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The Impact of Urban and Rural Income Inequality on Natural Gas Consumption: The Case of Iran

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Abstract

The environmental issues have received a lot of attention in recent years. Since environmental pollution is one of the issues that may damage the ability of future generations, it is important to examine the determinants of the environment quality. The main objective of this study is to investigate the impact of urban and rural income inequality on natural gas consumption in Iran. To this end, Iranian provincial panel data is used for the period 2006-2015. The Income inequality variable is measured with Theil index and Gini coefficient. To estimate the model, the Generalized Method of Moments (GMM) system is used. The results indicate a significant negative impact of urban and rural income gap on per capita consumption of natural gas as a benchmark for environmental performance. Furthermore, the current research findings show that the impact of rural and urban income inequality on natural gas consumption depends on income level. There is also a positive and significant relationship between urban level and per capita consumption of natural gas. The findings confirm that there exists an inverted U-shaped relationship between per capita GDP and natural gas consumption.

Keywords: Natural Gas Consumption, Rural and Urban Income Inequality, Quality of Environment, Generalized Method of Moments (GMM) System.

JEL Classification: D31, D39, Q53, C23.

1. Introduction

Nowadays, the environmental protection and the prevention of environmental destruction are important for international community. On the one hand, Energy supply is an important tool for achieving economic growth and development because energy plays an important

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role in the process of economic development; on the other hand, it releases carbon dioxide emissions.

In recent years, changes in ecosystems have been amongst the greatest concerns of the world. In this regard, aimed at reducing greenhouse gas emissions which cause climate changes on Earth, the Kyoto agreement was approved in 1997. Based on this agreement, large industrialized countries will reduce their greenhouse gas emissions by 5%, compared to 1990. According to the agreement, Iran is required to reduce its CO_2 emissions, as well. Also, according to the International Energy Agency statistics, after china, Iran has had the largest increase in CO_2 emissions which put it in the fifth place among developing countries. One effective way to improve the quality of the environment is to change the consumption pattern. Among energy carriers, natural gas is the least polluting and has an important place in environmental sphere. Natural gas is a nearly clean, abundant and inexpensive energy source which is used on a large scale for domestic and industrial use and its operation will expand in coming decades. Iran Energy Balance Sheet figures show that Natural gas consumption in domestic sector has been increased from 36896 million cubic meters in 2006, with average annual growth rate of about 3%, to 45363 million cubic meters in 2014, with 41% share of total natural gas consumption. Since economy is closely related to natural resources and environment, many production inputs originate from environment and natural resources. In production process, on one hand, as a driving force in economic development, energy is considered to be a desirable outcome; on the other hand, with production of environmental emissions that are poor output, it poses a serious risk to sustainable development (Fotros, 2009).

Kuznets (1995) studied time series of economic growth and environmental quality and concluded that there is an inverted U-shaped relationship between per capita income and environmental degradation index. Apart from per capita income, economic inequality is another factor that affects the quality of environment. Unequal distribution of income can affect environment through outcome of individual preferences for using public services such as the environment. Now, when income elasticity of demand for environmental quality is positive, transferring a unit of income from the poor to the rich increases demand for environmental quality among the rich and decreases it among the

poor (Harati et al., 2015). According to poverty-environment hypothesis, low deciles of income are more dependent on natural resources than high deciles of income because if they do not have access to other types of energy sources, they will exploit available resources more quickly (Terner et al., 1998).

Iran has witnessed rapid growth of urbanization and industrialization over the recent years. Studies have shown that the most important cause of explosive growth of urbanization is population and workforce migration from rural to urban areas which has its root mainly in income gap between the two groups. Therefore, urbanization growth increases energy demand, CO_2 emissions, and air pollution (Zhang and Lin, 2012).

According to the Central Bank of Islamic Republic of Iran, Gini coefficient of the country increased from 0.385 in 2008 to 0.395 in 2013. This indicates that the gap between urban and rural areas has expanded. So, on one hand, consumption of energy carriers, on the other hand, inequality has increased. As a result, study of the relationship between natural gas income inequalities is important for long-term energy policies. The present study, with respect to Theil index and Gini coefficient, as indicators of economic inequality, investigates the impact of urban and rural income inequality on natural gas consumption in Iran where it is the source of relatively clean energy. Understanding this relationship may be interesting to planners in terms of designing environmental policy and achievement of sustainable development goals.

The paper is divided into five sections. Following introduction in section1, the literature review is examined in section2. The model is specified in section3. In section4 the results of model assessment during 2006-2015 is analyzed; and in the final section, the research is concluded.

