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The Effects of Foreign Trade, Energy Consumption and Human Capital on GDP in Several Candidate Developed Countries and Developing Countries

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Abstract

This paper attempted to examine the effects of foreign trade, energy consumption, human capital and physical capital on GDP in 8 candidate developing countries and 8 candidate developed countries during 2002-2014.In this study, the effects of variables were estimated through panel cointegration technique and dynamic ordinary least squares (DOLS).The results of regression test indicated that all variables had significantly positive effects on the production process. Further details about the results were obtained by evaluating foreign trade in general (exports and imports combined), in addition to separately evaluating export and import, where there were significantly positive correlations evident over the period. In the candidate developed countries, the role of exports was more prominent than imports and total trade. In the candidate developing countries, the role of imports was more
prominent than exports and total trade.

Keywords: Foreign Trade, Energy Consumption, GDP, Panel Cointegration.
JEL Classification: C33, D2, Q43, F10.

1. Introduction

Production function is a purely physical concept, simply depicting the relationship between outputs and inputs of production. In fact, product function reflects the maximum volume of a product obtained from different combinations of inputs. Intrinsically, production function is an integral component of economic planning and development. Estimation of production function provides the possibility to specify the role

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and significance of each production input separately. Thus, any decision and policy made on the application of inputs will be realized through calculation of total and partial productivity levels of inputs, pricing of inputs and generally production planning and development of strategies (Hu and Mcaleer, 2005).

Over the last two decades, energy has been regarded as an important production factor, playing a decisive role in the national economies along with other production factors such as labor, capital and raw material plays. Nowadays, studies conducted worldwide have demonstrated that the rapid economic and industrial development in countries is largely correlated with the consumption rate of energy carriers, since energy has accounted for the largest share in international trade and economic activity (Yavari and Ahmadzadeh, 2010).

In this respect, foreign trade has been discussed as one of the most controversial elements of any economy. Most economists consider foreign trade as the engine of economic growth. As the trade flows in a few countries intensified owing to oil, countries around the world joined the World Trade Organization to break down boundaries (Sadorsky, 2011).

This study intended to evaluate the effects of several variables, including foreign trade, energy consumption, human capital and physical capital, on production rate in 8 candidate developing countries and eight candidate developed countries during 2002-2014 through panel cointegration and Dynamic Ordinary Least Squares (DOLS).Further details about the results were obtained by evaluating foreign trade in general (exports and imports combined), in addition to separately evaluating export and import, where a number of hypotheses were formulated and tested as follows:

1) Trade affects GDP in the candidate developed countries and developing countries.

2) Energy consumption affects GDP in the candidate developed countries and developing countries.

3) Human capital affects GDP in the candidate developed countries and developing countries.

4) Physical capital affects GDP in the candidate developed countries and developing countries.

The next section explores the relevant literature. The third section

deals with empirical studies, while the fourth section proposes the new model. The fifth and sixth section provide the, experimental results/conclusions and policy recommendations, respectively.

2. Literature Review

2.1 Role of Trade in Production

Most economists believe that trade is the engine of growth and development in today's world. They assert that international trade facilitates the utilization of potential economic capacities given the relative advantages readily available, leaving optimistic signs for investment in competitive economic projects at the global arena. Moreover, international trade affects economic growth through access to foreign markets, technology and resources (Lopez, 2003).

In experimental studies (Feder, 1982 and Edward, 1998), it has been argued that international transfer of technology is correlated with the stream of commerce. The more sectors of the economy are exposed to international competition, the greater the modern technology and pressure to adopt technology for keeping competitive edge (ibid).

Foreign trade modifies the allocation of resources from low-productivity sectors and industries to high-productivity industries, while directing resources to activities with most efficiency. With the expansion of foreign trade, business administration and economy are encouraged toward new discoveries in economic management, technological improvement and better methods of production. Hence, the previously-overlooked opportunities become the primary sources for economic growth and development. Moreover, the expansion of foreign trade provides the domestic industry owners with numerous input resources at low costs. This enables industries to deliver the finished products, thus gaining competitiveness in both domestic and international markets. Such implication of international trade can improve the productivity of factors, enhance growth and ultimately the process of economic development (ibid).In the process of production, imports and exports together can better explain the process of economic growth and development.

