Journal of Urban Management and Energy Sustainability (JUMES)

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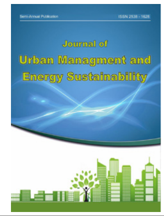

ORIGINAL RESEARCH PAPER

Explaining the Relationship Between Income and Water Consumption Using Smooth Transition Regression Based on Kuznets' Environmental Theory

Ali Reza Eghbali[1], Ali Sayehmiri[2*]

[1] *Department of Economic, Faculty of Management, Payam Noor University, Khozestan, Iran*

[2] *Department of Economic, Humanity and Social Science Faculty, Ilam University, Ilam, Iran*

ARTICLE INFO

Article History:
Received 2022-5-9
Revised 2022-7-12
Accepted 2022-10-18

Keywords:
Income
Water
Kuznets Curve
Smooth Transition Regression (STR)

DOI: 10.22034/jumes.2022.1971451.1092

ABSTRACT

Water plays an important role in the level and growth of economic activities, social welfare and environmental sustainability. The main purpose of this article is to study the non-linear effects of per capita income on water withdrawal in the domestic sector (drinking and urban) of the world. For this purpose, "The Environmental Kuznets Curve (EKC) hypothesis based on the natural resources" has been tested using cross-sectional data, Ordinary Regression and Smooth Transition Regression (STR) from 163 countries. The result is to accept the hypothesis in Water Economics. Furthermore, the "transition point" of the relationship between income and water consumption in gross domestic product (GDP) is $ 41,982. The effect of national income on water consumption in the domestic sector is non-linear, which can be caused by the scale, technology or composition effects. As a result, the stricter environmental regulations can reduce per capita water withdrawals and the rate of aquifer erosions. Indeed, increasing per capita income and changing societal structures will reduce per capita water use.

Running Title: Explaining the Relationship Between Income and Water Consumption...

NUMBER OF REFERENCES
42

NUMBER OF FIGURES
02

NUMBER OF TABLES
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*Corresponding Author:
Email: *a.sayehmiri@ilam.ac.ir*
Phone: +989124544821

1. Introduction

Every human, physical and natural capital plays an important role in the developmental process. In the meantime, the role of natural resources, especially freshwater resources, is of dual importance, which has not yet been fully understood. Consequently, research is needed on the factors determining water withdrawal and finding useful and effective solutions to preserve the environment and protect the recoverable water capacity for future generations. Water security not only requires the availability and access to safe and acceptable quality for domestic use, it is also linked to its distribution (Fing Mao et al., 2022). The question of economic growth and rising per capita income is closely related to water scarcity, because as incomes increase and water consumption increases, the amount of freshwater available per capita decreases and water scarcity increases. The global threat of water shortages, in particular the gradual reduction of drinking water, has become a global problem (Falkenmark et al., 1998). Due to population growth and economic development - increase in gross domestic product per capita - and general climate changes in the world, water shortages in some areas are expected to intensify, especially in agriculture, industry and households (drinking, urban) (Worth Marty et al., 2000 and Revenga et al. 2000). The challenges of managing water intake in a city are strongly influenced by weather conditions, so that every time the weather changes, the amount of water consumed also changes (Hamidi et al., 2021).

Rising per capita income as the main achievement of economic growth is regarded as a good indicator of living standards. Higher per capita income has two different effects on per capita water use. On the one hand, as per capita income and purchasing power increase, people's capacity to get the necessities of life increases, which may exert greater pressure on the capacity of natural resources, in particular fresh water resources (Barbier.E. B, 2004). On the other hand, once the per capita income has exceeded some threshold, shifting the production pattern towards the service sector and changing the consumption pattern, technical changes in water conservation, increased efficiency and more effective implementation of environmental regulations may reduce the use of natural resources, particularly freshwater. Especially when people become wealthier, their demand for environmental goods like clean water or air increases and public environmental regulations increase in environmental protection (Arrow et al.,1995). The results of the study (Hosseinzadeh and others, 2022) showed that there is a reverse U-shaped relation between water consumption and economic growth, and environmental Kuznets hypothesis exists between water collection and economic growth in agriculture and services. The result of these downward and upward effects is positive at low levels of income and negative at high levels of income, then it is expected that there will be a non-linear relationship between per capita income and per capita water withdrawal as an "inverted U-shaped" just like the Environmental Kuznets Curve (KCE).

