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DETERMINANTS OF RESIDENTIAL WATER DEMAND IN JORDAN

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Abstract: *The purpose of this paper is to estimate the determinants of per capita water consumption in Jordan. The study is based on a sub-sample of the original sample covered by a household income and expenditure survey, conducted by the Department of Statistics in Jordan in 2010. The sub-sample consists of 2773 households. Ordinary least square estimator (OLS) in linear form and Cobb-Douglas function are implemented to estimate variations in per capita water consumption contributed to each of the explanatory variables.* R^2 *for the linear models exceed 0.70 , while* R^2 *for Cobb-Douglas model exceeds 0.80. The elasticities are significant at 5% level and their signs are consistent with the findings of previous studies, except for price elasticity. Since this study is the first one in Jordan, it provides an assessment of the effectiveness of the water policy and its impact on consumers.*

Key words: *per capita water demand, multi block pricing, progressive tariff, Cobb-Douglas (log-log), price elasticity, Jordan*

1. INTRODUCTION

Securing and promoting social welfare is one of the prime responsibilities of the modern state. The supply of water of suitable quality and sufficient quantity is detrimental in realizing social and economic development goals. Demand for water in general and fresh water in particular has been increasing since the industrial revolution. Except for few countries endowed with abundant water resources, the rest of the world faces, at variant degrees, an increasing level of water scarcity. As fresh water becomes less available, water supply cannot be stretched to meet water demand without expensive projects. Given that most countries suffer from chronic budget deficit and high debt burden, coupled with taxpayers' resistance to devote more of their overstretched income for public spending on the expense of their basic standard of living, financing water projects has become increasingly difficult. Consequently, the widening gap between supply and demand has become inevitable. *"Presently, 70 % of the world's population lives in countries that withdraw more than 40 % of the available water resources. If current trends continue, by 2025 up to a third of humanity will be living in countries in regions where water withdrawals exceed 60 % of the amount available (Shiklomanov, 2003). At these levels of withdrawal there will be insufficient fresh water to maintain many existing natural habitats, and inhabitants will face acute water shortages, especially in times of drought* (Grafton, *et al.*, 2009).

The importance of water stems from the fact that it is indispensable, cannot be substituted, and cannot be manufactured or created. Therefore, water shortage has obvious negative effects on industrial, agricultural, and service sectors - especially in the areas of food production, health maintenance and disease prevention - and ultimately on job creation. Controlling water demand through water management policy to achieve efficient use has garnered increased attention in recent years. Water price is the main mechanism in water demand management.

Water supply in Jordan has fallen short of demand since the sixties. Annual per capita water allocation for domestic, industrial, agricultural, tourism and environmental needs was $146M^3$ in 2008 down from 3600 M^3 in 1946 (The Ministry of Water Irregation, 2009). Comparing water consumption per capita in Jordan with the Water Stress Index, which sets the water poverty line at 1000 m^3 and classifies countries having water per capita less than $500M^3$ annually as those facing absolute scarcity (Falkenmark, 1989), indicates the severity of water problem in Jordan**.** The proposed water requirements for meeting different basic human needs gives a total quantity of 50 liters per person per day (Gleick, 1996)**.** The World Bank has adopted this threshold.

Since mid 1970s, the Jordanian people have experienced a tremendous change in their way of life and their standards of living. Several factors have contributed to such change, among which are the transformation from an agricultural based economy to a semi-modern economy with its industrial, tourism, and service sectors, rapid increase in the rate of urbanization, from 5% to 82% (Department of Statistics, 2010), significant per capita income enhancement due to the above mentioned factors and the availability of well- paying jobs in the neighboring Arab countries after the sudden increase in oil prices in early 1970s. These developments, in addition to a rapid population growth which led to a substantial increase in demand for food, pushed the demand for water consumption in Jordan to unprecedented and unpredicted levels. Family size was less than five prior to the fifties of the twentieth century because of poor health care, and transmitted diseases. The average family size jumped to 10 before it fell to 5.6 (Department of Statistics, 2010).

The Jordanian family used to cook in one cooking pot and sit to eat around one big platter or tray using their hands. Now the average family needs 7-21 dishes and a set of 21 pieces of spoons, knives and forks. It needs at least 5 different sizes and shapes of cooking pots. Members of the family used to drink from the same cup and use the same towel. 30 years ago, few people adhered to Islamic religious practices; practicing five prayers a day require five washes or wudu (washing hands and arms, mouth, nose, face, head, ears, neck, and feet three times each wudu). Muslims are also required to shower before Friday prayers. Most families living far away from springs or water streams obtained their water from rain harvesting in the home's front yard and well. Modern lifestyles have abandoned this practice, hence requiring much more water.

Per capita housing was one square meter in a tent for Bedouins and less than 10 square meters for rural and urban areas. This figure has risen to a per capita average of 23 m^2 (Table 1 to 3). Each housing unit has 2-6 full bathrooms. A back yard or garden is essential in villas and ground floor apartments. In long and hot summers, plants need to be watered in order to survive and grow.

2. THE SIGNIFICANCE OF THIS STUDY

Early studies of the determinants of household water consumption began in countries rich in natural resources in general and water resources in particular; an indication of the importance of this issue. The study of residential water demand was pioneered in the United States (Worthington, *et al.*, 2006). Interest in this area spread to Europe and Australia later on and followed the same path of studies conducted in America. However, few studies have been conducted in developing countries (Statzu, *et al.*, 2006). The results of studies in developing countries are different from those in developed ones (Worthington, *et al.*, 2006). Hence, further investigation is needed with emphasis on developing countries.

