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Estimating the Demand for Electricity in Agriculture Sector of Iran

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Abstract:

The main purpose of this paper is examining the dynamics of electricity demand in the Iranian agricultural sector paper using empirical evidence over the period 2003-2014. The paper uses Panel cointegration test and Fully Modified Ordinary Least Squares method to determine the long run relationship between agricultural electricity consumption, agricultural GDP, real price of electricity, domestic price of diesel as substitute good and mechanization index (a number of electrified pumps of water wells). The results show that electricity demand is more responsive to changes in agriculture value added (income) than changes in prices. Results also indicated that price elasticity is negative and significant but low in magnitude, which implies that changes in electricity price apply minimal effect on the electricity consumption agricultural sector.

Keywords: electricity demand, agricultural sector, Dynamic panel data, Iran

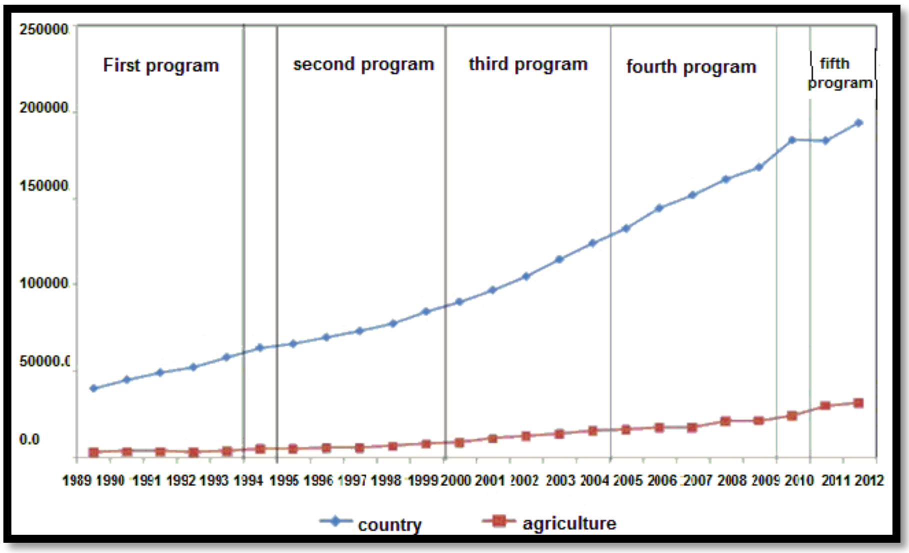
1. Introduction:

Energy has an important role in the development of key sectors of Iran economy such as industry, transport and agriculture. This has motivated many researchers to focus their research on energy management (Baruah and Bora, 2008). Agriculture has a significant role in every country's development. Particularly, the contribution of agriculture to development and competitiveness is increasing with agricultural productivity growth (Türkekul and Unakıtan, 2011). Also, electricity is considered an engine of economic growth and constitutes one of the essential inputs in the economic development of a country (Khan and Abbas, 2016). Thus, the importance of energy in agriculture cannot be denied as one of the basic inputs to the economic growth process.

Iran as a developing country with enormous energy resources, extensive oil reserves and large mineral deposits, is a model example of growth based on almost over-exploitation of natural resources (BaratiMalayeri, HooriJaffari, 2008). Energy consumption in Iran, particularly in the agriculture sector should be a major issue in country's economy. The agriculture sector is one of the most important consumers of electrical energy and oil products, like diesel. A considerable part of agricultural electricity is used for pumping water to irrigate fields. Despite the relative importance of the agriculture sector to economic activity and employment, agriculture use of energy tends to be small compared to that in industry or transport. The trend of energy consumption in the agriculture sector of Iran shows that the most important type of energy used in the agriculture sector in the last forty years have been diesel. While its share gradually decreased with the passing of time and electricity energy was replaced. The moderate increase in electricity consumption in recent years was depicted in Figure 1.

Figure 1: electricity consumption in the agricultural sector

And the country during development programs



The main reason for the accelerated growth rate of electricity consumption in the agriculture sector; returns to the implementation of macroeconomic policies in the energy sector, in order to electrify agriculture water wells. According to the energy balance sheet of 2013, electricity consumption in the water wells of agriculture sector in the year 1990 was 3352 million Kw/h but, with the electrifying water pump of agriculture sector, electricity consumption was about 24530 million kW/h per year in 2015.

