

COPING WATER SOURCES FOR HOUSEHOLDS IN RWANDA: ESTIMATION OF A WATER DEMAND FUNCTION

**WATER RESOURCES MANAGEMENT CONFERENCE
MARCH 20-21ST, 2018
UR-NYARUGENGE CAMPUS**

**Presented by Dr. Joseph Nkurunziza
CBE-School of Economics
University of Rwanda (UR)**

Background of the study

2

- Water is a key resource for:
 - domestic household uses;
 - for agriculture, and;
 - is an important input to most sectors of the economy.
- In developing countries, factors leading to water supply problems are:
 - ❖ The high rate of population growth,
 - ❖ a lack of investment in water supply infrastructure, and;
 - ❖ limitations to natural water resources.

Background of the study

3

- ❖ The difficulty in estimating a demand function in the context of developing countries:
- ✓ Both households connected and non connected to the piped network rely on a multitude of water sources.



Background of the study

4

- Access to clean tap water within the residence is far from universal in developing countries;
- In many of these countries, many households lack in-house piped connections as well as income to obtain;



Dr Joseph Nkurunziza, and Dr Claudine Uwera, UR

Background of the study

5

- Water-related diseases due to microbial contamination during and after collection continue to be a major health problem in such countries;
- In Sub-Saharan African cities, only 35% of the urban population has piped water into the dwelling, plot or yard.



Background of the study

6

- In Rwanda, households who lack piped connections rely on other sources including:
 - public taps,
 - springs,
 - dug-well,
 - surface water, etc.
- Most of these coping sources are located far from residence and household spend a considerable amount of time collecting potentially unsafe water.

Why this research?

7

- This study enters the debate on the basis that Rwanda's wealth of natural water resources ***is under increasing pressure from a combined high population growth and fast economic development.***
- Therefore under the above conditions, important natural resource functions such as regulation, habitat, production and information are also at risk.
- ❖ Then management and expansion of water systems in an effective way require more analysis of water demand formulation.



Why this research?

8

- Then, complexity in sources choice made by households that rely on different coping sources required ***specific modeling specification estimating a water demand function.***

Data & Methods

9

- To address these questions, the following methods were used:
 - ***a multinomial logit regression and;***
 - ***a two-step method for selection bias issue in the spirit of Heckman;***
 - The two methods were applied on data from 360 households selected in Rubavu (120) in Northern Province, in Kicukiro (120) in Kigali City and in Bugesera (120) in Eastern Province.

Data & Methods

10

- A two step method has been found better ***since it allows identifying substitutability and complementarity relationship between sources of water.***
- By estimating non-tap water demand for non- connected households, the present paper partly behaves much like that of Nauges and Strand (2007).
- But, in their study, they only estimated non-tap water demand among non-tap households;
- while in the present, ***we look at non-tap water demand for both connected and non-connected households***

Data & Methods

- we estimated a simultaneous equation system of water demand, in which we combined demand of piped water and demand of non-piped water for households who still complementing their consumption from piped network with other water sources.

Model specification

12

- In developed countries, the demand function can be specified as follow:
- $Q=f(P, I, Z)$
- The function concern in general the estimation of price (P), full income (I), elasticity and the measurement of the impact of a vector of socioeconomic characteristics (Z) (to control for heterogeneity of preferences and other variables affecting water demand) on the quantity of water used.

Model specification

13

- In developing countries: the above equation cannot be directly applied;
- In this research, we will focus on some points that show the interaction of different elements/variables and their impact on the demand function.
- The alternatives to tap water may depend on different factors such as “**average households’ income, household size, residence area, poverty level, education level**, etc...”.
- Hence, in order to avoid selectivity bias in the demand function estimation, these relationships must be controlled.

Model specification (con't)

14

- Although it is common, in all districts for households, to use different sources of water, preferences in all available sources might be unequal due especially to personal characteristics, water characteristics and levels such as:
 - availability,
 - price,
 - distance to the source,
 - quality,
 - reliability, etc.