As indicated earlier, Jordan lacks sufficient water resources. Growth in demand for water has not been matched by equivalent increase in water supply. In order to control household water consumption, the Ministry of Water Resources divided the country into three areas based on the development stage and income level. It then sets a tariff structure consisting of 12 blocks distributed into three price formulas, the first and most progressive one was for the Capital Governorate, Amman, the second and less progressive was for Zerqa governorate, and the third and least progressive was for the other nine governorates." *Despite the huge improvements in infrastructure to supply water, we are facing a critical and serious supply-demand imbalance. A sustainable water supply and demand balance must be secured. This means limiting and even reducing our water consumption, while not ruling out new supply Infrastructure*" (Ministry of Water and Irregation, 2007)

Jordanian households in each of the three areas receive at the end of each quarter water bills varying from one household to another, in terms of the quantity of water consumed during that period. Although price schedules were modified upwards several times, no independent studies have been carried out to investigate the effectiveness of water price in curbing the quantity demanded by households in different governorates in the country, nor have any investigated other variables that might influence the level of household water consumption in those governorates. The objective of this paper is to fill this gap; to identify the variables that affect per capita water consumption in Jordan as a whole, and to measure their unique influence, especially water price. The results of the study will provide feedback that can benefit policy makers in Jordan, as well as foreign aid agencies involved in financing water projects in the country. *"Water demand elasticity estimates* *have become central elements of planning tools and models"* (Bell, *et al.*, 2005). Such a step is a pre-requisite to reformulate and adopt a sound water policy.

This paper is divided into six sections: starting with the introduction followed by a literature review, data, methodology, results and finally the conclusion.

3. LITERATURE REVIEW

Five prime methodological issues received considerable attention in the literature: the definition of the dependent variable; the type of price that is more appropriate, the choice of the explanatory variables, type of data and the appropriate estimation techniques (Mu, *et al.*, 1990); (Worthington, *et al.*, 2006).

For the first issue, some researchers chose household consumption, while others per capita consumption as a unit of analysis. They have also differed in choosing the measure of consumption; some selecting maximum daily consumption and others peak daily consumption in liters. Other researcher yet have chosen monthly, quarterly, annual and average annual consumption in cubic meters as the measure of water consumption in their studies (Mu, *et al.*, 1990).

The second issue is whether consumers react to changes in average or marginal prices. This point generated a great deal of debate and testing (Moncur, 1987); (Nieswiadomy, 1992); (Garcia, *et al.*, 2003); (Ruijs, *et al.*, 2005). Water scarcity has induced most countries to abandon single price tariffs and to adopt multiple- block tariff structures to achieve a significant decrease in household water consumption. This tariff structure usually takes either a progressive form or a mixed form; being progressive in some stages and regressive in others (Worthington, 2010).

Although marginal price is more appropriate to use in case of multiple tariff schemes, because it is in line with economic theory, many researchers preferred average price because they found the difference in results between using marginal or average price insignificant while finding the average price easier to use. Other researchers adopted the average price; assuming that consumers are either lack information on marginal price, or because of information cost, or simply because they have more accurate information about their bill rather than marginal price and the tariff structure (Martinez-Espineira, 2003; Sch85); (Ruijs, *et al.*, 2005); (Sylvestre, 2005); (Gaudin, *et al.*, 2001; Grafton, *et al.*, 2009). Most studies have concluded that the quantity of water consumption is price inelastic. Price elasticity falls in the range between zero and -0.75 while the mean price elasticity was -0.51 ((Espey, 1997); (Renwick, *et al.*, 2000); (Dalhuisen, *et al.*, 2003); (Martinez-Espineira, 2003); (Olmstead, *et al.*, 2007); (Schleich, *et al.*, 2009).The conclusion from the previous studies is that, price is not the prime variable in determining the quantity of water consumption. Therefore, water policy formulation requires detecting other variables. (Worthington, *et al.*, 2006; Dharmaratna, *et al.*, 2010; Kostas, *et al.*, 2006).

For the third issue, the set of the explanatory variables, an equation in the form: Qwc = *f*(Pw, Z) appears in most studies (Worthington, *et al.*, 2006). Where Q_{wc} is the quantity of household or per capita water consumption, and Pw is water marginal or average price. Z represents the explanatory variables. Several sets of explanatory variables have been tried in the process of identifying the variables that shape the magnitude of water consumption.

Household size and per capita income in addition to some sort of price specification were common in most studies ((Schleich, *et al.*, 2009); (Ruijs, *et al.*, 2005); (Kemp, 2004); (Higgs, *et al.*, 2001)). Other variables such as lot size, number of rooms, and the number of toilets were tried too. Furthermore, climate, whether or not a housing unit includes a yard or garden, and rainfall were included in many studies because of their expected effect on out-door water consumption (Dharmaratna, *et al.*, 2010); (Khatri, *et al.*, 2009); (Arbues, *et al.*, 2003). The literature shows that income elasticity was in the range of 0.1 to 0.4 ((Arbues, *et al.*, 2003).The relationship between household size and the dependent variable was inconsistent among studies but in general had a positive sign (Schleich, *et al.*, 2009). Lots size has a positive sign, while rainfall has negative sign (Worthington, *et al.*, 2006).

The set of explanatory variables in developing countries was larger (Worthington, *et al.*, 2006; Mazzanti, *et al.*, 2005). It includes in addition to those in developed countries water sources or providers, number of women in the household, distance to water source, quality of water, reliability of water supply, education and gender of household head ((Mu, *et al.*, 1990); (Nauges, *et al.*, 2010); (Bello, *et al.*, 2006)**;** (Ayanshola, *et al.*, 2010).