Based on some facts of Iran's economy such as low electricity prices, the lack of a suitable substitute for electricity, High electricity consumption and its impact on macroeconomic variables, the present study aims to investigate the long run causalities between electricity consumption, agricultural GDP, energy prices and mechanization of agriculture sector. We base our analysis on thirty provinces of Iran on the period from 2003 to 2013. The paper's main methodological contribution is in that we employ for the first time in Iran on estimation of electricity demand a panel unit root, panel co-integration. To the best of the our knowledge, most of the studies in this field have applied the error correction models, auto regressive distributed lag and panel data based on fixed effect model in which coefficients obtained by these models cannot be deemed as a general finding applicable for other countries. Thus, to bridge this gap, we apply full-modified ordinary least square estimation method for heterogeneous panels of provinces of Iran.

The remainder of the paper is organized as follows. Section 2 provides short overview of current state of knowledge on this topic. Section 3 presents the research methodology, data and econometric methodology. Section 4 briefly reviews empirical model and methodologies employed in this study. Section 5 gives the summary and conclusion.

2. Literature review:

Most of the studies in the field of energy demand have applied the error correction models (ECM) and cointegration, among them are; modeling energy demand in Mexico (Galindo, 2005), road energy demand for Greece (Polemis, 2006), coal demand in China (Chan and Lee, 1997) and India (Kulshreshtha and Parikh, 2000), the UK's final user energy demand (Fouquet et al., 1997), gasoline demand in the United States (Park and Zhao, 2010), in Fiji (Rao and Rao,2009), in India (Ramanathan, 1999), in Brazil (Alves and Bueno, 2003), in South Africa (Akinboade et al., 2008), and to estimate electricity demand in Sri Lanka (Amarawickrama and Hunt, 2008). Studies on energy demand functions predominantly estimated the price and income elasticities of demand. Several studies in the field of energy demand in Iran is carried out, e.g., Abasinejad and Sadeghi (1999); Zibaii and Tarazkar (2004); Heydari (2005); Asgari (2002); Fallahi and Khalilian (2009); Mehrabi et al., (2012); Ziaabadi et al., (2013) and Bahmani et al (2015).

Abasinejad and Sadeghi (1999), in their paper, study the stable relationship between energy demand and energy prices and economic activity in Iran. The results indicated that income and price elasticity of electricity in Iran are lower than other energy elasticity's. Moreover, these elasticitis in short-term are less than one and in the long-term are larger than one. Heydari (2005), predict the demand (End - Use) for the three energy carriers in the economic production sectors including industry, agriculture, services, and transportation in Iranian Economics. The results show that the demand expansion path for gas and electricity is sharp, which meant that due to the structural effects and energy intensity effects energy consumption in all the three scenarios have increased. Fallahi and Khalilian (2009), using Auto Regressive Distributed Lag (ARDL) approach to estimate the importance of oil products and electricity with other factors in production of agricultural products. The results indicate that the estimated long-run coefficients for the factors of labor, capital, oil products, and electricity have been significant and equal to 0.29, 0.11, 0.06, and 0.45 respectively, which indicated positive role of mentioned factors including oil products and electricity in agricultural production. Ziaabadi et al., (2013), in their study, applied neural network concept and calculated significant factors affecting energy consumption between 1974 and 2008.

Conclusions of this study indicate that intensity of energy consumption variable in agricultural sector and Gross Domestic Product (GDP) are of great importance and have a decisive and considerable impact on energy consumption in agricultural sector of Iran. Zibaii and Tarazkar (2004), based on Juselius and Johansen Co-Test within the framework of Vector Autoregressive Model, studied long-term and short-term relationships between value added and consumption of energy in agricultural sector of Iran from 1967 to 2000. The authors show that there is a long-term causal relationship between value added gained and energy consumption whether in the form of electricity or oil by-products. Bahmani et al (2014, by utilizing the Particle Swarm Optimization (PSO) algorithm, they simulate the electricity demand function in the form of linear and exponentials functions for period of 1978-2006. Findings of the study demonstrated that the electricity demand had a direct relationship with real price of electricity and indirect relationship with augmented cost, number of subscribers, and consumption in previous period.

The other studies focusing on agricultural electricity consumption in rest of the world are the studies of Uri (1979; 1994) for the US, Jumbe (2004) for Malawi and Khan and Qayyum (2009) for Pakistan. Other recent studies in this field are as follows: Filippini - Pachauri (2004) electricity demand in urban households in India; Dergiades- Toulfidis (2008) electricity demand of citizens in America; Narayan-Smyth (2005) electricity demand of Australian citizens; Amusa et al (2009), the total demand for electricity in South Africa; Zachariadis- Pashourtidou (2007) in Cyprus, Razak- Al-Faris (2002) for GCC countries.

