomes a linear regressor which can then be estimated using the Ordinary Least Square method of analysis.

To estimate FS using OLS may give inconsistent and bias results. Cross sectional data like ours often suffer from heterogeneity problem that cuts across individuals in the

data. To be precise, the non-linear interaction of PWDU with some unobservable variables could cause results to be bias. Added to this is the fact that PWDU is cited to be potentially endogenous to the food security function. The sources of this endogeneity can be from simultaneity in the outcome variable-FS and the input variable-PWDU. This stems from the sense that having portable water for domestic use affect food security as well as being food secured can influence the availability of portable water for domestic use. Furthermore, it can be that PWDU has not been well captured in the model which gives rise to measurement errors as well some important variables might have been omitted from the model that affect FS (See Adeoti and Oni, 2017). To handle these, we choose to use the control function model that can simultaneously solve for these problems.

To do this, the reduce form for portable water for domestic use is projected from which the residual is predicted as in equations (2).

$$\text{PWDU} = \phi\Upsilon + \pi Z + \mu_1 \quad (2)$$

Where PWDU is the dependent variable, Z a set of instrumental variables that affect PWDU directly and μ_1 is the error. In choosing an instrument, care must be ensured that it is good instrument. In which case it must be strong and valid. Rain fall is the instrument used in the study which directly affects portable water for domestic use and not food security. The interest is to measure the principal equation in (2). To account for the potential endogeneity and heterogeneity problem identified, equation (2) is augmented to equations (3) and (4) which correspond to the control function without and with interaction respectively as follows;

$$\text{FS} = \phi\Upsilon + \omega\text{PWDU} + \beta\widehat{\mu_1} + \mu \quad (3)$$

$$\text{FS} = \phi\Upsilon + \omega\text{PWDU} + \beta\widehat{\mu_1} + \theta(\widehat{\mu_1}\text{PWDU}) + \mu \quad (4)$$

Where $\widehat{\mu_1}$ is the residual of portable water for domestic use (PWDU) derived from the reduced form model of PWDU in equation (4); ($\widehat{\mu_1}$PWDU) is the interaction of PWDU with its residuals and μ is the error term of the estimating equation; $\widehat{\mu_1}$ and $\widehat{\mu_1}$PWDU constitute the control variables in the model. The predicted residual- $\widehat{\mu_1}$ serves as a control for unobservable variables that are correlated with PWDU. This allows the independent variable to be treated as if it were an exogenous variable during estimation. The interaction term $(\widehat{\mu_1}\text{PWDU})$ controls for the effect of the neglected non-linear interaction of unobservable variables with the independent variable into the food security. The notationsϕ,ω, β and θ are parameters to be estimated.

Focusing on the data setting, in this study we have used the Cameroon 2018 Demography and Health Survey (DHS) this survey is an important set of household survey that has health information as well as information on portable water and food characteristics. The Ministry of Economic Affair, Programming and Regional Development is the executing agency of the DHS and it is the National Institute of Statistics that collects the data. The 2018 DHS was aimed at a national representative sample of about 9,733 households with children of 0 to 59 months; women of 15 to 49 years. The result of this survey was presented for Cameroon, Yaoundé and Douala, other towns, urban and rural zones and each of the 12 areas of study (constituting 10 regions). All the members of households drawn are registered in household questionnaire. The data file for each child is linked to household-level characteristics such as land holding and the women activities. In addition, we linked information external to the household survey to the analytic sample.

RESULTS

The results in this section is presented and discussed as follows: summary statistics, synopsis of the food security indicator, parameter estimates of food security function in Cameroon and the heterogeneity effects of portable water domestic use on food poverty by gender.

Descriptive Summary Statistics of Food Security Function

The descriptive statistics of the variables selected and used for the study is presented in Table 1 and this is clearly explained in the sections that follows.