Different types of data have been employed in the literature, including cross sectional data ((Bell, *et al.*, 2005); (Gaurdin, 2006). (Hadjispirou, *et al.*, 2002); (Nieswiadomy, 1992).

time series data (Martinez-Espineira, 2003); (Bithas, *et al.*, 2006), Panel data (Gaudin, *et al.*, 2001); (Hewitt, *et al.*, 1995); (Renwick, *et al.*, 1998); (Khatri, 2006)

Owing to its simplicity, ordinary least square (OLS) has been the mostly-implemented econometric technique in analyzing the structural relationships between household water demand and a set of independent variables including the price of water. (Agathe, *et al.*, 1980); (Chicoine, *et al.*, 1986); (Hewitt, *et al.*, 1995); (Higgs, *et al.*, 2001); (Dalhuisen, *et al.*, 2003) (Martinez-Espineira, 2003).

The results of OLS are satisfactory and straight forward in the case of single price tariff (Chicoine, *et al.*, 1986); (Worthington, *et al.*, 2006). However, in the case of multi-block structure, the results of OLS were criticized for being biased and inconsistent in many studies due to simultaneity. The assumption of constant elasticity is unrealistic in complex tariff structures (Gaudin, *et al.*, 2001); (Olmstead, *et al.*, 2007); (Dharmaratna, *et al.*, 2010); (Worthington, 2010).

To avoid these criticisms, other functional models were tried. In the case of cross –sectional data, in addition to ordinary least squares method, GLS, 2SLS and 3SLS, IV, logit, are recommended; (Chicoine, *et al.*, 1986); (Hewitt, *et al.*, 1995); (Worthington, *et al.*, 2006); (Gaudin, *et al.*, 2001); (Garcia, *et al.*, 2003). The Cobb-Douglas production function (double- log) is preferred by many analyst because it allows easy comparisons with the literature and it fits well ((Bell, *et al.*, 2005). Stone-Geary functions have been recently introduced to overcome the problem of constant elasticity. A Stone-Geary functions assumes that the demand for water has two parts: fixed quantity and a residual. Only the residual part is responsive to price change. (Dharmaratna, *et al.*, 2010) employed Stone-Geary function and found the price elasticity in Sri Lanka range from -0.11 to -.014.

Although the results from the above mentioned techniques are more satisfactory than those obtained by the linear form of OLS, (Espey, 1997) found no significant difference between linear versus log-linear. (Martinez-Espineira, 2003) (Chicoine, *et al.*, 1986) recommended using simple ordinary least squares in both single price tariff and discontinuous tariff structures.

4. THE DATA

This study is based on a cross-sectional data, a sub-sample representing 25% of the original sample covered by the 2010. Household Income and Expenditure survey carried out by the Department of Statistics in Jordan. The size of the sub sample is (2743) households. Due to legal constrains and secrecy considerations, the Department does not allow access to the whole data. However, by activating the weight variable assigned to each household in the data set, the data becomes representative of the whole population in each district and governorate just like the original sample would. The sample covers the 12 Governorates of the country. Although the data set provides information on a wide range of socioeconomic characteristics, housing features and demographic information, it does not include neither the price of water nor the quantity of household water consumption but the annual bill. Since the tariff was set on quarterly basis, and the bill frequency was 90 days too, household quarterly water consumption, per capita quarterly water consumption and average price were computed based on the annual bill data and the official tariff schedule. The tariff consists of three segments; fixed charge for quantity up to 20cm, volumetric charge of 11 increasing blocks, and three additional fixed amounts one for the fixed segment, the second for the quantity 21- 40 cm and the third for quantity greater than 40cm. Although the tariff structure was applicable in all governorates, the tariff formula was not. There are three tariff formulas and three price sets one for the capital district, the second for Zerqa district and the third for the other 10 districts.

5. METHODOLOGY

This study is carried out using the ordinary least squares multiple regression (OLS) to estimate the determinants of the variations in per capita water consumption. Two functions are utilized. The first is the linear method intended as a benchmark. The second form is Cobb-Douglas production function (log- log). The choice is based on the same rational of the previous studies as outlined earlier (Worthington, 2010); (Bell, *et al.*, 2005). Average price is chosen for this study for the same reasons mentioned earlier and to facilitate comparison with similar studies.

The following single equation specifies the linear model and the exogenous variables as determinants of per capita consumption. The choice of the explanatory variables is based on the empirical evidence suggested by the previous studies.

PWC = f(AP, PINC, HHS, NYS, FEM, PHA, PEXP,AGE ,SEX, WM,DW,U/R)

Where:

PWC = quarterly per capita water consumption in cubic meter.

AP = average price of cubic meter of water.

PINC = percapita income.

HHS = household size (number of people who live together in the same dwelling).

NYS = number years of formal education attained by household head

NFEM = number of females in the household;

PHA = per capita housing area in squared meters.

PEXP = per capita total expenditure.

Age = age of household head in years.

Sex = qualitative variable for gender = 0 if male, 1=female.

WM = qualitative variable for owning a washing machine. 1= yes; 2=no;

DW = qualitative variable for owning a dish washer. 1=yes; 2=no.

U/R = qualitative variable. 0=urban, 1= rural

The logarithmic formula took the following form:

Log PWC= f(log AP+ log PInc+log HHS+ log Age+log NYS+ log nfem+ logPHA+LOG NYS+LOGPEXP+ Sex+WM+DW+U/R

Since there are three tariff structures, both models were run for Amman Governorate, Zerqa Governorate, and the other Governorates.