Uri, N. D. (1979), examines the responsiveness of US agriculture to changes in the price of electricity. The author estimated Price and demand equations for electricity using data for 48 American states over the period I975-1977. The results show that Price elasticity has a sufficient magnitude to dispel doubts about the market mechanism in curtailing demand.

3. Methodology and data

Electricity-modeling studies focus on detecting both the existence and the magnitude of the nexus between electricity demand and economic activities, price and other exogenous variables. Ziyaee and Parsa Moghadam (2009) used the Johansen and Juselius (1990) technique, Samadi et al. (2009) applied the autoregressive integrated moving average technique, Soheily (2007) employed the ARDL approach. This paper pioneers the use of panel provinces of Iran to study the agricultural electricity demand, filling the existing gap in the methodological literature on agricultural- sector electricity consumption.

In order to enable a more environmentally and socially secure use of energy in the future, and to provide guidance for policy-makers in designing appropriate policies, the accurate prediction of how energy consumers react to changes in price, income and other explanatory variables is an important issue. Elasticity estimates provide some information as to how sensitive consumer behavior is with respect to changes in important explanatory variables (e.g. energy price and income).

Based on the applied data it can be inferred that the surveys on agricultural electricity demand have been built on the theory of consumer behaviour. In this approach, electricity is considered as a good that directly affects consumer utility; the maximization of consumers utility subject to a budget constraint results in the demand for electricity being a function of electricity price, household income and the price of substitute fuels for electricity. In addition, regarding agricultural electricity demand, one can conclude that the discussed studies have been established based on the cost-minimization theory. Through minimizing production cost subject to a production function constraint, this theory result in the demand for electricity being a function of the output level, the price of electricity and the price of other inputs. The rational behaviour of a firm can be modelled based on maximizing a profit function or minimizing a cost function. Generally, the cost-minimization theory is the theoretical framework used in Iranian studies of agricultural electricity demand. Thus, the focus of this paper also, is on the cost minimization approach.

In terms of review of literature, the following model is specified to determine factors influencing electricity consumption in agricultural sector:

$$Log(E_{it}) = C_{it} + \beta_{1it} Log(Y_{1it}) + \beta_{2it} Log(PE_{2it}) + \beta_{3it} Log(PD_{3it}) + \beta_{4it} Log(M_{4it}) + \varepsilon_{it}$$

Where E is agricultural electricity demand, Y is the agricultural GDP, PE is real price electricity, PD is real price of diesel as substitute good and M is mechanization index (a number of electrified pumps of water wells).

In this paper the applied time series are annual observations from 2003 to 2013 for 30 provinces of Iran. The series are available from the TAVANIR website, the website of the central bank, the website of Statistical Centre of Iran and from the energy balance sheets of different years.

4. empirical finding

Valid tests of above model require that the data be stationary (integrated of order zero) or if non-stationary (integrated of order one), cointegrated. Our econometric methodology proceeds in four stages. First, we implement the Fisher ADF panel unit root test proposed by Maddala and Wu (1999) to ascertain the order of integration of the variables. Second, conditional on finding that all variables are integrated of order one we test for panel co-integration using the approach suggested by Pedroni (1999). Third, conditional on finding co-integration we calculate panel fully modified ordinary least squares (FMOLS) estimate of the coefficients on electricity demand.

4.1 ADF Fisher Panel Unit Root Test

The ADF Fisher panel unit root test combines the p-values of the test statistic for a unit root in each cross-sectional unit. The Fisher test is non-parametric and is distributed as a chi-squared variable with two degrees of freedom. We report the results from the ADF Fisher panel unit root test in Table 1 for electricity consumption(E), real agriculture value added(Y), real price of electricity(PE), real price of diesel(PD) and mechanization index(M) both with and without a time trend. We conduct this exercise for the full panel of 30 provinces.

For the log-levels of electricity consumption, real agriculture value added, real price of electricity, real price of diesel and mechanization index, we are unable to reject the joint unit root null hypothesis at the 10 per cent level. However, when we conduct the joint unit root test for the first difference of each of these four variables we are able to reject the null at the 1 per cent level. This result implies that electricity consumption, real agriculture value added, real price of electricity, real price of diesel and mechanization index are integrated of order one.