2. Literature Review

The classical theory on the relationship between income inequality and the consumption rate emphasizes that if the propensity to consume decreases with income, then at the macro level, rising inequality could reduce the consumption rate. This ‘‘macro’’ reason for the inequality–consumption link is mechanically caused by the non-linear association

between consumption and income at the micro, or household, level. When income inequality increases, the benefit gap between the high-status and low-status groups widens, which in turn strengthens the incentives of status-seeking savings. In contrast to the macro mechanism, the status-seeking hypothesis implies that given household income, rising income inequality can still discourage (stimulate) household consumption (savings). Furthermore, rising income inequality also raises the entry wealth level for the high-status group, which means that more savings are needed for one to enter the high-status group. The status-seeking theory also leads to further testable hypotheses. First, income inequality has a greater effect on consumption and savings for poorer and younger people because they have stronger incentives for moving up. Second, rising inequality should have a strong positive effect on families' investment in education, which is an important indicator of social status. Third, inequality should have a negative effect on conspicuous (or unnecessary) consumption, and should have no impact on basic (or subsistence) consumption (Jin et al., 2011).

Many studies have considered consumption as a more comprehensive measure of wellbeing. Cutler and Katz (1991) find that changes in consumption inequality were comparable to changes in income inequality for the period between 1960-61 and 1988, but Slesnick (1994) finds consumption inequality rose less than income inequality for the 1960-1991 period.

In economic literature, an inverted U-shaped relationship between economic growth and environmental degradation is known as Kuznets Environmental Curve (EKC). Kuznets (1995) argued that the relationship between inequality in income distribution and income level is like an inverted U. Accordingly, during the early stages of economic development, due to factors such as low production technology, high priority of production and employment relative to healthy environment, economic growth will be accompanied by damage to environment. After reaching a certain level of per capita income, this relationship will be reversed and increase in economic growth will improve the quality of environment.

Examination of relationship between environmental quality and per capita income has always been a challenging topic. But, the question is

"what are the other factors that affect the quality of environment?" Various theories are developed to answer this question. Accordingly, one of the recently noticed economic variables is distribution of income. Selden and Song (1994) and Stern et al. (1996) believed that distribution of income affects the quality of environment.

Torras and Boyce (1998) stated that inequality of income may leave adverse impact on the quality of environment. In this regard, improvement of distribution of income through policies of sustainable development helps improving the quality of the environment. According to McConnell, income increase by changing the environmental preferences of individuals indirectly affects the quality of environment; thus, assuming that the quality of environment is a luxury commodity, by increasing the level of per capita income, demand for access to healthier environment will increase.

Magnani (2000) realized that moments of income distribution other than the mean are important for sustainable growth path.furthermore; the negative slope of the EKC emerges in high-income countries if and only if economic growth does not lead to a large increase in income inequality.

Ravallion et al. (2000) developed a carbon emission demand function, which is a function of income. It is assumed that if the marginal propensity to pollution in poor societies is greater than rich countries, expansion of inequality may increase policies adopted to reduce income inequality and lead to further decline in the quality of environment.

According to Padilla and Serrano (2000), air pollution in rich countries is more than poor countries, the same is true for emission distribution inequality between these two groups of societies compared to inequality in their income distribution. Accordingly, reducing inequality in CO2 emissions is mostly due to reducing inequality in low-income groups, on average.

Heerink et al. (2001) examined the relationship between income and environmental inequality in Saharan Africa and concluded increasing income inequality reduces CO_2 per capita emissions.

Baek and Gweisah (2013) Investigated and relationship between growth and environmental inequality and found that more equitable income distribution helps to improve the quality of the environment and

energy consumption has a negative impact on the environment.

Zhang and Zhao (2014) studied the impact of income inequality on CO_2 emissions in china and came to conclusion that inequality of income has a positive effect on CO_2 emissions.

Hao et al. (2016) investigated the relationship between income inequality and CO_2 emissions in china over the period of 1995-2010. They showed that there is a positive correlation between income inequality and CO_2 emissions.

The relationship between inequality and growth has been a popular academic subject for a long time. For instance, Murphy et al. (1989) establish a multi-sector model to analyze from the perspective of consumer demand and found that the widening income gap would reduce the consumer's demand and affect economic growth negatively to an extent.

Benjamin et al. (2004) used the household level data from 1986 to 1999 and found a negative correlation between economic growth and income inequality.

Furthermore, there have been a huge number of studies on the relationship between economic development and energy consumption. For instance, Huang et al. (2008) used a panel data of 82 countries for the 1972-2002 period to examine the causal relationship between energy consumption and GDP. The researchers concluded that, in the middle-income countries, the economic growth leads energy consumption positively, while in the high-income countries, economic growth leads energy consumption negatively.

The previous literature indicates that income inequality may affect economic growth and there may be relationship between energy consumption and economic development, income inequality may have influences on the energy consumption.