6. THE EMPIRICAL RESULTS

Tables 1-3 present a descriptive statistics for the governorates. The mean per capita water consumption varies among governorates. The capital district has the highest 11.5 M^3 which is equivalent to 6 liter per day, while the lowest mean was in Zarka district which is 5.4 liter per day only. These figures are less than 6% of the official figures.

Table (4) presents the estimated results for the linear and Cobb- Douglas forms of OLS multiple regression. The results are remarkably robust and reveal strong fit. The high values of R suggest a positive and strong relationships between the dependent variable and the independent variables.

The explanatory power of the two forms as represented by R^2 is significant and very high. Each form explains more than 71% of the observed variations in per capita quarterly water consumption. These values fall in the top range of the reported values of R^2 in the literature ((Bell, *et al.*, 2005). However, the log- log form is more powerful and explains the variations in per capita water consumption more than the linear form. The probability value for the F-test statistics is lower than 5% level of significance (sig=0.000) as shown in the Table. Therefore, the model is highly respectful and the null hypothesis, that the independent variables in the model have no significant influence on the dependent variable (per capita water consumption) can be rejected at $\alpha = 0.05$. All the estimated coefficients of the independent variables, as shown in Tables 5 to 10, have the expected signs and are significant at $\alpha = 0.05$ although the unique contribution of some of them is very small. Beta values (the standardized values of the coefficients) show the relative contribution of each of the independent variables. It is clear that average price, household size, per capita housing, number of school years completed and per capita income have the highest contribution in explaining variations in per capita water consumption.

The demand for water is price inelastic in all governorates. Price elasticity for Amman, Zerqa and other governorates are (-.554, -.504 and -.561) respectively. Thus, per capita water consumption falls slightly in response to an increase in price. Our result is consistence with the findings of most studies in developed and developing countries which concluded that the demand for water is price inelastic and falls in the range -0.11 to -0.75 (Schleich, *et al.*, 2009); (Mu, *et al.*, 1990); (Olmstead, *et al.*, 2007); (Espey, 1997). Regression results show that per capita quarterly water consumption is lower by 3 to 5 cubic meter for household who live in housing units connected to public sewage system because average price is higher. It includes a sure-charge per cubic meter. This another indication of the negative effect of higher price on quantity of water consumption.

The results have revealed that the coefficients of per capita income variable are .038, 0.95, .048 for the three regions respectively and all of them are statistically significant at $\alpha = 0.05$. An increase in per capita income Per capita water expenditure in Jordan, as well as in other countries, represents a small proportion of total expenditure and per capita income. Therefore, income elasticity falls in the range of 0.01 and 0.4 (Arbues, *et al.*, 2003); (Dany, *et al.*, 1997); (Hoglund, 1999); (Renwick, *et al.*, 1998) and zero in (Mu, *et al.*, 1990); (Worthington, et al., 2006); (Worthington, 2010).

The household size variable is significant at á=0.05. The estimated elasticities of household size in this study are 0.571, 0.429, 0.449 for Amman, Zerqa and other governorates respectively, that water consumption increases less than proportionally after an increase in the household size. Our estimates have the same sign but higher than those reported in the literature (Schleich, et al., 2009); (Cavanagh et al., 2002); (Hoglund, 1999); (Arbues, et al., 2000). In relation to per capita housing size the elasticity was (0.35, 0.23, and 0.27) for the three areas respectively. A 10 percent increase in per capita housing area leads to an increase in water consumption on average by 3%. Indeed, the larger the house the more water is needed. Elasticity of per capita housing can be used as a proxy for income elasticity. The parameter estimate associated with per capita total expenditure is positive and inelastic. As per capita total expenditure increases, per capita water consumption increases too but at lower percentage. The influence of household head age on per capita consumption is very low, but significant in the three areas. As the household head got older the household consumed more water in Amman but less in Zerqa and the other governorates. Such results are similar to the findings of (Schleich, *et al.*, 2009); (Martinez-Espineira, 2003); (Kostas, *et al.*, 2006).

Our study shows a positive influence of education on per capita water consumption. The result is statistically significant at α = 0.05.The elasticity of the number of years of studying in the three areas are (0.08, 0.08, 0.12). For a one year increase in number of school years, per capita water consumption increases on average by 1.4%. This result reflects that education is a positive externality and government expenditure on education is justified. Per capita water consumption falls by quarter cubic meter on average due to an addition of one female to the household. Our findings show that the influence of washing machines and dish washer on per capita water consumption was significant at α = 0.05 but very low. Both, washing machine and dish washer lower per capita water consumption.

Collinearty statistics in Tables 5to 10 show that there is no indication of multicollinearity problem in either, the linear or the log-log models. The Tolerance values are quite respectful being above the 0.10 threshold. Also the variance inflation factor (VIF) is below 5. Both results support the conclusion of the nonexistence of multicollinearity.

7. CONCLUSION

This study formulates a demand model to estimate the determinants of per capita water consumption in Jordan based on data from household income and expenditure survey carried out by the Department of Statistics in 2010. An econometric analyses of the impact of average price, per capita income, household size, per capita expenditure, number of females in the households, per capita housing area, number of years of studying, sex and age of household head, washing machine and dish washer on per capita water consumption. OLS procedure is employed in two functional forms, linear and log- log for the three areas. Both models were robust and fit the data well. However, the log- log model was superior. The values of R^2 in the linear model exceed 0.71. While the values of R^2 for the log-log in the same areas are much higher. The independent variables are significant in both models at a level of $\alpha = 0.05$. The signs of the coefficients are similar to the results of previous studies while their magnitude varies (Dharmaratna, *et al.*, 2010).