Table 1: ADF Fisher panel unit root test results

variable	No trend	Trend
Ln E	**0.4613**	**10.7606**
	(1.0000)	**(1.0000)**
Δ Ln E	**94.0700*** **	**131.127*** **
	(0.0033)	**(0.0000)**
Ln Y	**0.2463**	**3.8693**
	(1.0000)	**(1.0000)**

variable	No trend	Trend
Δ Ln Y	**173.711***** **(0.0000)**	**182.5672***** **(0.0000)**
Ln M	**10.7314** **(1.0000)**	**54.6014** **(0.6726)**
Δ Ln M	**147.078***** **(0.0000)**	**302.5692***** **(0.0000)**
Ln PE	**0.8278** **(1.0000)**	**7.5226** **(1.0000)**
Δ Ln PE	**111.2226***** **(0.0001)**	**114.027***** **(0.0000)**
Ln PD	**21.3118** **(1.0000)**	**51.5032** **(0.7746)**
Δ Ln PD	**94.4177***** **(0.0030)**	**115.9812***** **(0.0000)**

Note: probability values in parenthesis. *** denotes statistical significance at the 1 per cent level

4.2 Pedroni's (1999) Panel Co-integration Test

Once the existence of a panel unit root has been established, the issue arises whether there exists a long-run equilibrium relationship between the variables. Given that each variable is integrated of order one, we test for panel co-integration using Pedroni's (1999) test. An attractive characteristic of Pedroni's tests is that they permit heterogeneity in intercept and "slopes" across the provinces and thus combine the merit of using individual-province data with the advantage offered by much larger sample size. Pedroni (1999, 2004) has proposed seven test statistics for the null hypothesis of no-co-integration in panel data. The first four tests are referred to as the within-dimension tests or panel statistics tests, and assume a homogenous autoregressive coefficient for all cross sections under the alternative hypothesis. The remaining three tests are referred to as between-dimension or group statistics, and assume heterogeneous autoregressive coefficients for all cross sections under the alternative hypothesis. Thus, the alternative hypothesis in both within- and between-dimension tests seven tests is the rejection of the null hypothesis of no-co-integration across all cross sections.

The results of Pedroni's (1999) panel co-integration test based on the seven test statistics of above mentioned are reported in Tables 2. The results suggest that Looking at within-dimension tests, the panel PP- and panel ADF-statistics reject the null hypothesis of no-co-integration while panel v- and panel rho-statistics fail to do so. Similarly, the group ADF-statistic and group PP-statistics from the between dimension tests reject the null hypothesis of no-co-integration while group rho- statistics fail to do so. Thus, there are some indications of co-integration between before mentioned variables in panel data.

Table 2: Pedroni's panel co-integration test results

Test statistics	coefficient
Panel v-statistics	**0.0310**
	(0.4876)
Panel rho-statistics	**4.0066**
	(1.0000)
Panel pp-statistics	**-6.1047*****
	(0.0000)
Panel adf-statistics	**-5.1995*****
	(0.0000)
Group rho-statistics	**6.6411**
	(1.0000)
Group pp-statistics	**-5.8285*****
	(0.0000)
Group adf-statistics	**-4.7179*****
	(0.0000)

Note: probability values in parenthesis. *** denotes statistical significance at the 1 per cent level

4.3 MOLS Panel Estimates:

Because both models are co-integrated we calculate FMOLS panel estimates for real electricity consumption. The results for the panel FMOLS estimates are reported in Table 3. We find that elasticity of electricity consumption with respect to changes in real agriculture GDP (Y) is about 0.26. Since agriculture GDP is treated as a proxy for income, therefore electricity would be a necessary input in agriculture. While the coefficient on real agriculture GDP is positive, it is less than one. This result implies that a 1 per cent increase in real agriculture value added results in a 0.25 per cent increase in electricity consumption in agriculture sector. The coefficient on real price of electricity is -0.26, implying that a 1 per cent increase in real price of electricity results in a 0.26 per cent increase in real electricity consumption. Meanwhile the coefficient on real price of diesel is positive and 0.06, indicating that electricity may be substituted for diesel in agriculture production processes, because the cross-price elasticity of electricity with respect to changes in real diesel price is almost 0.06 and positive, while it is significant at 1% significance level. Moreover, we find that while the coefficient of mechanization in agriculture sector has the expected sign, however it is less than one and has a small effect on electricity consumption. This result may be due to use merely the number of electrifying water pumps to measure mechanization trend. Nevertheless, using machineries in agriculture would increase production and income of farmers.