Findings for Multinomial logit estimation: Public tap water (Reference Category)

15

Measures of fit

Log likelihood: -341.191

Likelihood ratio test, chi2(18):163.47

Prob: > chi2: 0.000

Observations: 360

Independent Variables	Other source of water		Piped water into yard		Piped water into dwelling	
	B	S.E	B	S.E	B	S.E
Intercept	-2.383***	0.066	-1.297**	0.608	-3.499 ***	0.803
Household size	0.034	0.101	0.129**	0.063	-0.092	0.088
Log of HH income	-0.052*	0.029	0.017	0.029	0.135***	0.041
Number of bathroom	1.093***	0.348	0.831**	0.351	2.298***	0.360
HH in Urban area (Ref. Cat.)						
HH in Rural area	1.011**	0.458	-1.756***	0.367	-1.687***	0.429
HH headed by male (Ref. Cat.)						
HH headed by female	0.102	0.344	0.194	0.377	1.305**	0.561
Own a house (Ref. Cat.)						
Not own a house	0.807**	0.394	-0.578	0.437	0.399	0.441

Note: Robust standard errors in parentheses: ***p < 0:01, **p < 0:05, *p < 0:1.

Findings for logit as a selection model

16

- Likelihood ratio test $Chi2(18)=163.47$, P value < 1%:
Thus the regressors are jointly significant.
- Relative to using a public tap, with high income the household's probability of using other sources of water decreased by about 5%,
- while the probability of piped water into dwelling increased by 10%.

Findings for multinomial logit as a selection model

17

- an additional member of the household will increase the probability of using piped water to yard sources, relative to using a public tap.
- household in rural areas are less likely to use piped water into dwelling and that from yard they are more likely to use other sources of water

Findings for Estimation of Water demand function

Dependent Variable: Monthly Water Use (Log) per Household Member	Estimated Coefficient	Bootstrapped Standard Error	P Value
Constant	3.523**	1.372	0.010
Log (total cost (public tap)	-0.084***	0.016	0.000
Percentage of Population living in (Midugudu)	-0.046	0.054	0.394
House ownership status dummy	0.032**	0.013	0.013
Number of rooms	0.406	0.486	0.403
Number of under 5 children	0.252	0.071	0.470
Bugesera district dummy	0.252	0.237	0.287
Rubavu district dummy	-1.219***	0.249	0.000
Lee correction parameter 1	-4.065***	0.416	0.009
Lee correction parameter 2	-0.396	0.175	0.449
Lee correction parameter 3	0.681	2.015	0.735
Lee correction parameter 4	-0.719	0.550	0.644

Findings for Estimation of Water demand function

19

- For public tap, the price elasticity is -0.1 (reflects an inelasticity of public water demand in the present study);
- This is not surprising as public tap is the most convenient coping source for majority of unconnected households.
- Results show again that as the number of kids less than five years increases, the per capita consumption decreases.

Findings for Estimation of Water demand function

20

- the first Lee correction term is negative and significant (-4.065^{***}).
- This reveals that some unobserved households characteristics are correlated with households 'choice and use in their coping sources.

Conclusions

21

- The preliminary findings reveal that around of 56% of households, in these districts, use public tap as their main coping source.
- Our main findings highlight that households are less sensitive to price change for water from public tap. This implies that water from public tap is found to be closer alternative to piped water and also safer and cleaner than other coping sources.
- This can lead to the conclusion that piped water and public tap water might be used as substitutes in the present case. Dr Joseph Nkurunziza, and Dr Claudine Uwera, UR

Policy implications

22

- We can conclude by saying that:
 - the welfare effect of extending public tap connections might be very large especially for poor households.
 - improving the current tariff schemes could increase revenue for the water utility which will in turn improve current services provisions.
 - However, different reactions might occur and it might be interesting to do a cost – benefit analysis for an optimal solution.

THANK YOU FOR YOUR KIND ATTENTION
Murakoze