Many experimental and theoretical studies have been conducted on environmental pollution and income, but few have focused on the relationship between water use and income. Based on cross-sectional data from countries around the world and integrated time series and cross-sectional data from different states in America, Rock (1998) demonstrated that there is a non-linear relationship in the form of a reverse U-shaped curve between water withdrawal per capita and national income per capita. He believes that this curve is compatible with Environmental Kuznets Curve. Michael, (1998), Seckler (1994), Falcenmark (1993) confirmed the existence of a reverse U-shaped curve between water withdrawal and income using cross-sectional data series for the countries of the world. Goklany (2002) reached a similar conclusion regarding the annual amount of agricultural water withdrawal and national income in the United States by qualitatively describing water use data.

Shekel and Manow (2000) estimated the EKC curve using demographic and per capita income data for the years 1990-2000 for the continents of Europe, North America, Africa, Asia, South America and Oceania. A major point in estimating the KCE curve is that economic growth exceeds its limits and creates environmental problems. Among other studies that have investigated the non-linear effects of income on water using cross-sectional data for countries around the world, we may refer to the studies of Cole (2004), Rock (1998) and Goklany (2002), Gu, A et al., (2017) and Alfonso et al., (2019). But, in terms of data, there are differences between the countries studied, the specification of the estimating function, and the year studied. The distinguishing point of this study with earlier ones concerns the water withdrawal in the domestic sector. The results of this study demonstrate that the environmental hypothesis of Kuznets is confirmed for the domestic sector (drinking and urban).

In the second part of this paper, we explain the theoretical foundations of Kuznets' natural resource-based environmental hypothesis, the third section focuses on the scarcity of water and its indicators. The fourth part deals with the introduction of the econometric model and the estimation and experimental results. Finally, the article's conclusion will be set out.

2. The theoretical framework and literature review

EKC curve analysis has a wide range of applications in environmental economics. The relationship between water sector pollution and income in developing countries has been confirmed by (Borhan et al., 2021) as a reverse U-shaped relationship. The KCE curve shows a reverse U-shaped relationship between per capita income and a wide range of indicators of environmental pollution. Of course, the origin of the above curve is due to the relationship between income inequality and economic growth, which was expressed by Kuznets. Based on the hypothesis, with the increase in per capita income, pollution or the environmental destruction will first increase, then it will reach its maximum and eventually decrease. Diagram number: 1 shows the diagram of this hypothesis concerning water withdrawal per capita. As can be observed, the shape of the environmental Kuznets curve is inverted in U.

The relationship between per capita income and pollution as a reverse U-shaped curve is attributed to three effects or factors including Scale effect (SE), Composition effect (CE) and Technical effect (TE).

The scale effect (ES) is the state in which the quantity of pollution will increase as the economic scale increases and other factors remain constant. The rising portion of the EKC curve is the result of the stated effect. The composition effect (CE) implies that along with economic development and increase in per capita income, the structure or share of the various economic sectors changes in favor of cleaner industries and sectors (such as the services sector or high technology industries). Given that the intensity of utilization of natural resources in these activities is lower, there will be a relative reduction in the use of these resources