Table3: FMOLS results

variable	coefficient
Ln Y	**0.2554***** **(0.0000)**
Ln DP	**0.0688***** **(0.0000)**
LNEP	**-0.2697***** **(0.0000)**
LN M	**0.0882***** **(0.0000)**

CONCLUSION

Electricity is an important and key input in the whole economy and agriculture sector production. This paper has estimated electricity demand in agricultural sector for Iran's provinces for the period 2003 to 2013. The analysis represents a methodological advance over previous studies estimating electricity demand because we use a panel unit root and panel co-integration. Real agricultural GDP, real electricity prices, real diesel prices and mechanization index are used as the explanatory variables in this model.

The income elasticity of demand, price elasticity of demand and cross elasticity of price is estimated to be 0.25, -0.26, and 0.06 respectively. The inelastic price relationship of electricity demand indicates that use of price increases is not a very effective tool for energy conservation. It further suggests that removal of subsidies for electricity can be achieved without reducing revenue for the electricity provider. In addition, Low income and price elasticities show that income and price policies cannot decrease electricity demand in large extent in the agriculture sector. An important point is to assure reduction in electricity use may occur due to energy efficiency and elimination of subsidies of energy in agriculture sector. We find that Diesel has a substitution relationship with electricity, as diesel and electric pumps can be used interchangeably for water pumping.

In analyzing the direct effect of mechanization on electricity demand, no significant impact was found, though the relevant cause and effect relationship had the expected sign. It is obvious that any addition to the number of electrified water pumps naturally moves up the demand for electricity.

References:

[1] Abbasinejad, H. and Sadeghi, H .1999. Stable relationship between energy demand and energy prices and economic activity in the economy, Journal of Economic Research, No. 45, p. 51 -32.

[2] Akinboade, O. A., Ziramba, E., & Kumo, W. L. (2008). The demand for gasoline in South Africa: An empirical analysis using co-integration techniques. *Energy Economics*, *30*(6), 3222-3229.

[3] Al-Faris, A. R. F. (2002). The demand for electricity in the GCC countries. *Energy Policy*, *30*(2), 117-124.

[4] Alves, D. C., & da Silveira Bueno, R. D. L. (2003). Short-run, long-run and cross elasticities of gasoline demand in Brazil. *Energy Economics*, *25*(2), 191-199.

[5] Amarawickrama, H. A., & Hunt, L. C. (2008). Electricity demand for Sri Lanka: a time series analysis. *Energy*, *33*(5), 724-739.

[6] Amusa, H., Amusa, K., & Mabugu, R. (2009). Aggregate demand for electricity in South Africa: An analysis using the bounds testing approach to co-integration. *Energy policy*, *37*(10), 4167-4175.

[7] Asgari, E .2002. Estimation of household demand for electricity, Journal of Planning and Budget, Number 62, 63, p 119-103

[8] Atakhanova, Z., & Howie, P. (2007). Electricity demand in Kazakhstan. *Energy Policy*, *35*(7), 3729-3743.

[9] Bahmani, M., Ghaseminejad, A., Karimian, A., & Aramesh, H. (2014). Simulating Electricity Demand Function in the Agriculture Sector: Application of Particle Swarm Optimization Algorithm. *Agr. Econ. Res, 2(22),* 1-11.

[10] Barati Malayeri, A., & Hoori Jaffari, H. (2008). Estimation of energy consumption in final consuming sectors. *Quarterly Journal of Energy Economics Surveys*, *1*(1), 56-97.

[11] Baruah, D. C., & Bora, G. C. (2008). Energy demand forecast for mechanized agriculture in rural India. *Energy Policy*, *36*(7), 2628-2636.

[12] Bose, R. K., & Shukla, M. (1999). Elasticities of electricity demand in India. *Energy Policy*, *27*(3), 137-146.

[13] Chan, H. L., & Lee, S. K. (1997). Modeling and forecasting the demand for coal in China. *Energy Economics*, *19*(3), 271-287.

[14] Dergiades, T., & Tsoulfidis, L. (2008). Estimating residential demand for electricity in the United States, 1965–2006. *Energy Economics*, *30*(5), 2722-2730.

[15] Fallahi, E., & Khalilyan, S. (2009). Study and Comparison of the Importance of Oil Products and Electricity with other Production Factors in Iran Agricultural Sector. *Agr. Econ. Res*, *1*(2), 1-20.