Consequently, in sum, compared with the previous research, the contribution of this paper is the first examining the explicit relationship between income disparity and natural gas using panel data at the province level. Also this study may have important policy implications.

3. The Model

In this study, following EKC’s theoretical framework, regression models are used to test the impact of urban and rural income inequality

on natural gas consumption based on assessment of GMM method:

$$Gas_{it}= \alpha + \beta_1 Theil + \beta_2 RGDP_{it} + \beta_3 (RGDP_{it})^2 + \beta_4 LnRGDP_{it}*Theil + \beta_5 urb + \varepsilon_{it} \quad (1)$$

$$Gas_{it}= \alpha + \beta_1 Gini + \beta_2 RGDP_{it} + \beta_3 (RGDP_{it})^2 + \beta_4 LnRGDP_{it}*Gini + \beta_5 urb + \varepsilon_{it} \quad (2)$$

In the framework of equations (1) and (2), the variables are:

Gas: Per capita gas consumption

Theil: Urban and rural income inequality index

RGDP: Gross domestic product per capita

Gini: Gini coefficient

Urb: Urban level control variable

ε_{it} : Disruption component

i ،t : Represents the province and time, respectively

Since the main objective of this study is to investigate the effects of urban and rural income on natural gas consumption, the main explanatory variable is urban and rural income inequality index, which is measured by the Theil index and Gini coefficient.

In the present study, Gini coefficient index is derived from Iranian Statistics Center. Another tool to measure income inequality is Theil index, which was presented by Thiel (1967). Based upon the research by Wang et al. (2008), the method for calculating Theil index to measure income gap between urban and rural areas is as follows:

$$Theil_{it}=\sum (I_{irt}/I_{it}) Ln [(I_{irt}/I_{it})/(P_{irt}/P_{it})]= (I_{i1t}/I_{it}) Ln [(I_{i1t}/I_{it})/(P_{i1t}/P_{it})] + (I_{i2t}/I_{it}) Ln [(I_{i2t}/I_{it})/P_{i2t}/P_{it})] \quad (3)$$

Here, i represents province, (r = 1) represents urban areas, (r = 2) rural areas, P_{irt} represents population in urban areas (r = 1) or rural (r = 2) of province i in year t, P_{it} indicates population of urban and rural areas of province i in year t, I_{irt} is the total income of urban areas (r = 1) or rural areas (r = 2) of province i in year t, I_{it} is total income of urban and rural areas of province I in year t. In this study, Eq.3 is used to calculate Theil index.

In addition, in equations (1) and (2), first-order lag of the dependent variable is considered as an explanatory variable. Also, according to a large number of studies related to Kuznets Environmental Curve (EKC), including Hao et al. (2015), the relationship among environmental quality, energy consumption, and per capita GDP may be nonlinear. In this regard, per capita GDP and its square are included among explanatory variables. In this paper, the regression models are estimated using GMM system and data of 29 provinces of Iran during 2006-2015. Data on natural gas consumption are derived from Iran energy balance sheet, income of urban and rural households as well as provincial population are gathered from annual statistic of the Iranian Statistics Center. Regarding the nature of model in this study, since there is a logged dependent variable on the right side of the equation, in order to estimate the equation, a dynamic panel model is used.

Assume U_{it} follows one sided error component model, i.e. only one factor is the cause difference between cross sections, and we have:

$$U_{it}= \mu_{it} + V_{it}$$

Where, V_{it}~IID $(0, \sigma_2)$ μ_i~IID $(0, \sigma_2)$ that are independent of each other between and at each cross section. Given that U_{it} is a function of μ_i, it is clear that Gas (-1) is a function of μ_i, as well. Therefore, Gas (-1), as an explanatory variable on right side of the equation, is correlated to U_{it} error component and this causes bias and inconsistency of ols estimators. Even if v_{it} is not serially correlated, GLS estimator would be biased assuming that there are random effects for dynamic panel data models. Arellano and Bond (1991) proposed GMM method which is more efficient than previous estimators.

In order to estimate these models, GMM method - developed by Arellano and Bond, and Arellano and Bover - is used. To resolve the correlation of lagged dependent variable and other regressors, the instrument matrix is used. In this estimation, Sargan test is used to verify the validity of the instrument matrix. This test measures validity of the tools used. Sargan test statistics, which have chi-squared distribution with degrees of freedom equal to the number of over-specified limitations, reject null test hypothesis based on the correlation

between wastes with instrumental variables, so the validity of results for interpretation is confirmed.

Another test is the serial correlation test of regression residuals. Lack of serial correlations shows that all lagged values of explanatory variables can be used as instrument variables. Serial correlation with a given order means that residuals follow a moving average process with similar order; this, in turn, shows that only observations with larger logs are suitable instrumental variables.