The notion that export growth leads to economic development has for many years been discussed in the literature of economic growth and development (export-led growth, 1970). Several explanations

have been provided for the validity of export-led growth hypothesis from the standpoint of economic theory. Firstly, export growth reflects greater demand for the country's products, thereby helping to expand the production rate. Secondly, exports expansion can lead to specialization in the production of export goods, thereby to boost the productivity level and multiply expertise in the exports sector. In the next phase, such trend can modify the allocation of resources, directing resources from relatively inefficient non-export sectors toward those with higher efficiency. This effect became well-known as Word Duran Law after P. J. Word Duran (1949) who proposed the idea back in 1949.The outward-oriented trade policies improved the access to advanced technologies, in-service learning and management practices, which ultimately bough about more efficiency (Cavel, 1980).Thirdly, the increase in exports could reduce foreign exchange restrictions, while facilitating the import of production inputs and expansion of production (Mckinaon, 1964). Fourthly, outward trade orientation facilitated the utilization of foreign capital for economic development without suffering foreign debt repayments. It also eliminated controls leading to excessive valuation of domestic currency. Fifthly, the expanded export of specific goods according to the country's comparative advantage can realize economies of scale and thereby increase economic growth and development. According to proponents of this theory, domestic markets are too small to achieve optimal scale of production. Increased production could be possible through access to domestic markets, and finally, export-led growth can be viewed as part of business-industry life cycle hypothesis (Carnwall, 1977). Accordingly, the theory of economic development is considered a cycle initiated with exports of goods and raw materials. Over time, economic growth and knowledge modify the structure of domestic economy (including consumer demand) leading to change and ultimately export of industrial commodities through utilization of high-end technical knowledge.

Imports can similarly facilitate the domestic economy through creation of competition in both quality (competing goods imported) and price (encouragement to lower the cost). The engagement and redirection of capital and intermediate inputs not available domestically can enhance the ability of efficient manufacturers to expand their shares in

the domestic and foreign markets, promote the domestic economy to produce highly diverse products and pave the way for larger exports rates and eventually active involvement in the international arena (Tayebi and Tavakoli, 2000).

In general, developing countries have common features in terms of economic structure, such as type of production covering mostly agricultural and traditional products. For transition from traditional production to industrial production through economic development, the imports of capital, industrial, intermediate and technological goods can smooth the process of industrial and social evolution. If infrastructure is provided for localization of knowledge and technology through the import of capital and industrial goods in the country, this trend can lead to technological overflow from the trading partners and thus transfer skills, managerial talents and employers, which ultimately affect the economic growth and development (Hosseininasab et al., 2007).

In transitional stages of economic development, developing countries need to establish capital infrastructure where imports of industrial and capital goods play a very important role. If developing nations lack the resources and factors of production, materials and equipment due to natural and technical reasons, they still can import them to overcome the production bottlenecks, facilitate the production of essential goods and expand production efficiency. Certainly, a non-breakable link is established in between the pattern of production, export and import over the course of economic transformation. In total, the main purpose of importing capital and industrial goods in developing countries is to empower a strong backward and forward linkage in the process of production (Farjadi and Lali, 1997).

2.2 Role of Energy Consumption in Production

Planning for national development can be fulfilled partly by this goal, where national resources are mobilized to produce more goods and services required. However, the efforts made to produce more and better when organizing the production factors should employee more extensively and densely the entire resources, including workforce, physical capital and natural resources. In other words, when the economic growth rate is remarkably high, excessive pressure is exerted on re-

sources. In this regard, there will be greater demand for skilled manpower, capital and capital equipment and consumption of raw materials and energy. If it is impossible to further exploit any of these resources in parallel with the production growth, production will face a bottleneck (Sadorsky, 2011: 739).Therefore, the relationship between the growths of national economy or consumption of various energy carriers has recently grabbed the attention of many economic analysts. The relationship between economy and energy is explained in several ways, each representing its specific theoretical background and analytical approach.

According to ecological economists such as Ayras and Nayer, energy is the only primary factor of production, while capital and labor are mediating factors requiring energy for operation (Daly, 1997).In modern theories of growth, energy is also deemed a key production factor in macro-economic debates, playing a dramatic role in economic growth as the outcome of all economic activities in a society, Hence, production is a function of labor, capital, energy and raw materials. In other words, we have:

$$Q = f(K, L, E)$$

Where Q represents product, K represents capital, L represents labor, and E represents energy. As an input, E can be supplied by a combination of factors such as oil, gas, power, coal, etc. known as energy carriers. Hence, all three inputs of capital, labor and energy lead to changes in production rates. It is assumed that there is a direct relationship between the application of these inputs and production rate, i.e. the higher each input the higher the production rate. Mathematically, it can be formulated:

$$\frac{\partial Q}{\partial K} > 0, \frac{\partial Q}{\partial L} > 0, \frac{\partial Q}{\partial E} > 0$$

Covering a variety of energy suppliers, energy consumption is in turn a reversed function of energy carrier prices. In other words, increase in the level of energy prices can curtail energy consumption, which in turn lowers the production rate (Stern, 2004).