Table 1 presents the descriptive statistics of the variables used to capture the effect of portable water for domestic use on food security. Results show that on average food security is about 89%. This implies that majority of Cameroonians are food secured. Results have also revealed that the mean number of people with portable water for domestic use is 83%. Concerning household altitude residence measured in meters, results show that on the average house residence altitude is 604.2. Table 1 has also revealed that on average 59% of mothers questioned were into agricultural activities. On average 91% of the households surveyed are married. Results also depict that fathers' years spent in school is about 4 ½ years. This same table reveals that on the average 41% of fathers are actively employed by agriculture and 74% households had a father in the house.

Table 1. Weighted Descriptive Statistics

Variable	**Mean**	**Std Dev**	**Min**	**Max**
Food security index	0.8912	0.1861	0	1
Portable water for domestic use	0.8343	12.82	0	1
Household altitude residence (meters)	604.2	380.0	3	2089
Mothers education in complete years	5.394	4.536	0	17
Mothers Occupation (1= agriculture, 0 otherwise)	0.5870	0.4924	0	1
Marital Status (1= married, 0 otherwise)	0.9048	0.2935	0	1
Fathers education in complete years	4.676	4.960	0	17
Father's Occupation (1= agriculture, 0 otherwise)	0.4060	0.4911	0	1
Father presence in the house (1= yes, 0 otherwise)	0.7419	0.4376	0	1
Father's age	39.75	10.56	15	95
Number of visitors in the household	1.5357	0.8842	1	5
Gender of household head (1= male, 0 otherwise)	0.8386	0.3679	0	1
Household size	10.74	6.026	1	40
Household size Squared	151.7	198.2	1	1600
Visit hospital in the last 12 months	0.6504	0.4769	0	1
Own a house (1= yes,0 otherwise)	0.1414	0.3485	0	1
Distance to health facility	0.4536	0.4979	0	1
Youth age	26.60	4.962	15	35
Adult age	39.36	2.957	36	49
Household residence (1= urban, 0 otherwise)	0.4014	0.4902	0	1
Residual (10^{-7})	0.0052	12.32	-21.2673	74.382
Interaction term	151.8	509.1	-350.887	7140.7
Total Observation	**9,733**			

Source: Computed by author from 2018 Cameroon DHS

The Table has further demonstrated that the father's average age is 39 years. This is indicative that men have a longer life expectancy than women. Still in the same table the descriptive statistics reveals that on average a household hosted at least 1 visitor in the course of the year. The population is revealed to be female dominated scoring 84%. The mean number of persons living in a household is 10

persons and household size squared is 151.7. The descriptive information further depicts that on average 65% of households under survey visited the hospital at least once in the course of the year. This tie with the postulation that disease prevalence is high in Cameroon. Descriptive findings have also revealed that household altitude residency is 604.2. A further revelation from the descriptive statistics is that on average 45% of the population had distance to health facility. This can have some implications on disease prevalence and household wellbeing. Of the total population surveyed, 27% registered as youths while 39% are adults-an indication that the population is aging. Concerning household residence 40% of the sample population is urban dwellers indicating that most households are in the rural setting. The residual of the model is 0.00000000005% which is used to correct for heterogeneity and endogeneity in the variables used in the study. Similarly, the interaction term is 151.7 % and is the joint effect of portable water use and food security.

Synopsis of Food Security Index (Multiple Correspondent Analyses)

The categories of variables used in constructing the food security index are presented and discussed in this section.

Food security is captured in the study using several indicators. As shown on the table above, the study employed seven indicators to build an index for food security guided by theories on food consumption. Results from this synopsis show that about 0.049 points in food security is accounted for by access to grain which ranks as the highest contributor in food security. Closely followed to this is vegetable consumption with milk consumption ranking last in terms of contribution in food security. An indication here is that Cameroonians do not mostly consume milk and its related

products. An interesting finding from this synopsis is that tuber consumption and eggs availability contribute low and the same in food security (0.013). Noteworthy is the fact that this index is normalized to lie between 0 and 1.