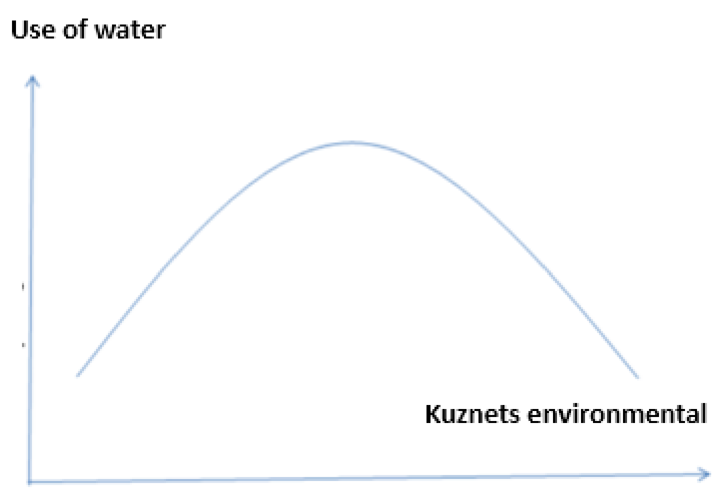

Diagram 1: The relationship between water withdrawal and income

and, naturally, a reduction in pollution. Finally, depending on the technical effect (TE), as incomes increase, an increasing demand for environmental rules and regulations is created. Due to these rules and regulations, the intensity of the use of natural resources, such as water resources, can be reduced, as well as, the production technology can be modified and enhanced to reduce pollution. The hypothetical EKC diagram is indeed a mixture of the aforementioned tripartite effects. Studies such as Arrow et al. (1995); Cole (2004) and Koop and Tole (1999), Gu, A et al. (2017) and Alfonso et al. (2019), Diego et al. (2022) estimated and confirmed the environmental Kuznets hypothesis based on the natural resources (*NRBEKC*) in different regions of the world.

3. Methodology and materials

In this section, we present and estimate the experimental model of the income effects on water withdrawal, based on the literature review (including theoretical foundations and experimental studies). First of all, using ordinary least squares regression, the nonlinear relationship between water withdrawal per capita and income per capita was explained based on 2006 cross-sectional data for 163 countries, and then this relationship is estimated by the smooth transition regression.

This model is specified as follows:

$$\text{Log}\,(AWW_{pc})i=\alpha+\beta\log\,(GDP_{pc})_i +\gamma\log\,(GDP_{pc})_i^2+u_i \quad i=1,2,3...,163 \tag{1}$$

Where, Log (AWW_{pc}) is the logarithm of annual per capita water withdrawal in 2006 in cubic meters, and log (GDP_{pc}) is the logarithm of per capita income (here, GDP per capita) in 2006 at the constant price of 2000 in dollars. i country, i=1 ,2,3,...,163 and u_i is also part of the disturbance. Cross-sectional data for the water withdrawal has been taken from the *AQUSTAT* data set of F.A.O. and per capita income data has been obtained from the world development indicators provided by The World Bank.

In recent years, the use of nonlinear models has become more common, and many researchers have attempted to develop these models. The Smooth transition regression model is a nonlinear time series regression model that can be considered as an advanced form of the "Switching Regression Model" introduced by Quant. The univariate type of the Switching Regression Model is known as the "threshold autoregressive" model. The STR model is a special type of Switching Regression Model which was applied by Bacon and Watts (1971). These researchers considered two regression lines and designed a model in which the transition from one line to another happens smoothly. In the time series literature, Chan and Tung (1986) were the first to explain and propose the STR model in their studies. Before these two, of course, other economists such as Goldfeld-Quant (1972) and Medala (1977), Granger and Terras Verta (1993, 1994 and 1998), Francis and Van Dieg (2000) and (2002) pointed it out. Of these, the most distinctive is Terrasorta (1998). The standard form of the STR model is defined as follows:

$$y_t=\varphi' z_t+\theta' z_t F(\gamma,s_t,c)$$
$$+u_t=\{\varphi+\theta F(\gamma,s_t,c)\}' z_t+u_t \quad t=1,2,\ldots,T \tag{2}$$

Zt is the vector of explanatory variables. In this equation, $Z_t=(W_t',X_t')$ a vector of $(m\times 1)\times 1)$ is the explanatory variables in which $w'_t=(1,y_{t-1}\ldots,y_{t-p})'$ and $X_t'=(X_{1t},\ldots X_k)'$ and φ θ are the parameters of the corresponding linear and non-linear parts, so that φ = $\varphi_0,\varphi_1,\ldots\varphi_n$. Meanwhile, the disturbance sentence also has the characteristic $u_t \sim iid(0,\sigma^2)$. The transfer function, $F(\gamma,s_t,c)$, is a bounded function in terms of the transition variable s_t. The parameter γ is slope and $(c_1, c_2,\ldots,c_k)'$ is Locational Parameters, so that $c_1\le c_2\le\ldots\le c_k$. The last term in the above equation shows that the model can be interpreted as a linear model with Time-Varying Parameters. In this section, we assume that the transition function is the general logistic function:

$$F(\gamma,s_t,c)=\left(1+\exp\left\{-\gamma\prod_{k=1}^{K}(s_t-c_k)\right\}\right)^{-1} \quad ,\gamma>0 \tag{3}$$

Considering equations (2) and (3) together (that is, substituting the value of equation (3) in place of the transfer function of equation (2)) yields the logistic STR of the model LSTR.

