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The Effect of Energy Carriers Prices on Manufactured Export in Iran, Using Panel Data Model

Nader Mehregan* Mahdi Keramatfar**

Abstract

According to international trade theories, countries attempt to produce and export commodities with their abundant resources. Iran has great energy resources and availability of inexpensive energy input has increased energy consumption per capita in manufacturing sector as well as in consuming sector. Relying on low energy price, manufacturers employ energy-intensive methods for producing and exporting commodities. It follows, then, that sensitivity to changes in energy price in Iran is very high. Employing panel-data model, this study seeks to investigate the intensity of the effects of changes in energy price on the export of manufacturing sector. The findings of this paper indicate that energy price and export are negatively related. Furthermore, those sectors that export a larger proportion of their GDP, due to high consumption of energy, are more sensitive to the changes in energy price.

Keywords: Energy Price, Manufactured export, Panel data, Comparative Advantage

JEL classification: F1, Q4

1. Introduction

In the recent decades, a lot of researches have been carried out about the effects of export expansion on economic growth which have culminated in the expansion of export-led growth hypothesis (ELG). According to the export-led growth hypothesis, expansion of export is one of the major factors in economic growth. Studies done by Balassa (1987), Tyler (1981), and Bahmani et al (2005) could be taken as examples in which a positive and meaningful relation directed from export to economic growth has been confirmed. The expansion of export through optimal resource allocation based on comparative advantages, allow for greater capacity utilization and permit the exploration of economies of scale,

* Associate Professor of Economics, Department of Economics and Social Science, University of Bu-ali Sina, Hamedan-Iran. Corresponding Author E-mail: mehregannader@yahoo.com.

** Phd Student of Economics, Department of Economics and Management, University of Tarbiat Modarres, Tehran-Iran. E-mail: mkeramatfar@gmail.com.

generate technological improvement in response to competition abroad, and full employment of resources will result in growth in production.(Balassa 1987)

In Iran, in which, oil, as the major export commodity, contributes to more than 80% of export, the significance of independence from oil revenues due to fluctuations in oil price, which in turn effects the country's economy dramatically, accords the non-oil export with a higher role than a mere instrument for gaining exchange income and economic growth presenting it as a prerequisite for sustainable development. An important point related to non-oil export is the special role of export in manufacturing sector in a way that its contribution to the total non-oil export has raised from 20% in 2000 to 75% in 2007. Undoubtedly, the higher the exchange income from non-oil export, especially manufactured goods, accordingly the lower the economic dependence on oil revenues and the more the economic sustainability of the country. Based on this, the expansion of non-oil export has been emphasized in all Five-Year Development Plans (FYDP), for instance, in the second Development Plan in 1995 initiation of the high council of export expansion presided over by the president was ordered.

In 2010, with the beginning of economic reform plan, energy carriers' price rose drastically. Since energy is one of the main inputs of production in manufacturing sector, this sector, like other production sectors, encountered input price rise. Therefore, based on what was said about the significance of expansion of manufacturing export in Iran and the shock of energy price , this study seeks to provide answer to these two questions; do changes in the price of energy carriers have any impact on export in manufacturing sector?, and is this impact the same in all sectors of manufacturing? In order to do so, this study is structured into four sections, the second section lays down the theoretical bases and the review of literature, the third section focuses on model introduction and estimation, and the last section presents the conclusion.

2. Theoretical bases and the review of literature

2.1 Theoretical bases

One of the most known theories of international trade about the causes of establishment of trade between countries is Heckscher-Ohlin Theorem (H-O Theorem). Bertil Ohlin, based on Eli Heckscher's paper, explored the role of factor endowment in interregional and international trade and eventually the findings of his study were presented as H-O Theorem. According to this theorem, a country exports the commodity which uses intensively its relatively abundant factor(s), and imports the commodity which is intensive in the use of its relatively scarce factor(s). Although at first only labor and capital were considered as production factors for examining H-O Theorem, gradually other inputs such as technology , natural resources, human capital, and energy also entered trade analyses.