Our findings reveal that the demand for water in Jordan is price inelastic with a negative sign. Consequently, per capita water consumption would respond less proportionally to an increase in water price. Municipal water is overpriced to compensate for water leakage which accounts for 44% in 2008 down from 57% in 1999 of total distributed water (The Ministry of Water Irregation, 2009). Therefore, residential water price does not reflect its marginal cost but the average cost of supplied water. International Monetary Fund Adjustment Programs which have imposed on Jordan since 1990 have been behind such policy to achieve efficiency and to generate more revenue for government budget which suffers from unacceptable annual deficit and accelerated foreign and internal debt (Department of Budget, 2008- 2011) (International Monetary Fund, 2007) .This scenario is familiar in several developing countries." *The inelastic nature of water consumption allows authorities to raise more revenue by increasing water tariff to cover fixed and variable costs of water supply and distribution",* (Dharmaratna, *et al.*, 2010). Still the cost of water consumption in Jordan still very low and does not represent a real burden on families for two reasons: first, the tariff for the first two blocks is not expensive, second, the quantity of water available for household is restricted to 10-15 m^3 a month because water is distributed for one day or one night every one week in some areas, two weeks in others and probably one month in many areas. Households store the water in tanks of 1-2 cubic meter on the roof of their houses. Families who live in houses or villas can store double that quantity in well in their back yards.

The policy implication of our study is quite clear. Water price in Jordan turned out to be not an effective tool in controlling the level of water consumption. The distribution of water is the prime tool to restrict the quantity of consumption. The mean of quarterly per capita consumption was (less than 10 liter per day). This quantity is incomparable with reported quantities in the literature (Dharmaratna, et al., 2010)) even the lowest limit (27-200 lpcd) accepted by the World Bank (Gleick, 1996). The mean quantity is around 6% of the official figure 146lpcd (The Ministry of Water Irregation, 2009). The three tariff structure designs are differentiated to take into account income levels, not the needs of households characterized by different family size. Large household consumption leads to bracket creep; that they become within the brackets subject to higher tariff and pay more even their per capita consumption is lower. Water distribution policy driven by high water leakage and limited water supply has an adverse effect on water consumption and consequently on public health, especially of larger families as well as low income households who cannot buy water from tankers. From an equity and efficiency point of view, the social cost of water pricing policy exceed the social benefit and the budget concern.

Despite its importance, price is not the only variable that determines the quantity of per capita water consumption. Family size, per capita total expenditure, residency size, number of females in household, number of years of studying are significant too at $\alpha = 0.05$ level. Some of these variables could be controlled by government policies. Therefore, the imbalance between total water demand and total water supply cannot be dealt with through mere adjustments in water prices.

Our recommendation is that, water tariff should be increased significantly for high brackets especially for household who use water in pools and garden irrigation, and at a lower level for the lower brackets. On the other hand water distribution schedule should modified to twice a week allowing the price to determine the quantity of water consumption. Such a modification would generate more revenue to the budget that can be invested in new sources of water supply and in the maintenance of the old water network.

Table 1
Descriptive Statistics for Amman Governorate

Variables	*N*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
type of sewage	432342	.00	1.00	.774	.418
Per capita quarterly water consumption in M^3	432342	2.33	70.20	11.54	7.018
Average price of water per M^3	432342	.19	1.12	.685	.157
Per capita income	432342	153.88	32571.43	1905.97	2190.69
Family size	432342	1	15	5.38	2.27
per capita housing area in m^2	432342	3.13	250.00	30.91	24.93
Per capita expenditure	432342	324.87	13544.13	2237.48	1698.49
sex of household	432342	0	1	.87	.336
age of household	432342	21	91	49.59	14.18
Number of females in hh	432342	0	11	2.72	1.478
Washing machine	432342	0	1	.99	.104
Dish washer	432342	0	1	.02	.150
Number of school years completed successfully	432342	.0	25.0	10.48	5.07

Table 2
Descriptive Statistics for Zerqa

Variables	*N*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Per capita quarterly water consumption in M^3	147081	2.50	48.57	9.8	6.14
Average price of water per M^3	147081	.30	1.33	.9587	.1759
Per capita income	147081	75.38	17209.9	1323.1	1564.38
Family size	147081	1	12	5.30	1.96
per capita housing area in m^2	147081	6.00	100.00	21.96	13.6
Per capita expenditure	147081	316.51	4285.17	1385.9	713.5
sex of household	147081	0	1	.91	.288
age of household	147081	23	87	45.23	14.3
Number of females in hh	147081	1	7	2.63	1.28
Washing machine	147081	0	1	.98	.129
Dish washer	147081	0	0	.00	.000
Number of school years completed successfully	147081	.0	18.0	9.13	4.22

Table 3
Descriptive Statistics for other Governorates

Variables	*N*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Per capita quarterly water consumption in M^3	455806	.82	90.10	11.47	8.29
Average price of water per M^3	455806	.13	1.55	.9593	.22
Per capita income	455806	74.55	8962.40	1305.76	900.8
Family size	455806	1	22	5.87	2.635
per capita housing area in m^2	455806	1.76	160.00	24.3	16.9
Per capita expenditure	455806	231.01	10013.76	1434.6	955.87
sex of household	455806	0	1	.89	.311
age of household	455806	20	97	47.38	13.79
Number of females in HH	455806	0	11	2.85	1.629
Washing machine	455806	0	1	.97	.174
Dish washer	455806	0	1	.00	.044
Number of school years completed successfully	455806	.0	22.0	8.98	5.038