Typical values for K are k=1 and k=2. For k=1, the parameters $\varphi+\theta F(\gamma,s_t,c)$ varies smoothly from φ to $\varphi + \theta$ as a function of s_t. But for k=2, they vary symmetrically around the midpoint $\frac{c_1+c_1}{2}$ (when this logistic function reaches the minimum). And, at least, it is between zero and half. The minimum value of this relationship reaches zero when $\infty \rightarrow \gamma$, and when $c_1=c_2$, it turns into identical to half. The parameter γ is slope and c1, c2 show the location parameters or the transition function.

LSTR model with k = 1 model (LSTR1) is capable of modeling the symmetric behavior of variables. For example, consider that s_t is equal to GDP per capita or water withdrawal. The model (LSTR1) can be a reliable and appropriate model to describe processes whose dynamic characteristics are different from one situation to another (e.g., processes that behave differently in periods of prosperity than periods of recession) and transfer from each situation to another situation happens smoothly. On the other hand, the LSTR model with k=2 as (LSTR2) is appropriate for conditions where the dynamic adjustment process has a similar behavior in high and low values of s_t and shows a different behavior only in intermediate values.

When γ=0, the transition function will be $F(\gamma,c,s_t)=0.5$ and so, the STR model becomes a linear model. On the other hand, when $\infty \rightarrow \gamma$, the LSTR1 model turns into Switching Regression Model with two states (both states have equal variance). In the LSTR2 model, if $\infty \rightarrow \gamma$, the STR model will turn into a three-regime Switching Regression Model so that its behavior in the middle state will be different from the same behavior in the upper and lower states. In the second state where the LSTR2 model exists, the STR model is called the exponential model (ESTR). If we reconsider equation (2) again, except for the exponential transition in equation (4), we will get the ESTR model.

$$F_E(\gamma,c,s_t)=1-\exp\left\{-\gamma\left(s_t-c_1\right)^2\right\},\ \gamma>0 \tag{4}$$

In the ESTR model, the function is symmetric around the point $s_t=c_1^*$ and in the lower and middle values of the variable, the slope parameter (γ) has almost the same value. The transition variable s_t is a random variable and is often one of the variables Z_t. Of course, the transition variable can be a composition of several variables. In some cases, the transition variable can be the difference of one of the variables in Z_t.

In general, it may be established that the LSTR model has two upper and lower states, in which the behavior of the parameters is different from each other (in other words, this model is a suitable model for modeling the asymmetric behavior of the parameters). While the ESTR model has two upper states and an intermediate one that the parameter has a similar behavior in the two limit states, and in the intermediate state, it shows a different behavior from the other two states, so this model used to explain some variables which show symmetrical behavior is an ideal model.

The process of STR modeling includes three phases: specification, estimation and evaluation. In the specification phase, the nonlinear model starts first with a linear model, then it will be tested by a nonlinearity test. If the null hypothesis is rejected (zero coefficients other than the intercept), the model is non-linear. Then, among the potential nonlinear models, the desired nonlinear model of LSTR1 and LSTR2 type is selected and its parameters are estimated. It is worth mentioning that while economic theory may be able to help the researcher in selecting variables for the linear model and give him/her the necessary idea to select the variables of the model, but it cannot help much in the field of nonlinear models and its dynamics. Therefore, if the model is non-linear, other criteria are used to select and specify the model (such as: R^2, AIC, SSR SBC, Reset test, etc.).

The nonlinear model is estimated with the help of a predetermined transition variable. The transition variable is selected in such a way that if the economic theory has not explicitly selected the transition variable, the non-linearity test is repeated for the potential transition variables which are typically a subset of S_t and among these variables, a variable which leads to better results is selected as a transition variable to estimate the model. In fact, the modelers pursue two goals performing the nonlinearity test: first, to detect linearity against (various) nonlinear models; second, to select the desired model using the test results, so that if the null hypothesis is rejected for more than one non-linear model, a model with a lower P-Value is selected based on the P-Value (test probability).