H-O Theorem, which was very appealing, was first examined and investigated in 1953 by Wasilli Leontief who used the information from 1947 input-output table of America. Since America, in comparison with other countries, is considered a country well-endowed with capital, Leontief' expectation US exports to consist of capital intensive goods and its import of labor intensive goods. However, this examination of his was in contrast to H-O Theorem and indicated that exports were more labor intensive than imports by 30%. Since, due to proximity of that year to World War's years, it was likely that that year was an atypical year, this examination was repeated in 1956; however the findings of this examination differed from the first one only by 6%. In order to overcome this contradiction, Leontief and others went out of their ways and provided various reasons such as import tariffs, heterogeneity of technology, variance in consumption pattern, and high productivity of labor force in the US. However, one the major reasons put forward for overcoming Leontief contradiction was the fact that only two production factors, labor and capital, had been taken into account and in order to complete this model a wider range of factors have to be allowed for. Vanek's multifactor model in 1968 was one of the best ways to dissolve Leontief's contradiction. Vanek believed that exporting goods meant exporting factor services used in the goods. This re-expressing of H-O Theorem by Vanek reiterates this point that, in fact, factor services are exchanged through trade and goods are only a cover for services. Based on Vanek theorem, if the country A's relative endowment of factors is as follows:

$$\frac{x_1}{x_1^*} \geq \frac{x_2}{x_2^*} \geq \cdots \geq \frac{x_n}{x_n^*} \qquad (1)$$

in which X_i is the country endowment A from factor *I* and X_i^* is total-world endowment of that factor, then the trade structure among countries will possibly be like this: country A will be the exporter of factor services

$X_1, X_2, \ldots, X_j$ and the importer of factors $X_{j+1}, X_{j+2}, \ldots, X_n$. In other words, countries will be the exporters of their abundant factor(s) services.
The framework presented by Vanek produced this result: whereas in the former investigations of trade structure of countries only the two factors were allowed for, after Vanek framework a larger number of factors were possibly taken into account and therefore further studies based on Vanek proved H-O Theorem.

2.2 Literature overview

The framework presented by Vanek, known as Heckscher- Ohlin-Vanek theorem, ended in the result that in the following studies in order to elaborate on the causes of trade formation among countries a larger number of factors such as human capital, technology, and energy were taken into account. For instance Maskus et al (1994) analyzed trade pattern between US and UK and listed 17 factors, including 5 natural resources, 4 types of physical capital, and 8 skill classifications for labor. Although After labor and capital, energy is the most important factor in production and can be an important driver of geographic specialization (Michielsen, 2011); however, in spite of the large literature on factor endowments and the pattern of trade, few papers have analyzed the role of energy in detail.

Hillman and Bullard (1987) examined the H-O theorem for US trade structure on the basis of Vanek theorem and for resolving the Leontief paradox they employed energy as a factor of production for the first time. They viewed energy as a non produced input symmetric with labor and capital. They used US input-output table of 1963 and 1967 and a three-factor model of capital, labor force, and energy. Their results confirmed H-O theorem. Based on Vanek theorem, they calculated US relative factor endowments and the result was as follows:

$$\frac{L}{L^*} > \frac{K}{K^*} > \frac{E}{E^*} \qquad (2)$$

They concluded that the United States exhibited a comparative disadvantage in energy-intensive output, so the US imports energy-intensive goods.

Gavelin (1983) employed physical capital, human capital and technology as factors of production and examined H-O theorem in a regression model for Sweden. In addition to these factors, he said that since Sweden is presumably relatively well endowed with energy, primarily in the form of hydroelectric power, therefore energy was tentatively introduced as a forth factor. But He mentioned that energy coefficient was positive but never significant. Therefore it was not reported. His results show that since Sweden is well endowed with human capital, so there is a significant positive relation between human capital and net exports.

One of the first effects of trade is that it enables producers to separate location from demand so that they tend to move to countries abundant in factors for which the sectors need relatively large inputs (Gerlagh & Mathys, 2010). So goods are produced in the abundance places and then are transfered to the other places. Employing this effect, Ellison and Glaeser (1999) used a list of 20 sources of comparative advantages; including electricity, natural gas and coal, to explain the location of industry within US states.

Gerlagh & Mathys (2010) studied the effect of countries energy abundance on trade and sector activity. They found out that (i) energy abundant countries have a high level of energy embodied in exports relative to imports. (ii) For energy intensive sectors, net exports are larger in energy abundant countries, and (iii) sector activity is higher in these countries. In short, energy is a major driver for sector location through trade. Michielsen (2011) on the basis of H-O theorem analyzed the relationship between factor endowments, trade pattern and sector location. They studied the effect of energy resource abundance on industry location within the US. Their result shows that energy abundant states can benefit from low domestic energy prices through attracting more energy intensive sectors and firms.