Table 2. Synopsis of the Disease Prevalence Index

Categories		**Overall**			**Dimension 1**			**Dimension 2**		
		mass	**quality**	**%inert**	**coord**	**sqcorr**	**Contrib**	**coord**	**sqcorr**	**Contrib**
Access to Grain	No	0.094	0.858	0.042	0.685	0.814	0.044	0.929	0.044	0.081
	Yes	0.049	0.858	0.080	-1.299	0.814	0.083	-1.762	0.044	0.153
Consumption of Tubers	No	0.130	0.712	0.025	0.417	0.696	0.023	-0.377	0.017	0.018
	Yes	0.013	0.712	0.265	-4.338	0.696	0.236	3.921	0.017	0.193
Availability of Eggs	No	0.130	0.712	0.025	0.417	0.696	0.023	-0.377	0.017	0.018
	Yes	0.013	0.712	0.265	-4.338	0.696	0.236	3.921	0.017	0.193
Access to Meat	No	0.131	0.966	0.006	0.222	0.903	0.006	0.345	0.063	0.016
	Yes	0.012	0.966	0.062	-2.454	0.903	0.071	-3.808	0.063	0.172
Vegetable Consumption	No	0.120	0.913	0.020	0.434	0.900	0.022	0.312	0.014	0.012
	Yes	0.023	0.913	0.100	-2.225	0.900	0.115	-1.600	0.014	0.060
Fruit Consumption	No	0.132	1.015	0.007	0.263	1.012	0.009	0.082	0.003	0.001
	Yes	0.011	1.015	0.088	-3.273	1.012	0.114	-1.019	0.003	0.011
Milk Consumption	No	0.139	0.993	0.000	0.055	0.887	0.000	0.112	0.106	0.002
	Yes	0.003	0.993	0.015	-2.271	0.887	0.017	-4.596	0.106	0.072

Source: Computed by author from 2018 Cameroon DHS

Estimate of Portable Water for Domestic Use and Food Security Function

Results of the effect portable water for domestic use on food security is presented in Table 3.

Table 3: Estimate of Portable Water for Domestic Use and Food Security Function

Variable	OLS	2SLS	Control Function (CF)	
			CFa	CFb
	Food Security			
Portable water for domestic use	-0.0072 (-1.40)	0.3462* (1.97)	0.0007*** (3.20)	0.0008*** (3.98)
Household altitude residence(10^{-2})	-0.0031*** (-6.03)	-0.0023*** (-3.10)	-0.0030*** (-5.85)	-0.0030*** (-5.91)
Mothers education in complete years	-0.0011* (-1.76)	0.0008 (0.68)	0.0013 (2.18)	-0.0015** (-2.34)
Mother's status (1= married, 0 otherwise)	0.0184* (2.27)	0.0153 (1.55)	0.0180** (2.22)	0.0181** (2.23)
Mother's occupation (1= Agriculture, 0 otherwise)	-0.0203*** (-4.87)	-0.0017 *** (-0.15)	0.0199*** (4.79)	0.0217*** (5.51)
Gender of Household head (1= male, 0 otherwise)	-0.0073 (-1.00)	-0.0202** (-1.83)	-0.0037 (-0.50)	-0.0027** (-0.37)
Fathers education in complete years	-0.0026*** (-4.96)	-0.0016 (-1.91)	-0.0026*** (-5.10)	-0.0027*** (-5.17)
Father's occupation (1= Agriculture, 0 otherwise)	-0.0123** (-2.70)	-0.0259** (2.91)	0.0096** (2.09)	0.0082* (1.70)
Household Owns a house	-0.0058 (1.04)	0.0053 (0.60)	-0.0054 (-0.97)	-0.0067 (-1.16)
Household Size	-0.0008 (0.81	-0.0013** (1.03)	-0.0003 (0.29)	-0.0002 (-0.18)
Household Size Squared(10^{-2})	-0.0027 (-0.91)	-0.0079* (-1.76)	-0.004 (-1.19)	-0.0034 (-1.13)
Residual	n/a	n/a	-0.0266*** (3.83)	-0.0287* (-1.99)
Interaction term	n/a	n/a	n/a	-0.1804*** (-2.86)
Constant	0.9479*** (78.74)	1.2206*** (8.62)	0.9618*** (78.63)	0.9689*** (65.55)
R-Squared/Uncentered R2	0.0155	0.9404	0.0173	0.0174
F-statistics	13.93 [11, 9721; 0.0000]	19.83[11, 9721; 0.0000]	14.25 [12, 9720; 0.0000]	13.21 [13, 9719; 0.0000]
F test of excluded instruments/	n/a	12.03[1, 9721; 0.0005]	n/a	n/a
Cragg-Donald Wald F statistic	n/a	16.38 [12.031]	n/a	n/a
Anderson canon. corr. LM statistic	n/a	12.031(0.0005)	n/a	n/a
Sargan statistic	n/a	0.000	n/a	n/a
Durbin-Wu-Hausman χ^2 test of endogeneity	n/a	5.432 (0.0018)	n/a	n/a
Observation	**9,733**	**9733**	**9,733**	**9,733**