Nonlinearity hypothesis of the variables is tested by two non-linear parametric models including the logistic non-linear regression model (LSTR) and the exponential nonlinear regression model (ESTR), following the work done by Saikonen and Verta (1998 a) and Verta (1998), and using the regression equation (4).

$$y_t = \beta' z_t + \sum_{j=1}^{T} \beta_j' \tilde{z}_t s_t^j + u_t^* \qquad t = 1, 2, \ldots, T \tag{5}$$

Where, $u_t \sim iid(0,\sigma^2)$. and $z_t = (1, \tilde{z}_t)$ is a vector of explanatory variables and S_t is a transition variable and F is a transition function whose value is limited between zero and one, and it can be one of these two forms, the logistic of equation (3) or the exponential of equation (4). The linearity null hypothesis can be tested as the following relation for equation (4).

$$H_0 = \beta_1 = \beta_2 = \beta_3 = 0 \tag{6}$$

If the null hypothesis is accepted, the model is linear; but if the null hypothesis is rejected for the selected transition variable, the model will be nonlinear. The optimal number of intervals for the time series transition variable should be determined after specifying the transition variable. If the linearity null hypothesis is rejected for more than one transition variable interval, an interval is chosen as the optimal one for which the P-Value of the test is minimized. However, if the P-Value for different transition variables is close to each other, it is rational to estimate the model for all potential transition variables and select the model that has the best characteristics in the evaluation phase of the fitted model.

After the linearity hypothesis is rejected and the transition variable is selected, the next step to estimate the nonlinear model is choosing the type of nonlinear model. Among the different STR models, i.e., LSTR1 and LSTR2 (ESTR), the equation (4) and the null assumptions mentioned below are used according to what has presented in the literature of non-linear regressions.

$$H_{ü}3 : \beta 2 = \beta \;\; = 0,\; H \;\; 4 : \beta 3$$
$$= 0,\; H_0 2 : \beta 1 = \beta_2 = \beta_3 = 0 \tag{7}$$

For the selected transition variable (S_t), if H_{04} or H_{02} is rejected, the LSTR model is selected, and if H_{03} is rejected, the ESTR model is selected. If all three hypotheses are rejected, the LSTR model is (ESTR) and H_{04} or H_{02} is rejected with more (less) power than H_{03}.

4. Results and discussion

The estimation results of the equation (1) for all countries in the world are shown in table (1). In the domestic sector, water is used for drinking, cooking, personal and public hygiene, green spaces, and other public uses. The equations have been estimated with three linear, quadratic and cubic specifications.

The specification of the Quadratic function, among the different specifications, provides the best fit for the domestic sector based on the two criteria of Akaike (AIC) and Schwartz (SIC) information. The results of the diagnostic tests are presented at the end of table (1) for each specification. In the mentioned table, RESET is the Ramsey' s RESET test for the following form of the model based on the square of the fitted values. As it can be seen, the results are generally satisfactory, especially for the specification of the quadratic function (the assumptions of homogeneity of variance are violated in some linear specifications and accepted in non-linear specifications), which the test (White 1982 Approach fixes autocorrelation) fixed autocorrelation. The criteria of Akaik and Schwarz information in non-linear specifications are also far less than linear ones. The water-income regression models in table 1 of the quadratic column have passed all the tests of goodness of fit (heteroscedasticity, Ramsey functional form, normality and autocorrelation). The most important specification of the model is the theoretical specification; concerning this, the selection of variables is in terms of normal, proportional, logarithmic variables, explaining the type of their cause-and-effect relationship, and the mathematical form of estimable equations

Table 1: Regression results of different models

Domestic sector (drinking and urban)			
Cube	Quadratic	Linear	Independent variables/ model
17/24 (0/66)	-14/49 (4/09) *	-2/47 (4/97)*	Intercept
-7/86 (0/83)	3/59 (4/27) *	0/71 (12/3) *	Log (GDPpc)
1/19 (1/07)	-0/17 (3/43) *	- -	Log $(GDPpc)^2$
-0/05 (1/22)	- -	- -	Log $(GDPpc)^3$
0/52	0/52	0/49	$\bar{R}^2$
58/45	86/66	151	F
-	41989	-	Turning points
2/54	2/54	2/60	AIC
2/62	2/60	2/64	SIC
2/14	2/16	2/13	D.W
(2/17) ***	(2/63) **	1/45	RESET

Explanations: The number of observations in 163 countries, the numbers in parentheses below are the coefficients of the t statistic. (*, **, ***) represents the significance of the coefficient at the level of 1 percent, 5 percent, and 10 percent.
Source: Research findings

in terms of linearity or non-linearity (functional form of the 1st, 2nd and 3rd degrees).