2.3 Iran export structure

One of the characteristics of Iran's economy that has influenced all its economic sectors and relations is its endowment of abundant energy resources. Iran owns the third largest oil resources and the second largest gas resources in the world (BP 2011). Due to abundant energy resources, energy consumption is very high in Iran and this consumption is increasing constantly in a way that energy per capita consumption in 2007 has become more than four times and a half as much as it was in 1971. Iran has higher energy per capita consumption than countries such as China, India, Brazil, Turkey, Malaysia, and Portugal. Also, in production sector the proportion of energy consumption to GDP, which indicates the energy intensity of goods, has been rising constantly in a way that the energy required to produce a unit (dollar) of GDP from 1.88 in 1971 (Barrels of Oil per $1000 GDP) has increased to 7.14 in 2007. The growth of this proportion has been far more in manufacturing sector so that with an increase from 0.4 in 1971 to 4.1 in 2007 it signals a 440% growth. It could be said that manufactured goods export in Iran is in fact a cover for the indirect export of oil and gas. This indicates the high dependence of manufacturing sector on energy input and the sensitivity of this sector to supply and energy price.

Based on what was said, on the one hand, Iran enjoys abundant energy resources and on the other hand, manufactured goods, as the major sector of non-oil export, are highly energy intensive. In fact, it can be said that that because of the relative abundance of energy in Iran and its inexpensiveness, many sectors by employing this input attempt to produce and export energy intensive goods at a lower price and in this way they are provided with a spurious advantage. The following diagram obviously illustrates the positive relation between energy intensity (EI) and export. The horizontal axis indicates energy intensity and the vertical axis indicates the export quantity for two-digits ISIC classified codes.

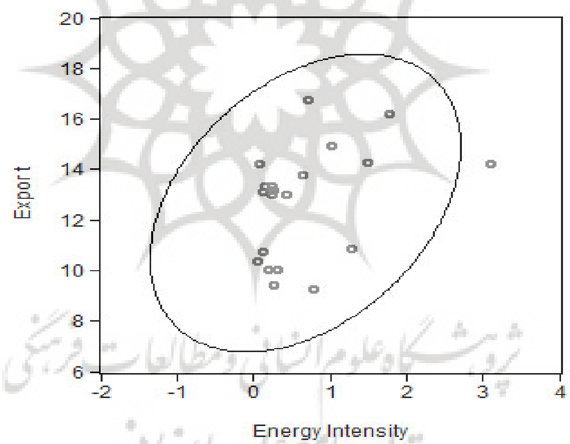

Fig. 1. Energy intensity and export nexus

As it is evident, there is a high correlation between energy intensity and export quantity which confirms the theory that manufactured goods are energy intensive.

3. Data, Methodology, and Model

Data required for this study involve the annual data for the period from 2000 to 2007 which have been mainly taken from domestic resources. Data concerning the value-added and export concerning two-digit ISIC classified codes are extracted from Statistics Center of Iran and energy carriers prices are taken from power ministry balance sheets. These three variables have been deflated using price index of 1997. Exchange rate data were taken from International Macroeconomic Data Set. All the variables and abbreviations are mentioned in the following table. It should be noted that i) indicates class, while *t* indicates time.

Table 1- Abbreviations and short description of examined variables

Abb	Description of variable
$lexp_{it}$	Logarithm of export
$lvad_{it}$	Logarithm of value added
$lrer_t$	Logarithm of real exchange rate
$lelecp_t$	Logarithm of electricity price
$lgasp_t$	Logarithm of natural gas price
$loilp_t$	Logarithm of fuel oil price

This study seeks to investigate the effects of changes in the price of electricity, gas, and fuel oil on various sectors according to Extraversion respectively. For doing so, two-digit ISIC classified codes are classified into four groups based on their Extraversion. For making this classification, the share of export from the value-added has been employed. This proportion has been calculated for the years between 2000 and 2007 for 23 subdivisions of two-digit ISIC classification the average is shown in the table below. On the basis of this proportion, the amounts larger than 0.2 are placed in group A, the amounts between 0.05 and 0.2 in group B, the amounts between 0.01 and 0.05 in group C, and the amounts smaller than 0.01 in group D. it should be noted that group D has been left out of the calculations because it is too small. Thus, the other 20 subdivisions have been placed within 3 main groups. In the econometrics model these three groups have been separated by using a dummy variable.

