



## HOW GLOBALIZATION IS RELATED TO ENERGY PRODUCTIVITY? (A MATHEMATICAL ANALYSIS ON IRAN'S AGRICULTURAL DATA)

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ABSTRACT. Agriculture is recognized as a key economic sector for almost all developing nations including Iran. Nowadays, world economy has been highly integrated as economic performance of a given country is more susceptible to policies taken by other countries than four decades ago. So, investigating the possible impacts of this new worldwide phenomenon (globalization) would be a vital issue. This paper is an empirical examination of the association between globalization and energy productivity in the Iran's agriculture context by using time series econometrics techniques including causality and cointegration tests for the period 1967-2018. Main results confirm existence of a unidirectional causality from globalization to agricultural energy productivity. Other findings revealed that every one percent increase in globalization index is expected to lead in 0.75 percent rise in agricultural energy productivity in the long-run. The error correction coefficient is estimated at -0.25 implying that the effect of every shock imposed on the long-run equation would be vanished in just four years.

### 1. INTRODUCTION

Energy is categorized among the essential drivers of global development in general and developing nations' economic growth in particular [19,13,30,31,32]. Some ecological economists believe that in the biophysical growth model, energy acts as the most influential factor [27,23,24,26,27,29]. Also many studies have reported the impact of economic growth on export

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Received May 14<sup>th</sup>, 2020; accepted June 26<sup>th</sup>, 2020; published September 29<sup>th</sup>, 2020.

2010 Mathematics Subject Classification. 62P20, 91G70.

Key words and phrases. energy productivity; globalization; cointegration; error correction model; Iran.

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(growth-driven export) [20,1,14,33,34]. So, one may think of an association between energy use and export. In other words, trade is an important driver of economic growth and export enhancement promotes the economic activities and, thus, the energy demand [25,2,17,18,20,22]. On the other hand, globalization is currently a popular and controversial issue, though often remaining a loose and poorly-defined concept. Sometimes too comprehensively, the term is used to encompass increases in trade and liberalization policies as well as reductions in transportation costs and technology transfer. As far as its impact is concerned, discussion of globalization tends to consider simultaneously its effects on economic growth, employment and income distribution.

As many other developing nations, agriculture plays an important role in the Iranian economy. Based on recent data, it accounts for about 9.8% of gross domestic product, 22% of employment and more than 20% of non-oil exports (CBI<sup>1</sup>, 2018). Also as a member of OPEC<sup>2</sup>, Iran is an example of oil-dominant economies that has provided cheap energy to different sectors, including agriculture, for decades. It has been seeking non-oil export promotion and low dependency on oil export for three decades. So from policy making point of view it would be very informative to know how energy use has affected major economic variables (growth and export) of the sector.

Little empirical studies can be found dealing with the nexus between energy productivity (EP<sup>3</sup>), and globalization (G) in the Iranian agriculture context. Considering the vital role of agriculture in the Iranian economy and rapid development of globalization in the world, the main motivation of current study can be defined as how globalization affects energy productivity in the sector. The remainder of the paper is structured as follows. Next section deals with methodology employed. Section 3 provides main obtained results and discusses, and finally section 4 presents conclusion.

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<sup>1</sup> Central Bank of the Islamic Republic of Iran

<sup>2</sup> Organization of Petroleum Exporting Countries

<sup>3</sup> Energy used per unit of output (agricultural value added in this study)

## 2. MATERIALS AND METHODS

### 2.1. Econometric techniques

In this study the commonly used method in examination of the causal association between two series, namely; Granger causality test is applied. Considering two variables of interest including EP and G following equations are specified:

$$EP_t = \sum_1^p a_i G_{t-i} + \sum_1^q b_j EP_{t-j} + e_{1t} \quad (1)$$

$$G_t = \sum_1^r m_i EP_{t-i} + \sum_1^s n_j G_{t-j} + e_{2t} \quad (2)$$

where p, q, r, and s are lags, and  $e_i$ 's are residuals assumed to possess all favorite statistical features. According to estimation results following alternatives are expected:

$\sum_1^p a_i \neq 0 \rightarrow$  unidirectional causality from G to EP

$\sum_1^r m_i \neq 0 \rightarrow$  unidirectional causality from EP to G

$\sum_1^p a_i \neq 0$  and  $\sum_1^r m_i \neq 0 \rightarrow$  bidirectional causality between G and EP