4. Empirical Results

The purpose of this paper is to investigate the empirical relationship between urban and rural income inequality with natural gas consumption in provinces of Iran. Before empirical examination of the above relationship, we first look at the stationary of the variables.
The results of the Fisher-Phillips Perron test are shown in Table (1). As it can be seen, all the variables are stationary

Table 1: Stationary Test Results

Variables (level)	Fisher-PP	
	Statistic	Prob
Gas	330.276	0.0000
Gini	321.108	0.0000
Theil	217.578	0.0067
Urb	283.787	0.0000
RGDP	378.081	0.0000

The results of estimating regression models using GMM system are shown in tables (2) and (3). In Table (2), the results of model estimation are considered with respect to Theil income inequality index and Table (3) shows the result with Gini coefficient.

Table 2: Estimation Results of Model 1

Dependent Variable: Gas		
Explanatory Variables	Coefficients	Prob
Gas(-1)	0.0738357	0.0000

Theil	2.815064	0.0000
RGDP	0.0004615	0.0000
Urb	0.4513873	0.0000
LnRGDP*Theil	-1.003898	0.0000
$(RGDP)^2$	$-2.81e^{-08}$	0.0000
Constant	-0.431255	0.0000
Sargan test	0.6468	
Arellano- Bond test for AR(1)	0.0050	
Arellano- Bond test for AR(2)	0.2312	

Table 3: Estimation Results of Model 2

Dependent Variable: Gas		
Explanatory Variables	**Coefficients**	**Prob**
Gas(-1)	0.0615652	0.003
Gini	3.287621	0.0000
RGDP	0.0009862	0.0000
Urb	0.180559	0.0000
LnRGDP*Gini	-1.191714	0.0000
$(RGDP)^2$	$-1.59e^{-07}$	0.0000
Constant	-0.5189936	0.0000
Sargan test		0.9971
Arellano- Bond test for AR(1)		0.0093
Arellano- Bond test for AR(2)		0.2013

As it can be seen, the results of GMM system estimative show that variables of both models are significant at 99% confidence level and have an impact on natural gas consumption. Also, the estimated results indicate that the effect of income inequality on natural gas consumption depends on the level of per capita GDP. Although the coefficients of income inequality variables - (Theil) and (Gini) - are positive and significant, negative and significant the coefficients of inequality interaction and per capita GDP - (LnRGDP * Theil) and (LnRGDP * Gini) - show that when the level of income is high, inequality mostly tends to reduce per capita consumption of natural gas. Natural gas is almost clean, abundant and inexpensive source of energy that is

currently available on a large scale for domestic and industrial use. An environmental benefit of natural gas is reduction of CO2 emissions. As noted by Ebrahimi et al. (2016), dominant consumption pattern in the society is such that the high-income people have marginal propensity to release carbon dioxide and when income is distributed in their favor, by increasing the consumption of highly-pollutant products, pollution created by this group will be more than the reduction of pollution by low income people.

This finding is consistent with the results of Zhang and Zhao studies (2014), Hao et al. (2016), and Baek and Gweisah (2013).

Coefficient of variable (RGDP) has a positive and significant effect on per capita consumption of natural gas. There is also a non-linear relationship between per capita natural gas consumption and RGDP. Since coefficient of $(RGDP)^2$ variable is negative and significant, there is an inverted U-shape relationship between economic growth and per capita consumption of natural gas during the sample period.

Expansion of urbanization has been a hallmark of Iranian society. Positive and significant effect of this variable on consumption of natural gas is in line with theoretical expectations. Also, estimation of both models using Sargan statistic accept the null hypothesis, which indicates over-specified limitations. Thus, the instruments are correctly been selected. Furthermore, the null hypothesis of lack of autocorrelation of first-order difference of the error terms may be rejected, but null hypothesis based on the lack of second-order serial correlation of difference of the error terms cannot be rejected.

5. Conclusion

The results of the estimated GMM model indicated that the urban and rural income inequality has effect on the natural gas consumption in Iranian provinces for the period 2006-2015 so that any increase in inequality will decrease the use of natural gas. Therefore, the policy makers should consider employing the policies such as progressive taxes, the increase of transfer payments and improvement of the Gini coefficient.

Furthermore, since the substitution of the use of natural gas instead of other high-pollution fuels like kerosene causes the decline of environmental pollution, increasing the use of natural gas and decreasing other alternatives are suggested. To do so, the gas

transmission to rural area should be accelerated and more infrastructure investment must be done by government through gas national company.

In addition, government can decrease demand for high-pollution goods through applying taxes on these goods. Another way to control air pollution is the increasing of the use of natural gas instead of the use of high-pollution carriers and decreasing the inequality of income between rural and urban area. This can be conducted through village residents' tax exemptions.

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