2.3 Role of Human Capital in Production

In economic debates, labor is regarded as a factor contributing to production and economic growth. The discussion mainly revolves around quality of labor, rather than quantity. Quality of labor is so important that certain development economists such as Kuznets believe the difference between the levels of economic growths in countries can be justified by the difference in their education spending and quality of labor.

Simon Kuznets believed that the main capital in a developed country is not the industrial equipment but the technical capacity and expertise of its workforce (i.e. educated and skilled labor).In confirmation of Kuznets' opinions, the example of Germany and Japan after World War II is often raised, since a major portion of physical capital in the two countries were destroyed while a remarkable portion of labor remained. That is why the two countries managed to push their economies back to ideal within less than two decades.

In fact, trained individuals today play a key role in organizational growth and development. An overview of today's growth rate of labor and development of modern organization would prove the same fact. In principle, the qualitative characteristics of human are capital, since they can facilitate economic growth through increased productivity, production, higher levels of income and welfare.

Although technical skills of the workforce constitute one of the desirable characteristics of labor, the quality of labor does not only involve technical knowledge but also covers concepts such as interest in the product, spirit of teamwork, willingness to save costs, labor discipline, labor mobility and desire to earn more income. In other words, desirable labor has a set of characteristics outlined above. That is why, according to the above, shortage of skilled workers is not the only bottleneck in developing countries (Vaziri, 1978).

Empirical research has shown that individuals with higher education tend to earn more income in ordinary conditions. On-monetary return on investment in education, although difficult to measure, can be particularly important leaving significant effects in developing countries. The question is how education expenditures will improve the quality of labor and generate human capital, and what effect such an investment has on the structure of production? The main contribu-

tion of education includes the dissemination of knowledge in all forms whether skills training or cognitive power. The contribution of education in production efficiency and productivity can be divided into three different factors or three effects:

1) Labor: It refers to the abilities fostered as a result of education in the workforce. This ability helps the labor to faster carry out the assigned tasks at better quality.

2) Allocation: It refers to the ability to choose the best and most appropriate paths. This ability requires cognitive, knowledge, skill and judgment abilities such capabilities are fostered only through formal training and in-service training.

3) Innovation: Without a doubt, innovation can increase productivity effectively. Judgment, knowledge and skills acquired through education can enhance the power of initiative, creativity and confidence in labor (Shishvani, 2012).

3. Empirical Studies

3.1 Domestic Studies

Azamzadeh Shoraki et al. (2011) estimated the production function in the agricultural sector using ARDL's method. This study explored and tested the effect of energy along with two inputs of capital and labor during 1974-2004. The results showed that in the agricultural sector, there is a long-term relationship between production and inputs of labor, capital and energy.

In their study, Al-e Imran and Al-e Imran (2012) evaluated the efficacy of enhancing human capital on economic growth in candidate OPEC countries during 1998-2007. In this study, the effects were estimate through least squares panel data. The results suggested the positive impact of human capital on economic growth over that period.

Heidari and Saeedpour (2012) examined the relationship between long-term and short-term GDPs and energy consumption, gross fixed capital formation and employment during 1967-2007.In this regard, econometric techniques were used to test the boundaries through cointegration and ECM model. The results of boundary test confirmed the long-term relationship between the variables. The estimated long-term coefficients also indicated that energy consumption, fixed capital for-

mation and employment had significantly positive effects on GDP.

Damankeshideh et al. (2013) examined the relationship between energy consumption and economic growth. This study was conducted on candidate countries for 20-Year Vision during 1990-2009 through panel data and ordinary least squares (OLS). The regression analysis demonstrated a significantly positive relationship during the period.

Inan article, Sadeghi et al. (2014) explored the causal relationship between energy consumption and GDP. This study focused on countries in the MENA region during 1980-2009, relying on GMM technique. The results of model estimation suggested that there is a unilateral causal relationship from energy consumption to gross domestic product.

3.2 Foreign Studies

Apergis & Payne (2010) investigated the cointegration and causality relationships through Granger's technique between energy consumption and economic growth in 9 South American countries during 1980-2005 using panel cointegration and error correction model. They found that based on the Pedroni's heterogeneous integration test; there is a long-term relationship between real GDP, energy, labor and real gross fixed capital formation. Moreover, the coefficients of variables were positive and statistically significant.