Table 4
Model Summary for Amman Governorate

Area	*Form*	*R*	*R^2*	*Adjusted R^2*	*Std. Error of the Estimate*	*Model*	*F*	*sig*
Amman	linear	.879[a]	.773	.773	3.34231	Regression Residual T.	122819.8	.000[a]
Zerqa	linear	.842[a]	.709	.709	3.30878	Regression Residual T.	32595.5	.000[a]
Other Governorates	linear	.858[a]	.736	.736	4.26468	Regression Residual T.	105671.5	.000[a]
Amman	Cobb-Douglas	.947[a]	.896	.896	.16846	Regression Residual T.	311742.3	.000[a]
Zerqa	Cobb-Douglas	.857[a]	.735	.735	.28049	Regression Residual T.	37094.6	.000[a]
Other Governorates	Cobb-Douglas	.928[a]	.862	.862	.21354	Regression Residual T.	237130.3	.000[a]

Table 5
Coefficients for Amman Governorate

Linear Model	*Std. Error*	*Standardized Coefficients Beta*	*sig*	*Collinearity Statistics*	
				Tolerance	*VIF*
(Constant)	.068		.000		
Average price of water M^3	.039	-.465	.000	.707	1.415
Per capita income in JD[1]	.000	.038	.000	.443	2.258
Family size	.004	.571	.000	.302	3.314
per capita housing area in M^2	.000	.351	.000	.368	2.714
Per capita expenditure	.000	.015	.000	.284	3.521
age of household	.000	.014	.000	.729	1.371
Number of females in hh	.005	.021	.000	.423	2.362
Number of school years completed successfully	.001	.075	.000	.747	1.338
sex of household	.017	.020	.000	.783	1.276
Washing machine	.049	-.033	.000	.980	1.021
Dish washer	.035	-.039	.000	.953	1.049
type of sewage	.013	-.191	.000	.887	1.127

Table 6
Coefficients for Zerqa Governorate

Linear Model	*Std. Error*	*Standardized Coefficients Beta*	*sig*	*Collinearity Statistics Tolerance*	*VIF*
(Constant)	.112		.000		
Average price of water in M^3	.053	-.554	.000	.849	1.178
Per capita income	.000	.095	.000	.789	1.267
Family size	.008	.429	.000	.277	3.612
per capita housing area in M^2	.001	.233	.000	.381	2.623
Per capita expenditure	.000	.163	.000	.475	2.103
age of household	.001	.027	.000	.623	1.606
Number of females in hh	.010	.017	.000	.449	2.228
Number of school years	.003	.080	.000	.621	1.609
sex of household	.038	.066	.000	.635	1.575
Washing machine	.068	-.019	.000	.963	1.038
type of sewage	.023	-.366	.000	.884	1.131

Table 7
Coefficient for Other Governorates

Linear Model	*Std. Error*	*Standardized Coefficients Beta*	*sig*	*Collinearity Statistics Tolerance*	*VIF*
(Constant)	.066		.000		
Average price of water M^3	.031	-.504	.000	.833	1.200
Per capita income in JD	.000	.048	.000	.424	2.359
Family size	.005	.449	.000	.279	3.580
per capita housing area in M^2	.001	.267	.000	.424	2.358
Per capita expenditure	.000	.226	.000	.369	2.707
age of household	.001	.015	.000	.691	1.447
Number of females in hh	.006	.032	.000	.404	2.474
Number of school years	.002	.116	.000	.627	1.595
sex of household	.023	.003	.001	.775	1.290
Washing machine	.037	.069	.000	.963	1.038
Dish washer	.144	-.010	.000	.995	1.005
type of sewage	.014	-.165	.000	.925	1.081

Table 8
Coefficients for Amman Governorate

Cobb- Douglas Model	*Std. Error*	*Standardized Coefficients Beta*	*sig*	*Collinearity Statistics Tolerance*	*VIF*
(Constant)	.006				
log average price	.001	-.561	.000	.685	1.459
log per capita income	.001	.001	.000	.308	3.245
log family size	.001	.798	.492	.233	4.299
log per capita housing area	.001	.034	.000	.239	4.183
log per capita expenditure	.001	.058	.000	.242	4.137
log age of household head	.001	.035	.000	.709	1.410
log number of females	.001	.007	.000	.453	2.207
log years of studying	.000	.009	.000	.673	1.486
sex of household	.001	.000	.000	.740	1.352
Washing machine	.003	.007	.807	.964	1.037
Dish washer	.002	-.009	.000	.951	1.052
type of sewage	.001	-.213-	.000	.881	1.135

Table 9
Coefficients for Zerqa Governorate

Cobb- Douglas Model	*Std. Error*	*Standardized Coefficients Beta*	*sig*	*Collinearity Statistics Tolerance*	*VIF*
(Constant)	.020		.000		
log average price	.003	-.516	.000	.873	1.145
log per capita income	.002	.047	.000	.427	2.340
log family size	.004	.554	.000	.211	4.729
log per capita housing area	.003	.024	.000	.277	3.614
log per capita expenditure	.003	.066	.000	.335	2.985
log age of household head	.003	.011	.000	.591	1.692
log number of females	.002	.043	.000	.453	2.209
log years of studying	.001	.051	.000	.531	1.882
sex of household	.003	.093	.000	.621	1.611
Washing machine	.006	-.001-	.402	.956	1.046
type of sewage	.002	-.367-	.000	.924	1.082