Source: Author. Note: values in parentheses represent robust t-statistics, while ***, **, * indicate 1%, 5% and 10% level of significance respectively. OLS= Ordinary least squared

The Table above presents the effects of portable water for domestic use on food security by various models. Our parsimonious result is the control function estimates with interaction denoted as CFb and is based on this that conclusions will be drawn. The results from the OLS and 2SLS presented in the first two columns respectively on Table 3 above suffer from some econometrical issues such as endogeneity and heterogeneity which are corrected for in the control function models. The availability of portable water for domestic use significantly and positively affects food security. The OLS findings reveal that it negative and insignificantly affect food security. The 2SLS show that at 1% level of significance availability of portable water for domestic use positively affects food security by 0.34. When controlled for endogeneity and heterogeneity without interaction, results show that portable water for domestic use affects food security by 0.0066. However, when interacted, the magnitude increases to 0.0083 at a significant level of 1%. Hence an increase in availability of portable water for domestic use increases food security. Water is therefore an important determinant of food security.

The household residence altitude reduces food security as revealed by all the models at a statistically significant rate of 1% level. Looking at the final results presented as CFb in the 4th column of Table 3, results show that household altitude residence reduces food security by 0.003. This finding is realistic from logical reasoning in the sense that most of these areas of settlement are usually heavily populated and food security may be problematic. The variable mother's years in education is estimated to be negative and at a statistical significant level, reduces food security. A probable reason for this could be that when mothers get more involve with education they spend less time on improving their food intake habits.

Concerning the marital status of mothers and male headed households, results show that they both affect food

security significantly at 1 and 5% level of significance respectively. Specifically, when a mother is married than single, food security increase by 0.018. On the other hand, when a household is male headed than female, food security increases by 0.022. It goes without say that a married woman is more careful with dietary habits than her unmarried counterparts. Equally a household that is headed by a man is more guaranteed to consume good food than when it is female headed. This same Table illustrates that an additional year in father's years in education reduces food security by 0.0027 at 1% level of significance. Based on this a sweeping statement can be made that when parents are more into schooling and education food security falls. Similarly owning a house relative to not owning one reduces food security by 0.0067 but this finding is insignificant. Other variables such as household size and household size squared have also been revealed to be insignificant in explaining changes in food security in the study. However, they all portray a negative effect on food security. The control variables of the model like the residual and interaction term are all significant but indicate a negative effect. Their significance show that the model actually suffered from endogeneity and heterogeneity which confirms the choice of our method of analysis.

Heterogeneity Effect of Food Security Function by Gender of Household Head

This section presents the estimate of portable water for domestic use and food security by gender of household head.