In an article, Halicioglu (2011) examined the dynamic causal link between total production, energy consumption, export, capital and labor in Turkey using time series data during 1968-2008. The results of Granger test showed that in the long-term the causality flow of labor, capital, export and energy consumption progresses toward total production. In the short term, there is a bilateral causal link between energy consumption and total production on the one hand, and total exports and production on the other hand.

In a study using the panel cointegration technique, Sadorsky (2012) examined the relationship between energy consumption, production and trade in a sample among seven South American countries during 1980-2007. The results indicated a long-term relationship between 1) production, capital, labor, energy and export, 2) production, capital, labor, energy and imports. There is also evidence of a short-term relationship between energy consumption and import. In the long-term,

there is evidence of a causal link between trade (exports or imports) and energy consumption.

Fitzová & Žídek (2015) examined the effect of trade on economic growth in Czech Republic and Slovak Republic. Carried out during 1996-2014 (based on quarterly data), this study utilized the VAR method. Finally, the regression analysis indicated that exports and imports (especially the former) played a significant role in promoting economic growth in the mentioned countries.

Madadkhah (2016) investigated the effects of indices related to foreign trade, physical capital, human capital and energy consumption on economic development. To this end, seven candidate developing countries were evaluated through panel cointegration and generalized least squares approach (GLS) during 1990-2011. The results of estimation demonstrated that all indices over that period had a significantly positive effect on the trend of economic development.

Given that previous empirical studies in connection with the impact of foreign trade and energy consumption on production for candidate developed and developing countries never adopted panel cointegration and Dynamic Ordinary Least Squares (DOLS), the current study attempted to explore the effect of foreign trade and energy consumption on production for candidate developed and developing countries through Panel Cointegration and Dynamic Ordinary Least Squares (DOLS).

4. Overview of the New Model

In this article, the effects of foreign trade, energy consumption, human capital and physical capital on production were investigated for 8 candidate developing countries[1] and 8 candidate developed countries[2] during 2002-2014[3]. (These specific countries were selected because developing and developed countries can yield contrasting results to relevant literature. Hence, simultaneous results from both categories of countries can propose more practical policy recommendations.) The effects of variables were estimated through panel cointegration and dynamic ordinary least

1. Colombia, Costa Rica, Ukraine, Romania, Iran, Mexico, Bulgaria and Turkey.
2. UK, Denmark, Finland, France, USA, Netherlands, Sweden and Luxembourg.
3. These countries were selected because of their economic conditions and degrees of development putting them under the categories of developed and developing. In terms of human development index, both categories cover developing and developed countries.

squares method (DOLS).The DOLS estimator yields more satisfactory results than OLS and FMLOS estimators. On advantage of DOLS over the other two estimators lies in its application for small samples, prevention from simultaneous bias while providing normal asymptotical distribution. In addition, DOLS is a parametric technique for estimation of variables, resolving the correlation between the explanatory variables and disturbance terms by including the priori and a posteriori interrupted explanatory and dependent variables .In this procedure, the optimal interruption of interrupted explanatory and dependent variables was determined through Akaike's test and Schwarz's Bayesian statistic. The important point is that the dynamic least squares also provide the possibility to estimate the cointegration vector where the integration degrees vary (Kao & Chiang, 2000).The new model in this paper was similarly based on theoretical and empirical principles as explained below in the following three equations, where Models (2) and (3) serve to find out more details:

$$LnY_{it}= \alpha_0 + \alpha_1 LnO_{it} + \alpha_2 LnE_{it} + \alpha_3 LnH_{it} + \alpha_4 LnK_{it} + \varepsilon_{it} \quad (1)$$

$$LnY_{it}= \alpha_0 + \alpha_1 LnX_{it} + \alpha_2 LnE_{it} + \alpha_3 LnH_{it} + \alpha_4 LnK_{it} + \varepsilon_{it} \quad (2)$$

$$LnY_{it}= \alpha_0 + \alpha_1 LnM_{it} + \alpha_2 LnE_{it} + \alpha_3 LnH_{it} + \alpha_4 LnK_{it} + \varepsilon_{it} \quad (3)$$

Y: Represents real GDP according to base year of 2010.

E: represents energy consumption according to base year of 2010 that is combination of renewable energy (as nuclear energy and electricity) and no-renewable energy (as fossil fuels coal, petroleum and natural gas)

O: presents total trade (sum of import and export) according to base year of 2010.

X: presents real export according to base year of 2010.

M: presents real import according to base year of 2010.

H: presents human capital index that labor is one of the most important indexes of model.

K: presents physical capital index that real gross fixed capital formation according to base year of 2010 is used as its index.

Ln: It is the symbol of natural logarithm[1].