Table 10
Coefficients for other Governorates

Cobb- Douglas Model	*Std. Error*	*Standardized Coefficients Beta*	*Sig*	*Collinearity Statistics*	
				Tolerance	*VIF*
(Constant)	.007		.000		
log average price	.001	-.626	.000	.854	1.170
log per capita income	.001	.003	.000	.438	2.284
log family size	.001	.762	.000	.226	4.417
log per capita housing area	.001	.062	.000	.311	3.217
log per capita expenditure	.001	.054	.000	.356	2.812
log age of household head	.001	.050	.000	.646	1.549
log number of females	.001	.028	.000	.434	2.306
log years of studying	.001	.020	.000	.530	1.888
sex of household	.001	.023	.000	.724	1.381
Washing machine	.002	.000	.000	.928	1.077
Dish washer	.007	.002	.000	.997	1.003
type of sewage	.001	-.195	.000	.920	1.087

References

Agathe R. and Billings R. Dynamic Models of Residential Water Demand [Article] // *Water Resources Research*, 16. - 1980. - pp. 476-480.

Arbues F., Barberan R. and Villanua I. Water price impact on residential water demand in the City of Zaragoza [Conference] // 40th European Congress of the European Regional Studies Association in Barcelona. - Barcelona : [s.n.], 2000.

Arbues F., Garcia-Valinas M. and Martinrz-Espieira R. Estimation of residential water demand: a state of the art review [Journal] // *Jornal of Socio-Economics*, 32. - Barcelonea : [s.n.], 2003. - pp. 81-102.

Ayanshola A.M., Sule B.F. and Salami A.W. Modelling of reidential water demand at household level in Iloron, Nigeria [Journal] // *USEP Journal of Research Informationin Civil Engineering*, Vol. 7, No. 1. - 2010. - pp. 59-67.

Baumann D.D, Boland J.J. and Hanemann W.M. Urban water demand managemen and planning [Book]. - New York : McGrow-Hill, 1998.

Bell David R. and Griffin Ronald C. Determinants of Demand for water used in Texas Communities [Conference] // Western Agricultural Economics Association. - San Francisco : Department of Agricultural Economics, Texas A&M University, College Station, TX 77843-2124, 2005.

Bell R. David and Griffin Ronald C. Determinants of demand for water used in Texas Communities [Conference] // Annual Meeting of the Western Agricultural Economics Association. - San Francisco : Department of Agriculural Economics, Texas A&M University, College Station, TX &&843-2124, 2005. - pp. 1-10.

Bello H. M., M. Malefane R. and S. Babatope-Obasa An estimation of water demand function in some peri-urban settlements [Conference] // 11 Annual African Econometrics Society Conference. - Dakar-Sengal : UNIDEP, 2006.

Bithas Kostas and Stoforos Chrysostomos Estimating urban residential water demand Determinants and forcasting water demand for Athens Metropolitan area 2000-2010 [Journal] // South-Eastern Europe Journal of Economics,1. - 2006. - pp. 47-59.

Chicoine D., Deller S. and Ramamurthy G. Water Demand Estimation Under Block Rate Pricing: Asimultaneous Equation Approach [Article] // Water ResourcesResearch,22. - 1986. - pp. 859-63.

Dalhuisen J., P. Nijkamp and H. Florix, R. de Groot Price and Income Elasticities of Residential Water Demand: A Meta-Analysis. [Article] // Land Economics,79. - 2003. - pp. 292-308.

Dany G., Nguyen T. and Davies C. Estimating residential water demand in the presence of the allowances [Journal] // Land of Economics,73. - 1997. - pp. 125-139.

Department of Budget. *The Budget Law*. Amman: Department of Budget, Ministry of Finance, Jordan, (2008- 2011).

Department of Statistics Jordan in Figures [Report]. - Amman : Department of Statistics, the Hashemite Kingdom of Jordan, 2010.

Dharmaratna Dinusha and Harris Edwyna Estimating residental water demand using the Stone-Geary Functional form: the case of Sri Lanka [Article] // Department of Economics, Issn 1441-5429, Discussion paper 46/10. - 2010.

Espey Molly Price Elasticity of Residential Demand for Water: A Meta Analysis [Article] // *Water Resources Research*, 33. - 1997. - pp. 1369-1374.

Falkenmark The massive water scaricity threatining Africa-why isn't it being addressed [Journal] // Ambio,2. - 1989. - pp. 112-118.

Garcia S. and Reynaud A. Estimating the Benefits of Efficient Water Pricing in France [Article] / / *Journal of Resouces and Energy Economics*,26. - 2003. - pp. 1-25.

Gaudin Sylvestre, Griffin Ronald C. and Sickles Robin C. Demand Specification for Municipal Water Management: Evaluation of the Stone-Geary Form [Article] // *Land Economics*, 77(3). - 2001. - pp. 399-422.

Gaurdin S. Effects of price information on resdintial water demand [Journal] // *Applied Economics*, 38. - 2006. - pp. 383-393.

Gleick H. Peter Basic Water Requirments for Human Activities:Meeting Basic Needs [Journal] / / *Water International*, vol.21.NO.2. - 1996. - pp. 83-92.

Gleick Peter H. Basic water requirments for human activities:Meeting basic needs [Journal] // *Water International* (IWRAI) 21. - 1996. - pp. 83-92.

Grafton Quentin R., Clay Landry and Gary D. Libecap Water markets:Asutralia's Murray-Darling Basin and the US Southwest [Report]. - Acton,ACT 0200 : University of California Santa Barbara and the National Bureau of Economic Research, 2009.