$\sum_1^p a_i = 0$  and  $\sum_1^r m_i = 0 \rightarrow$  independent variables

After detecting causal possible causal relationship one should check existence of long-run association between variables. Here the Johansen-Juselius (JJ) test is applied. It lets to estimate not only magnitude of association but also presence of long-run equilibrium relationship between variables. Based on JJ test, if  $Z_t$  is a vector containing two non-stationary time series ( $EP_t, G_t$ ) then behavior of  $Z$  can be stated via a vector autoregressive process:

$$Z_t = C_1 Z_{t-1} + \dots + C_k Z_{t-k} + V_t \quad (3)$$

Equation 3 is commonly estimated by the ML<sup>1</sup> methodology. In the case of existence of long-run association, the short-run dynamics can be related to long-run stable relationship via vector-error-correction model (VECM). This model has a very important policy making implication as it reveals how the impact of a shock would be corrected as time passes [13,6,7,8,11,12,15].

### 2.2. Data

All required information for estimation of equations 1-3 is taken from relevant sources including Ministry of Energy, Ministry of Agriculture and CBI. Furthermore annual data for the period spanning from 1967 to 2018 is used in estimation process.

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<sup>1</sup> Maximum Likelihood

### 3. RESULTS AND DISCUSSION

Descriptive statistics of variables of interest are presented in Table 1.

Table 1. Descriptive statistics

variable	description	unit of measurement	average	min	max	standard deviation	growth rate (%)
EP	agricultural energy productivity	billion Rials per one barrel OE energy	12321	8925	16539	1023	0.08
G	KOF globalization index	-	32.02	21.32	49.28	4.07	17.5

Note: OE denotes Oil Equivalent

As Table 1 shows, both variables have followed upward trend. Also, according to figures presented in Table 2 both two variables are non-stationary, so we are allowed to examine possible long-run equilibrium relationship between variables.

Table 2. Results of three unit root tests

variable	KPSS		PP		ADF	
	level	first difference	level	first difference	level	first difference
EP	0.32*	0.18	-3.12	-5.33**	-1.02	-8.49**
G	0.85*	0.28	-1.27	-6.75**	-1.13	-8.69**

Note: Variables are in natural logarithm

Table 3 portrays the output of JJ test of cointegration that clearly confirmed existence of one long-run equilibrium relationship.

Table 3. The results of JJ test

null hypothesis	trace statistic		maximum eigenvalue statistic	
	value	critical value 5%	value	critical value 5%
r=0*	29.36	15.49	19.31	14.26
r=1	1.11	6.02	2.93	3.84

Table 4 reports results of Granger causality test. Existence of one way causal relationship from globalization to energy productivity in agriculture is confirmed. It means that by getting Iranian economy more integrated into the world economy, energy productivity in agriculture will change. This is consistent with some previous studies in the field [9,28,14,3,4,5].

Table 4. Results of causality test

null hypothesis	No of observations	F-statistic	probability
G doesn't Granger cause EP	48	7.51	0.01
EP doesn't Granger cause G		0.36	0.78

Note: variables are in natural logarithm

Moreover, the long-run cointegrating coefficient is estimated at 0.75 implying that by one percent rise in globalization index one could expect 0.75 percent increase in energy productivity in the Iran's agriculture. Some other studies including Adebola, 2011; Apergis and Payne, 2010 have reported same results. In addition, the error correction coefficient is estimated at -0.25 meaning that the impact of any external shock (stemming from policies such as energy price liberalization) is expected to be completely vanished in just four years.

#### 4. CONCLUSION

This study empirically dealt with the causal association between energy productivity and globalization in the context of Iranian agriculture. Annual information on two variables of interest is gathered from official national sources. Results obtained from application of Granger causality test reveals existence of a unilateral causal association from globalization to energy productivity in the agriculture sector. Further examinations showed presence of a long-run equilibrium relationship between globalization and energy productivity. Based on estimation results it is expected that one percent increase in globalization index lead to 0.75 raise in energy productivity. Considering direct and relatively strong effect of globalization on energy productivity at one hand and undeniable role of agriculture in Iranian economy at the other hand, taking measures to reduce susceptibility of domestic agriculture from foreign shocks (such as border measures and bilateral trade agreements) is highly recommended.

**Conflicts of Interest:** The author(s) declare that there are no conflicts of interest regarding the publication of this paper.

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