Table 4. Estimate of Portable Water for Domestic Use and Food Security by Gender

Variable	**Estimated Model: CFb**	
	Male	**Female**
	Food Security Index	
Portable water for domestic use	0.0155*** (2.24)	-0.0010 (0.27)
Household altitude residence	-0.0002*** (6.38)	-0.0002*** (2.92)
Mothers education in complete years	-0.0013 (0.38)	-0.0182** (2.31)
Mother's status (1= married, 0 otherwise)	. 0.1032** (2.44)	0.0005 (0.01)
Mother's occupation (1= Agriculture, 0 otherwise)	-0.1243*** (5.51)	-0.107** (2.28)
Gender of Household head (1= male, 0 otherwise)	-0.0956** (2.06)	0
Fathers education in complete years	-0.0126*** (4.64)	-0.0039 (0.67)
Father's occupation (1= Agriculture, 0 otherwise)	-0.1106*** (3.59)	-0.1015 (1.49)
Household Owns a house	-0.0438 (1.49)	0.0002 (0.00)
Household Size	-0.0134** (2.05)	0.0228* (1.65)
Household Size Squared	0.0000 (0.27)	-0.0008* (2.04)
Residual	-0.0141* (1.92)	0.0052 (0.32)
Interaction term	-0.0001* (1.71)	-0.0001 (1.18)
Constant	-0.0698 (0.41)	0.3095 (0.84)
R-Squared/Uncentered R2	0.0168	0.0190
F-statistics	12.77 [13, 9719; 0.0000]	3.61 [12, 2239; 0.0000]
Observation	**9,733**	**2,252**

Source: Author. Note: values in parentheses represent robust t-statistics, while ***, **, * indicate 1%, 5% and 10% level of significance respectively.

Table 4 above hosts the results for by gender analysis of the estimates of the effect of portable water for domestic

use on food security from the control function with interaction (CFb). This result shows that portable water for domestic use is very significant in making informed choices on food security when household is male-headed but insignificant for female-headed households. Specifically, an increase in the availability of portable domestic water use when household is male-headed increases food security by 0.0155 at 1 % level of significance. On the contrary being a female-headed household reduces food security with an increase in portable water for domestic use by 0.0040 at an insignificant level. This is indicative of the fact that men maximize portable water in domestic use than women. Another interesting point to note from this table is that household altitude residency is revealed to be a very significant and important determinant of food security by gender perspective.

Results show that for both male and female-headed households, household altitude residency reduces food security and the reduction is more serious with the male sub-population. To further explore the gender analysis, an additional year in the mother's education reduces food security for both the male and female sub-populations however being statistically insignificant for males and significant for females (5%). The implication for this finding is that mother's years in education do not affect male food security. When a woman devotes her time for an additional year of schooling, she may tend to neglect quality and quantity of food intake which reduces food security.

Table 4 further shows that, even though a married mother increases food security for both male and female-headed households, the increase is only significant for the male and insignificant for the female-headed households. This result is in line with the general view that households where a man heads is surer to have food than the one where a woman heads. The estimated coefficient for mother occupation in agriculture is negative for male and female

sub-populations. To be more precise results illustrate that when a mother is into agriculture in a male-headed household, food poverty reduces by 0.1243 and reduces by 0.1074 for female-headed households. Food poverty falls more when household is male-headed and mother is into agriculture. In the same light the male-headed household negatively and significantly affects food security. This is in not in conformity with the aforementioned expectation that male-headed households should increase food security. A possible reason for this could be that the men do not pay attention to food security.

Father's education and occupation in agriculture is revealed to be negative and statistically significant in determining food security for the male sub-population by 0.0126 and 0.1105 respectively. Conversely these are highly insignificant determinants of food poverty for the female sub-population. It can be perceived that as a father gets more into education, it reduces food security when it is male-headed because the father is the main source of livelihood. Contrary to logical thinking, a father's involvement in agriculture reduces food security probably because men cultivate mostly cash crops which they hardly consume. To own a house does not play an insignificant role in food security for both populations.

In terms of household size results demonstrate opposite effects on food security by gender Specifically, for the male sub-population an increase in household size reduces food security by 0.0134 but increases it by 0.0228 for the female sub-group. This finding is significant at 5 and 10% levels of significance for male and female sub-groups respectively. One possible explanation for this could be that a woman can better manage a bigger household than a man will do. Closely connected to this is the household size squared. Findings reveal that when squared, household size increases food security for the male sub-population but results are insignificant. For the females, as household size

increases beyond a given limit, food security reduces by 0.0008 at 10% level of significance. This implies that a woman will not better manage a household when its size becomes excessively large causing food security to fall. Other control variables used in the study like the residual and the interaction term used to correct errors in the model are negative and significant for the male but insignificant for the female-headed households.