[16] Filippini, M., & Pachauri, S. (2004). Elasticities of electricity demand in urban Indian households. *Energy policy*, *32*(3), 429-436.

[17] Fouquet, R., Pearson, P., Hawdon, D., Robinson, C., & Stevens, P. (1997). The future of UK final user energy demand. *Energy Policy*, *25*(2), 231-240.

[18] Galindo, L. M. (2005). Short-and long-run demand for energy in Mexico: a cointegration approach. *Energy Policy*, *33*(9), 1179-1185.

[19] Heydari, E. (2005). Energy Demand Forecasting in Iranian economics based on decomposition approach. *Journal of Economic Research*, *69*, 27-56.

[20] Jumbe, C. B. (2004). Co-integration and causality between electricity consumption and GDP: empirical evidence from Malawi. *Energy economics*, *26*(1), 61-68.

[21] Khan, M. A., & Abbas, F. (2016). The dynamics of electricity demand in Pakistan: A panel cointegration analysis. *Renewable and Sustainable Energy Reviews*, *65*, 1159-1178.

[22] Khan, M. A., & Qayyum, A. (2009). The demand for electricity in Pakistan. *OPEC Energy Review*, *33*(1), 70-96.

[23] Kulshreshtha, M., & Parikh, J. K. (2000). Modeling demand for coal in India: vector autoregressive models with cointegrated variables. *Energy*, *25*(2), 149-168.

[24] Mehrabi Boshraabadi, H., & Sadat Naghavi, S. (2012). Estimation of Energy Demand in the Agricultural Sector in Iran. *Agr. Econ. Res, 2(3),* 147-162.

[25] Narayan, P. K., & Smyth, R. (2005). The residential demand for electricity in Australia: an application of the bounds testing approach to co-integration. *Energy policy*, *33*(4), 467-474.

[26] Park, S. Y., & Zhao, G. (2010). An estimation of US gasoline demand: A smooth time-varying cointegration approach. *Energy Economics*, *32*(1), 110-120.

[27] Polemis, M. L. (2006). Empirical assessment of the determinants of road energy demand in Greece. *Energy Economics*, *28*(3), 385-403.

[28] Ramanathan, R. (1999). Short-and long-run elasticities of gasoline demand in India: An empirical analysis using cointegration techniques. *Energy economics*, *21*(4), 321-330.

[29] Rao, B. B., & Rao, G. (2009). Cointegration and the demand for gasoline. *Energy Policy*, *37*(10), 3978-3983.

[30] Samadi, S., Shahidi, A., & Mohammadi, F. (2009). Electricity Demand Analysis in Iran by using Co-integration and ARIMA Modeling (1363-1388). *Knowledge and Development Journal, vol. 25,* 113-136.

[31] Soheyli, K. (2007). Demand Models and Dynamic Analysis of Demand for Energy in Iran. *Quarterly Journal of the Economic Research, 2*, 12-26.

[32] Türkekul, B., & Unakıtan, G. (2011). A co-integration analysis of the price and income elasticities of energy demand in Turkish agriculture. *Energy Policy*, *39*(5), 2416-2423.

[33] Uri, N. D. (1979). The demand for electrical energy by agriculture in the USA. *Energy Economics*, *1*(1), 14-18.

[34] Uri, N. D. (1994). The Impact of Measurement Error in the Data on Estimates of the Agricultural Demand for Electricity in the USA. *Energy economics*, *16*(2), 121-131.

[35] Zachariadis, T., & Pashourtidou, N. (2007). An empirical analysis of electricity consumption in Cyprus. *Energy Economics*, *29*(2), 183-198.

[36] Ziaabadi, M., Alavi, S., Mehrjerdi, M. Z., & Irani-Kermani, F. (2013). Forecast of Energy Consumption in Agricultural Sector of Iran Using Neural Network.*Interdisciplinary Journal of Contemporary Research In Business*, *4*(9), 1042.

[37] Ziaee, O., Kian, A. R., & Moghadam, M. P. (2009, July). Estimation of power interruption cost using causality model for industrial sector in Iran. In *Power & Energy Society General Meeting, 2009. PES'09. IEEE* (pp. 1-5).

[38] Zibaii, M., & Tarazkar, M. H. (2004). Examining short run and Long run relationship between value added and energy consumption in the agriculture sector. *Quarterly journal of Bank and Keshavarzi*, *6*(1), 157-171.