ε: It denotes random error.

1. Logarithm was obtained to calculate the elasticity of production inputs, human capital, physical capital and energy.

Data of total trade, export, import, human capital, physical capital, consumer price index, GDP are extracted from World Bank. Energy consumption data are extracted from British Petroleum web site. CPI is used to realize the nominal variables. All analyses were conducted in Eviews 9.

5. Data Analysis

5.1 Stability Test

The stability of variables was examined through Im, Pesaran& Shin (IPS) test. The IPS is one of the important unit root tests in panel data. In this test, the null hypothesis suggests there is a unit root. The results of this test have been summarized in Table (1).

According to the results in Tables (1) and (2), energy consumption, imports and GDP are stable at level (I(0)), while total trade (exports and imports combined), exports, human capital and physical capital are not stable and can be stabilized through a single differencing (I(1)).Generally speaking, however, all variables are stable at I(1). Given that the variable have been stabilized through a single differencing, it is essential to examine the cointegration of variables.

Table 1: Results of Stability Test for Developing Countries

Im, Pesaran& Shin (IPS) Test		
Variable	Intercept mode (at level)	Intercept mode (Single differencing)
LnE	0.0014	-
	(3.0519-)	
LnO	0.1543	0.0000
	(1.0018-)	(10.8103-)
LnX	0.3451	0.0000
	(0.4409-)	(11.5634-)
LnM	0.0043	-
	(2.5421-)	
LnY	0.0014	-
	(2.3461-)	
LnH	0.4217	0.0000
	(0.2478-)	(8.1765-)
LnK	0.4326	0.0000
	(0.5682-)	(10.6543-)

Resource: Research Calculations

Table 2: Results of Cointegration Test for Developing Countries

Im, Pesaran & Shin (IPS) Test		
Variable	Intercept mode (at level)	Intercept mode (Single differencing)
LnE	0.0088	-
	(2.3751-)	
LnO	0.1441	0.0001
	(1.1118-)	(3.7096-)
LnX	0.2718	0.0002
	(0.6070-)	(3.4168-)
LnM	0.0002	-
	(2.9425-)	
LnY	0.0002	-
	(3.5273-)	
LnH	0.6545	0.0445
	(0.3854)	(1.7087-)
LnK	0.1370	0.0016
	(1.1209-)	(2.9576-)

Resource: Research Calculations

5.2 Cointegration Analysis

It is highly crucial to examine whether there is cointegration in the combined data. Cointegration can help avoid the occurrence of spurious regression and determine the long-term relationship between variables. Kao test was used to assess the cointegration of variables.

In particular, the results in Tables (3) and (4) indicate a long-term relationship between:1) total trade (exports and imports combined), energy consumption, human capital and physical capital, and GDP, 2)exports, energy consumption, human capital, physical capital and GDP, and 3) imports, energy consumption, human capital, physical capital and GDP. According to the results of Kao test, it can be argued that although the variables are stable at level (1)I, they are at zero cointegration level (Kao & Chiang, 1999).

Table 3: Results of Cointegration Test for Developing Countries

Model (1)		
	t-Statistic	**Prob**
ADF	4.0356-	0.0007
Model (2)		
	t-Statistic	**Prob**
ADF	4.0095-	0.0006
Model (3)		
	t-Statistic	**Prob**
ADF	4.0336-	0.0023

Resource: Research calculations

Table 4: Results of Cointegration Test for Developing Countries

Model (1)		
	t-Statistic	**Prob**
ADF	-5.0436	0.0019
Model (2)		
	t-Statistic	**Prob**
ADF	-5.7621	0.0024
Model (3)		
	t-Statistic	**Prob**
ADF	-5.1234	0.0003

Resource: Research calculations

5.3 Model Estimation

After the unit root and cointegration tests, it is necessary to conduct the diagnostic tests to determine the type of estimation model.In order to ensure the members of sample group are significant; the group significance test was used. For this purpose, the fixed effects test was employed. If the calculated F-statistic is greater than the F in table, H_o (equal intercepts) is rejected, and different intercepts should be inserted into model estimation. As a result, the panel method can be used for estimation. At the next stage, Huasman Test was performed to specify whether the difference in intercepts of cross-sectional units are constant or random functions can explain more clearly the difference between the units. Hausman test focuses on H_o based on consistency of random effect estimates versus H_1 based on inconsistency of random effect estimates. If H_o is rejected, the constant effect method is employed for estimation. Otherwise, estimation will involve the random effects method. The following section will elaborate each of the above estimates through the corresponding diagnostic tests.