The effect of the presence or absence of new variables in the model was investigated by removing and adding new variables to the right side of equation (1). Then, based on the Omitted variables test and the Redundant variables test, the necessary decision was made in this regard. The new variable was the initial amount of water in each country (Endowment of renewable water resources), which did not have such an effect on the goodness of model fitness and the significance of other coefficients. In this case, even the coefficient of the variable itself (water availability) was statistically meaningless. Therefore, it was not necessary to add a new variable for the water-income relationship. After the Omitted variables test, the Redundant variables test was added and its results were compared, which there was a necessary justification for removing the new variable. The necessity of the presence or absence of the new variable and by goodness of fit values and Akaike or Schwartz statistics was taken into consideration, and the coefficients were estimated again. Given that the disturbance sentences had variance, the corresponding error was corrected using the test (White 1982 approach). It is also possible to prove the non-linear relationship through the smooth transition regression method, which is discussed further.

The results of the linear model estimation are as follows:

$$\text{Log}(Yi) = 4.64162 - 0.59049 * log(xi) + \tilde{\varepsilon}_t \quad (8)$$
$$(17.12) \qquad (-2.14)$$
$$\tilde{\sigma}_y = 1.19 \,,\ n = 163 \,, R^2 = 0.540,$$

As it can be seen, the Ramsey test is significant and indicates the specification error of the linear pattern. In addition, the distribution diagram (1) with the Kernel curve also involves a non-linear relationship between the mentioned variables.

The results of the non-linearity test of the pattern in table (6) strongly reject the null hypothesis (H_0), which the model is linear. Given that, the p-value of the hypothesis (H_0) is lower than the corresponding value of the test statistic. Furthermore, the test of hypotheses suggests the LSTR model as the preferred model among the non-linear ones. The results of the linearity test are as follows:

Using the diagram (2), which shows the non-linear relationship between the two variables of water withdrawal and per capita income, the STR model was estimated on the logarithm

Table 2: P-Value of the linear test

Hypothesis	P-Value
H0	1.7602e-02
H4	3.3605e-01
H3	6.3933e-01
H2	2.6633e-03

Source: Researcher's findings

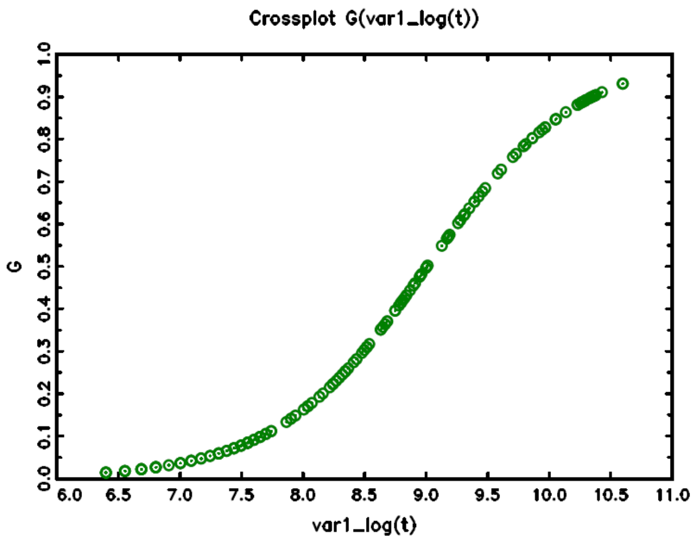

Diagram 2: Transfer function of STR model on logarithmic data of per capita income and water withdrawal

data of the two variables. The LSTR model was obtained from the STR modeling process, then with the necessary specifications (the process of restricting the nonlinear part of the LSTR model), the obtained model was optimized and the optimal model (Relation 9) was obtained. The estimation results after applying simplification restrictions (removing unnecessary parameters) are as follows:

$$Ly_i = 0.38462 - 0.25163X_i + (0.15857LX_i)\left(1+[\exp\left(\frac{-7.59216/\sigma Lx)}{(LX_i - 7.53808}\right)\right]^{-1} \quad (9)$$

(0.3499) (1.5038) (2.8550) (1.4029) (62.0638)

n=163 $R^2 = 5.4123e-01$, σ'=1.1938, σ'/σ' 1.4539

The transfer function fitted on the data of the STR model is shown in diagram (2).