DISCUSSION

From the empirical result section, the descriptive statistics of the variables used to capture the effect of portable water for domestic use and food security showed that on average food security is about 89%. This implies that the majority of Cameroonians are food secured. Results have also revealed that the mean number of people with portable water for domestic use is 83%. Concerning household altitude residence measured in meters, results show that on the average house residence altitude is 604.2 meters squared. On average 59% of mothers questioned were into agricultural activities. This observation is closely similar to that of Tambi (2019) who equally estimated similar issues in quantifying the effects of climate change on crop production.

Results from the synopsis show that about 0.049 points in food security is accounted for by access to grain which ranks as the highest contributor in food security. Closely followed to this is vegetable consumption with milk consumption ranking last in terms of contribution in food security. An indication here is that Cameroonians do not mostly consume milk and its related products. An interesting finding from this synopsis is that tuber consumption and eggs availability contribute low and the same in food security. Noteworthy is the fact that this index is normalized to lie between 0 and 1. This actually correlates with the observation of FAO (2021) which equally

constructed food security indexes from different nations in Sub Saharan Africa.

An increase in availability of portable water for domestic use increases food security. Water is therefore an important determinant of food security. This study is consistent with the views of MoFA (2017), he observed that increased portable water supply considering all favorable hygienic conditions, could have positive effects on a number of important development outcomes, such as household agricultural productivity, food security, and nutrition security. According to MoFA, in developing countries, particularly in rural communities, women household heads are underserved by public services (public tap), expanding such services could bring about significant improvements. A study on the Indian state of Gujarat estimated that reducing to 1 hour a day the time spent fetching water by women would allow the women to increase their incomes by $100 yearly using the time saved (United Nations Development Programme, (UNDP) 2016). This simply means that defining priorities for public services in a way that recognizes the imperative of relieving women and girls of these burdens is vital to their empowerment. In addition to the establishment or expansion of public services, improved access to cleaner energy sources for household needs should be central to such a strategy. This would not only save women time, but also enhance agricultural production directly and food security indirectly.

The heterogeneity effect of food security function by Gender of Household Head shows that it is more of a male phenomenon that otherwise. These views fall in line with those of Food and Agricultural organization of the United Nations, in 2019, focused on food access, leading to a definition based on the balance between the demand and supply side of the food security equation: “Ensuring that all people at all times have both physical and economic access to the basic food that they need” (FAO, 2019). The definition

was revised to include the individual and household level, in addition to the regional and national level of aggregation, in food security analysis. In this perspective, the FAO observed that if the male household heads are in favorable health conditions, they will increase food access as compared to the female counterparts. In 2019, the highly influential World Bank Report on Poverty and Hunger (World Bank, 2020) focused on temporal dynamics of food insecurity, distinguish between chronic food insecurity, associated with problems of continuing or structural poverty and poor portable water supply and transitory food insecurity, which involved periods of intensified pressure caused by inadequate supply of male manpower labour supply, natural disasters and economic collapse or conflict. This was complemented by Sen.'s theory of famine which highlighted the effect of personal entitlements on food access i.e. production, labor, trade and transfer based resources.

IMPLICATIONS

The implication for this finding is that mother's years in education do not affect male food security. When a woman devotes her time for an additional year of schooling, she may tend to neglect quality and quantity of food intake which reduces food security. The finding suggest that the decision makers should intensify the provision of good portable water for domestic use campaigns to enhance food security.

CONCLUSION

This study target as objectives; to explore the influence of portable water for domestic use on Food Security in Cameroon and to verify the heterogeneity effect of the food security function by gender. The study used

control function model which handles endogeneity, simultaneity and heterogeneity bias concurrently. Data was obtained from 2018 Cameroon household consumption survey collected by the national institute of statistics. Food security is captured in the study using several indicators. The study employed seven indicators to build an index for food security guided by theories on food consumption.

The main result shows that Portable Water for Domestic Use is strongly corroborating with Food Security in Cameroon while the results by gender group showed that for both male and female-headed households, household altitude residency reduces food security and the reduction is more serious with the male sub-population. To further explore the gender analysis, an additional year in the mother's education reduces food security for both the male and female sub-populations however being statistically insignificant for males and significant for females (5%).

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