4.3.1 Model Estimation for Developing Countries

Based on the results in Table (5), in all developing countries, H_o is rejected and different intercepts should be inserted in the estimation. As a result, the panel method can be used for estimation.

At this point, the type of estimation method with respect to fixed or random effects was examined through Hausman test. The results of Hausman test in Table (6) suggested that H_o was rejected about the consistency of random effect estimates in all countries under study, and fixed effect estimation should be employed.

Table 5: Results of Fixed Effects Test for Developing Countries

	(1)		
Effects test	**Test statistic**	**Degree of freedom**	**Prob**
Section F- Cross	69.6861	(92, 7)	0.0000
Cross-section Chi-square	191.4536	7	0.0000
	(2)		
Section F- Cross	69.6541	(92, 7)	0.0000
Cross-section Chi-square	191.6531	7	0.0000
	(3)		
Section F- Cross	69.8751	(92, 7)	0.0000
Cross-section Chi-square	191.8731	7	0.0000

Resource: Research Calculations

Table 6: Hausman Test for Developing Countries

	(1)		
Effects test	**Test statistic**	**Degree of freedom**	**Prob**
Cross-section random	187.3161	4	0.0000
	(2)		
Cross-section random	187.6531	4	0.0000
	(3)		
Cross-section random	187.8952	4	0.0000

Resource: Research Calculations

Table 7: Results of Model Estimation for Developed Countries

	(1)			
Variables	**Coefficient**	**Standard deviation**	**T statistic**	**Prob**
C	-4.4180	1.3149	3.3599-	0.0019
LnO	0.1925	0.0535	3.5984	0.0010
LnE	0.3424	0.1309	2.6164	0.0132
LnH	1.3264	0.7574	1.7512	0.0889
LK	0.2765	0.0538	5.1367	0.0000
R^2		0.9965		
Adjusted R^2		0.9943		
Durbin–Watson statistic		1.8520		
	(2)			
C	-13.5813	3.2689	1547/-4	0.0002
LnX	0.5918	0.1309	4.5199	0.0001
LnE	1.0528	0.4161	2.5299	0.0162
LnH	4.0777	2.3186	1.7586	0.0876
LK	0.8502	0.1616	5.2604	0.0000
R^2		0.9863		
Adjusted R^2		0.9847		
Durbin–Watson statistic		1.5999		
	(3)			
C	3253/۰	0.0711	5715/-4	0.0001

LnM	0.2765	0.0538	5.1367	0.0000
LnE	0.3424	0.1309	2.6164	0.0132
LnH	1.3264	0.7574	1.7512	0.0889
LK	0.1925	0.0535	3.5984	0.0010
R^2		0.9861		
Adjusted R^2		0.9843		
Durbin–Watson statistic		1.8828		

Resource: Research Calculations

The results of model estimation in Table (7) have been summarized as follows:

- Total trade has a positive effect on GDP by about 0.19 at a significance level of 1%.
- Export has a positive effect on GDP by about 0.59 at a significance level of 1%.
- Import has a positive effect on GDP by about 0.27 at a significance level of 1%.
- It can be argued that in the candidate developed countries, the role of exports was more prominent than imports and total trade.
- Energy consumption has a positive effect on GDP at a significance level of 5%.
- Coefficient of energy consumption in the candidate developed countries for Equations (1), (2) and (3) are 0.34, 1.05 and 0.34, respectively.
- Human capital has a positive effect on GDP at a significance level of 10%.
- Coefficients of human capital in the candidate developed countries for Equations (1), (2) and (3) are 1.32, 4.07 and 1.32, respectively.
- Physical capital has a positive effect on GDP at a significance level of 1%.
- Coefficients of physical capital in the candidate developed countries for Equations (1), (2) and (3) are 0.27, 0.85 and 019, respectively.
- Based on Durbin-Watson value, there is no autocorrelation problem in the models.
- According to values of R^2 and adjusted R^2, it can be stated that energy consumption, total trade, export, import, human capital and physical capital desirably responded to variations of gross domestic production as the dependent variable.

4.3.2 Model Estimation for Developing Countries

Based on the results in Table (8), in all developing countries, H_o is rejected and different intercepts should be inserted in the estimation. As a result, the panel method can be used for estimation.

Table 8: Results of Fixed Effects Test for Developing Countries

	(1)		
Effects test	**Test statistic**	**Degree of freedom**	**Prob**
Section F- Cross	48.0598	(85, 7)	0.0000
Cross-section Chi-square	160.2838	7	0.0000
	(2)		
Section F- Cross	48.0986	(85, 7)	0.0000
Cross-section Chi-square	160.4321	7	0.0000
	(3)		
Section F- Cross	48.1287	(85, 7)	0.0000
Cross-section Chi-square	160.6543	7	0.0000

Resource: Research calculations

At this point, the type of estimation method with respect to fixed or random effects was examined through Hausman test. The results of Hausman test in Table (9) suggested that H_o was rejected about the consistency of random effect estimates in all countries under study, and fixed effect estimation should be employed.