Grafton R. Quentin [*et al.*] Residential Water Consumption: A Cross Country Analysis [Journal]. - May 2009.

Hadjispirou S., Koundouri P. and Pashardes P. Household demand and welfare implications of water Pricing in Cyprus [Journal] // *Enviromental and Development Economics,* 7. - 2002. - pp. 399-422.

Hewitt J. and Hanemann W. A Discrite /Coninuous Choice Approach to Residential Water Demand Under Block Rate Pricing [Article] // *Land Economics*, 71. - 1995. - pp. 173-192.

Higgs H. and worthington A. Consumer Prefernces and Changing Options in a large Urban Municipality: a case study. [Article] // Public Works Management and Ploicy 5. - 2001. - pp. 209-207.

Hoglund L. Household demand for water in Sweden with implications of a potential tax on water use [Journal] // *Water Resources Research*, 35. - 1999. - pp. 3853-3863.

International Monetary Fund. *Jordan – Aide-Mémoire for the Fifth Post-Program Monitoring (PPM) Discussions*. IMF, 2007.

Kemp Adrian The determinants of urban residential water demand in Sydney, the Blue Mountains and Illawarra [Report]. - New South Wales : Independint Pricing and Regulation Tribunal of New South Wales, IPART, Wp1, ISBN 1 877049 43 3, 2004.

Khatri Hrihna Risk and Uncertainty Analysis for Sustainable Urban Water Systems // PhD Thesis. - [s.l.] : 018530- SWITCH: Global Change Ecosystem, Integrated Project, 2006.

Khatri K. and Vairavamoothy K. Water Demand Forcasting for the City of the Future against the Uncertainities and the Global Change Pressure:Case of Birmingham [Conference] // Pro. EWRI/ASCE. - Kansas.US : [s.n.], 2009.

Kostas Bithas and Chrysostomos Stoforos Estimation Urban Residential Wate rDemand Determinants and Forcasting Water Demand for Athens Metropolitan Area, 2000-2010 [Journal] // *South-Estern Europe Journal of Economics*, 1. - 2006. - pp. 47-59.

Martinez-Espineira R. Estimating Water Demand Under Increasing Block Tariffs Using Aggregate Data and Proportions of Users Per Block [Article] // *Enviromental and Resources Economics,* 26. - 2003. - pp. 5-23.

Mazzanti Massimiliano and Montini Anna The determinants of residental water demand: Empirical evidence for a panel of Italian Municipalities [Article] // *Natural Resources Management*. - February 2005. - pp. 1-7.

Ministry of Water and Irregation water for life, Jordan's water strategy 2008-2022 [Report]. - Amman : Ministry of Waterand Irrigation, the Hashemite Kingdom of Jordan, 2007.

Moncur J. Urban Water pricing aand Drought Management [Article] // *Water Resources Research*, 23. - 1987. - pp. 393-398.

Mu Xinming, Whitington Dale and Briscoe John Modeling Village Water Demand Behavior: A Discrete Choice Approach [Article] // *Water Resources Research*, Vol. 26 No.4.. - 1990. - pp. 521-529.

Nauges Celine and Whittington Dale Estimation of water demand in developing countries: an overview [Journal] // Oxford Journals,2, 25. - 2010. - pp. 263-294.

Nieswiadomy M. Estimating Urban Resential water Demand: Effects of Price Strucure, Conservation and Education [Article] // *Water Resource Research*, 28. - 1992. - pp. 609-615.

Olmstead Sheila M., Hanemann Michael W. and Stavins Robert N. Water Demand under alternative price structures [Journal] // *Journal of Enviornmental Economics and Management*, 54. - 2007. - pp. 181-198.

Renwick M. and Archibald S. Demand side management policies for residential water use: who bears the conservation burden [Journal] // *Land Economics*, 74. - 1998. - pp. 343-359.

Renwick M. and Green R. Do residential water demand side management policies measure up?An analysis of eight California water agencies [Journal] // *Journal of Enviromental Economics and Management*, 40. - 2000. - pp. 37-55.

Ruijs A., Zimmermann A. and Van den Berg M. Demand and equity effects of water pricing plicies [Report]. - Wageningen, Netherlands : Mansholt Graduate School Hollandseweg, 2005.

Schleich Joachim and Hillenbrand Thomas Determinants of residential water demand in Germany [Journal] // *Ecological Economics*, 68. - 2009. - pp. 1756-1769.

Statzu Vania and Strazzera Elisabetta Water demand for residential uses in a Mediterranean Region:Economeric Analysis and Ploicy Implications [Report]. - Cagliari ,Italy : Department of Economic and Social Researc, University of Cagliari, 2006.

Statzu Vania and Strazzera Elisabetta Water demand for residential uses in a Mediterranean Region:Economeric Analysis and Ploicy Implications [Report]. - Cagliari, Italy : Department of Economic and Social Researc, University of Cagliari, 2006.

Sylvestre Gaudin Water Bills and the Power of Price Signals: Evidence from the U>S> [Conference] // IWA International Conference on Water Economics, Statistics and Finance, Rethymno . - Greece : [s.n.], 2005. - pp. 8-10.

The Ministry of Water Irregation The Annual Report [Report]. - Amman, Jordan : Water Authority, 2009.

Worthington A.C. and Hoffmann M. A state of the art review of residential water demand modelling [Article] // University of Wollongong Research Online, Working Papers Series. - 2006.

Worthington Andrew C [Article] // Griffith Businesss School, Discussion Papers Economics, ISSN 1837-7750. - No. 2010-11 2010.