The income elasticity can also be calculated in the STR model. In this model, the income elasticity of water withdrawal depends on the per capita income, that is, the parameters change smoothly and will be a function of the transition variable. In fact, the income elasticity is determined by the weighted average of the parameters $\beta 0$ and $\beta 1$ and the changes of the dependent variable are obtained for the independent variable. The income elasticity Ei for the mentioned country is obtained by equation (10) as follows:

$$E_i = \partial ly_i/\partial lx_i = \alpha + \beta_0 F(lx_i,\gamma,c) + \beta_1 lx_i(\partial F(lx_i,\gamma,c)/\partial lx_i) \quad (10)$$

Where, Ei is the income elasticity, Lxi is the transition variable, and other variables and signs are the same as equation (2). In this equation, the negative value of $\beta 1$ may lead to an increase in the income elasticity of water withdrawal. In equation (12) the income elasticity of water withdrawal is estimated. All calculations have been extracted using Jmullti 4 and Matlab 2009 software. According to the above, equation (11) has been obtained:

$$\mathrm{E}_{\mathrm{i}} = Ei = lyi / lxi = -.0599 - \frac{0.59049}{\left[1+\exp\left(-1.55948\left(lx-7.20461\right)\right)\right]} - \frac{1.55948+(0.59049\left(lx-0.30498\right) \;{}^{*}exp\left(-1.55948\left(lx-10.25\right)\right)}{\left[1+\exp\left(-1.55948\left(lx-7.20461\right)\right)\right]^{2}} \quad (11)$$

5. Conclusion and suggestions

As a renewable resource of natural, economic, social and environmental agents, water plays a substantial and unique role in economic growth. Both the amount of per capita income and the amount of water withdrawal per capita have had many differences among the countries all over the world. The results of this study show that the EKC curve hypothesis is consistent with the water-income relationship. This result is consistent with the results of Keller and Fald (1993) and Falkenmark (1993). More precisely, the results of the regression estimates confirm the confirmation of the hypothesis in the domestic sector.

The reverse U-shaped relationship regarding water use can be explained in the form of an environmental curve based on natural resources (NRBEKC). It has different theoretical foundations but is common with pollution- based EKC. The common point of these two curves is the existence of a non-linear relationship and also the existence of scale, composition and technical effects. In contrast, their difference is in the different nature of pollution as a bad economic good versus natural resources as a good economic good. Moreover, the objective function of production in water use and the objective function of production and consumption in pollution are completely different from each other.

Since many countries in the world do not use water efficiently or don′t have sufficient water resources for development, (World Bank, 1992), the first part of the EKC curve in the water sector is still upward for them. On the other hand, by reforming water pricing policies, changing production techniques in the industrial and agricultural sectors, moving away from the policy of self-sufficiency in agricultural products or increasing water productivity in the agricultural sector in some countries have led to the use of composition and technical effects, and these countries are actually in the downward part of the curve.

Using the results of this article, it can be concluded that rising the income globally runs mechanisms that increase the amount of water use, and it continues up to a certain point and finally decreases. This particular point is the "turning point" which based on the research findings, it was 41989 dollars in the domestic sector. The turning point in Tuke's study (1998) was 20,000 dollars, which is different from the results of this study. This difference is due to the year under review, the type and number of data, the functional form of the model and its specifications.

Higher per capita income in many countries of the world is a sign of structural changes and economic development in there, which has itself many consequences in the use of natural resources and greatly affects the level of water use. Every country has different thresholds for change, capabilities and limitations in domestic sector. Rising the efficiency of water use, especially in domestic sector, is one of the basic solutions to fight the water shortage crisis in the countries thorough the world. The lack of continuous, comprehensive and coordinated statistics and information in the field of water economy at the watershed, river as well as local, national and global levels is a fundamental barrier to knowing more about the realities and problems of the water and economy, policy-making, management and planning, which should be considered by those involved in the affairs.

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HOW TO CITE THIS ARTICLE

Eghbali, AR.; Sayehmiri, A. (2022). Explaining the Relationship Between Income and Water Consumption Using Smooth Transition Regression Based on Kuznets' Environmental Teory. J Urban Manage Energy Sustainability, 3(2): 97-107.

DOI: 10.22034/jumes.2022.1971451.1092