Table 9: Hausman Test for Developing Countries

	(1)		
Effects test	**Test statistic**	**Degree of freedom**	**Prob**
Cross-section random	157.7403	4	0.0044
	(2)		
Cross-section random	157.6578	4	0.0023
	(3)		
Cross-section random	157.6543	4	0.0029

Resource: Research calculations

The results of model estimation in Table (10) have been summarized as follows:

- Total trade has a positive effect on GDP by about 0.17 at a significance level of 1%.
- Exports have a positive effect on GDP by about 0.17 at a significance level of 1%.
- Imports have a positive effect on GDP by about 0.30 at a signifi-

cance level of 1%.

- It can be argued that in the candidate developing countries, the role of imports was more prominent than exports and total trade.

- Energy consumption has a positive effect on GDP at significance levels of 5% and 1%, respectively.

Table 10: Results of Model Estimation for Developing Countries

	(1)			
Variables	**Coefficient**	**Standard deviation**	**T statistic**	**Prob**
C	1.1075	0.0999	11.0812	0.0000
LnO	0.1725	0.0394	4.3757	0.0002
LnE	0.3290	0.1301	2.5295	0.0174
LnH	17.3000	4.4453	3.8917	0.0006
LK	0.2158	0.1072	2.0121	0.0539
R^2		0.9987		
Adjusted R^2		0.9965		
Durbin–Watson statistic		1.7654		
	(2)			
C	159.8124	47.7585	3.3462	0.0023
LnX	0.1725	0.0394	4.3757	0.0002
LnE	0.3290	0.1301	2.5280	0.0174
LnH	3.0393	1.4149	2.1479	0.0405
LK	0.1082	0.0496	2.1822	0.0376
R^2		0.9876		
Adjusted R^2		0.9754		
Durbin–Watson statistic		1.6542		
	(3)			
C	0.4863	0.1263	3.8489	0.0005
LnM	0.3000	0.0717	4.1843	0.0002
LnE	0.8616	0.1817	4.7412	0.0000
LnH	9.1981	2.3117	3.9683	0.0003
LK	0.7221	0.3905	1.8489	0.0729
R^2		0.9965		
Adjusted R^2		0.9796		
Durbin–Watson statistic		1.8765		

Resource: Research calculations

- Coefficient of energy consumption in the candidate developing countries for Equations (1), (2) and (3) are 0.32, 0.32 and 0.87, respectively.

- Human capital has a positive effect on GDP at significance levels of 1%, 5% and 1%, respectively.

- Coefficients of human capital in the candidate developing countries for Equations (1), (2) and (3) are 17.30, 3.03 and 9.19, respectively.

- Physical capital has a positive effect on GDP at significance levels of 10%, 5% and 10%, respectively.

- Coefficient of physical capital in the candidate developing countries for Equations (1), (2) and (3) are 0.21, 0.10 and 0.72, respectively.

- Based on Durbin-Watson value, there is no autocorrelation problem in the models.

- According to values of R^2 and adjusted R^2, it can be stated that energy consumption, total trade, export, import, human capital and physical capital desirably responded to variations of gross domestic production as the dependent variable.

6. Conclusions and Policy Recommendations

This study attempted to investigate the effect of foreign trade, energy consumption, human capital and physical capital on production rates in 8 candidate developing countries and 8 candidate developed countries between 2002 and 2014.The new extended models were evaluated through theoretical and empirical principles, panel cointegration and dynamic ordinary least squares (DOLS).The results were examined in more detail based on foreign trade as a whole (exports and imports combined), in addition to exploring export and import separately. In this regard, the ISP test was conducted to evaluate the unit root of model variables. The results of unit root test confirmed the stability of panel data at level I(1). Then, the cointegration analysis was performed using Kao method. The results of Kao test suggested that residuals were cointegrated at level I(0), which confirmed the false regressions as well as a long-term strong correlation between: 1) total trade (exports and imports combined), energy consumption, human capital and physical capital, and GDP, 2)exports, energy consumption, human capital, physical capital and GDP, and 3) imports, energy consumption, human capital, physical capital and GDP. Finally, the results of estimates showed that GDP was affected by total trade (exports and imports combined), exports, imports, energy consumption, human capital and physical capital in the countries under study. The results have been provided in more detail as follows:

1) Energy consumption has a significantly positive effect on production (Hypothesis 2 proven).Coefficient of energy consumption in the candidate developed countries for Equations (1), (2) and (3) are 0.34, 1.05 and 0.34, respectively. Similarly, coefficient of energy consumption in the candidate developing countries for Equations (1), (2)

and (3) are 0.32, 0.32 and 0.87, respectively.

- This positive relationship can be associated with large share of energy in production. In fact, production accounts for the largest energy consumer in any economy. In other words, the process of production and economic growth is impossible without energy.

2) Total trade index (exports and imports combined), import and export separately have a positive significantly positive effect on production (Hypothesis 1 proven), i.e. exports plays a more prominent role than imports in developed countries. In the candidate developing countries, the role of imports was more prominent than exports and total trade. This can be justified by large volume of exports of capital goods from developed countries and large volume of import of capital goods and raw materials in developing countries. Based on available business statistics, developing countries have become importing countries, whereas developed countries have become exporting countries.

- According to the theories of economic growth, trade leads to expansion of production and economic growth through improved resource allocation, access to better technology and intermediate goods, adopting economies of scale, and increased domestic competition.

3) Physical capital has a significantly positive effect on production (Hypothesis 4 proven).Coefficients of physical capital in the candidate developed countries for Equations (1), (2) and (3) are 0.27, 0.85 and 019, respectively. Similarly, coefficient of physical capital in the candidate developing countries for Equations (1), (2) and (3) are 0.21, 0.10 and 0.72, respectively.

- The reason behind the significant positive correlation is obvious. Investment is regarded as a major component of production, economic growth and development in any economy. In fact, it is considered one of the basic necessities of production and economic progress, so that lack of financing will lead to sluggish production and economic growth and extravagant costs.

4) Human capital has a significantly positive effect on production ((Hypothesis 3 proven)).Coefficients of human capital in the candidate developed countries for Equations (1), (2) and (3) are 1.32, 4.07 and 1.32, respectively. Similarly, coefficients of human capital in the candidate developing countries for Equations (1), (2) and (3) are 17.30, 3.03 and 9.19, respectively.

- The reason for this positive correlation is obvious. Nowadays, individuals play a key role in the growth and development of organizations. An overview of today's growth rate of labor and development of modern organization would prove the same fact. In fact, the qualitative characteristics of humans can provide a type of capital, because these characteristics can enhance productivity.

- Given the results, several recommendations are made as follows:

1) Given the positive correlation between energy consumption and production, governments need to take major steps in management of energy consumption. The energy sector is so vital that authorities cannot be indifferent to overconsumption patterns; otherwise there will be detrimental consequences against the energy reserves. Given that the production process is impractical without energy consumption and the fact that energy reserves are limited, the government need to design and implement reasonable economic policies and take major steps in the field of energy management and expand production and economic growth. Instances of such policies involve the security of energy supply according to each specific economy, enhancing energy efficiency, utilization of renewable energy and adoption of punitive and encouraging policies. In other words, an optimal combination of renewable and non-renewable energy resources has been selected to as much as possible minimize the consumption of non-renewable energy, no matter how expensive the utilization of renewable energy is. Put simple, it is critical to build capacities for production of renewable energy, thus paving the way for consumption of non-fossil energy carriers in the production sector. In fact, fossil fuels need to be replaced by clean energy resources, thereby to facilitate the growth of added value in various economic spheres. Nevertheless, the prices energy carriers are high and their production capacity is limited against non-renewable energy.

2) Given the positive relationship between trade, export and import, and production, it is crucial to provide the ground for expansion of trade activities in the countries under study. To achieve this purpose, it is vital to adopt appropriate policies in trade liberalization through business and investment opportunities in the global economy and opening of economy toward foreign markets where production can be expanded and economy can grow. Moreover, the global financial crisis and international sanctions have somewhat hindered the trade de-

velopment in the countries under study, restricting the opportunity to promote production particularly in developing countries such as Iran.

3) Given the positive relationship between human capital and production, it is recommended to expand investment in human resources. Governments should devise a well-calculated plan to train the workforce, while implementing desirable policies in management of human resources. Additionally, it is vital to focus on quality and quantity of labor in an integrated perspective.

As the opportunities are provided, the labor will actualize its capabilities and skills in more fitting job positions and various economic sectors in terms of expertise. Moreover, the human capital index will more effectively contribute to the production process.

4) Given the positive relationship between fixed capital and production, it can be asserted that expansion of investment in various production sectors can facilitate the development of production and economic growth.

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