Table 2- ISIC classification codes and sub division

ISIC classification code	Description	Share of export from value added	Group
15	Manufacture of food products and beverages	0.19	B
16	Manufacture of tobacco products	0.03	C
17	Manufacture of textiles	0.15	B
18	Manufacture of wearing apparel	0.07	B
19	Manufacture of leather and related products	0.69	A
20	Manufacture of wood and of products of wood and cork, except furniture	0.02	C
21	Manufacture of paper and paper products	0.03	C
22	Printing and reproduction of recorded media	0.00	D
23	Manufacture of coke and refined petroleum products	0.06	B
24	Manufacture of chemicals and chemical products	0.60	A
25	Manufacture of rubber and plastics products	0.10	B
26	Manufacture of other non-metallic mineral products	0.09	B
27	Manufacture of basic metals	0.36	A
28	Manufacture of fabricated metal products, except machinery and equipment	0.08	B
29	Manufacture of machinery and equipment n.e.c.	0.06	B
30	Manufacture of computer, electronic and	0.00	D
31	Manufacture of power supply and transport equipments	0.09	B
32	Manufacture of TV radio and electronic tools	0.02	C
33	Manufacture of medical and optical tools	0.02	C
34	Manufacture of motor vehicles, trailers and semi-trailers	0.04	C
35	Manufacture of other transport equipment	0.17	B
36	Manufacture of furniture	0.02	C
37	Manufacture of recoverable products	0.00	D

The first step before model introduction and estimation is to investigate if the variables are stationary. Recent literature suggests that panel-based unit root tests have higher power than unit root tests based on individual time series. For unit root test, LLC test has been employed. This test has been chosen for these two reasons; first it is applicable to small T, large N panels, second, Westerlund and Breitung (2009) have demonstrated that the local power of the IPS test is always smaller than that of the LLC test. Table 1 reports the results of unit roots tests.

Table 3- Panel unit root test results

variable	statistic	prob
$lexp_{it}$	-4.3847	0.0000
$lvad_{it}$	-3.5163	0.0002
$lrer_{t}$	-2.0021	0.0226
$lelecp_{t}$	-1.4186	0.0780
$lgasp_{t}$	-15.9077	0.0000
$loilp_{t}$	-2.5862	0.0049

After ensuring that variables are stationary and are not spurious, it is possible to consider model estimation. The methodology employed in this study is panel data, the advantage of using this methodology is the possibility of simultaneous consideration of time disparity and sectional disparity. In this way, there is the possibility of estimating the export function in various sections, within the time period of the study. Then, using Random Effects model three separate models will be estimated for three carriers of electricity, gas, and fuel oil in each of which different coefficients will be calculated for each of the three export groups (A-B-C). The reason behind choosing these three carriers is the fact that on average these three carriers contribute to 89% of the total energy consumption in manufacturing sector.

The intended model for analyzing the sensitivity of the manufacturing export to the price of energy is based on Khan and Knight's export supply function model which has been used in many studies as the main framework and in which export supply is dependent on GDP and relative prices. However, since this model's variables are not enough for explaining export, in many studies, according to circumstances and researcher's goals, price and non-price factors are included in Khan's model. Knight and Khan's export supply function is based on this hypothesis that producers maximize their benefit under the cost constraint. As a result, supply function positively depends on exchange rate and negatively on the prices of the inputs. For instance, for estimating steel export function of Ukraine, Chornyy (2010), using Khan's model, presents a model in which export depends on capital cost and labor cost.

In accordance with the present study's goals, suggested models for Iran's manufacturing export supply are as follows:

$$lexp_{it} = \alpha + \beta_1 lvad_{it} + \beta_2 lrer_t + \beta_3 lelecp_t + \varepsilon_{it} \quad (3)$$
$$lexp_{it} = \alpha + \beta_1 lvad_{it} + \beta_2 lrer_t + \beta_3 lgasp_t + \varepsilon_{it}$$
$$lexp_{it} = \alpha + \beta_1 lvad_{it} + \beta_2 lrer_t + \beta_3 loilp_t + \varepsilon_{it}$$

However, as was mentioned before, sectors are divided into three export groups and this study seeks to investigate the effects of changes in the price of energy carries on each these groups separately. It is expected that an increase in the proportion of export to value-added will result in an increase in sensitivity to the price of energy as an abundant and inexpensive input. In other words, it is likely that changes in energy price will affect group A more than groups B and C. it is due to disparity in intensity of energy consumption. The average intensity of energy within the time period of the study for the three groups is as follows:

EI_A =0.93 EI_B =0.79 (4)
EI_C =0.41

Because of this, in each of these models separate coefficients have been calculated for energy price by using three dummy variables. The result of estimation of sensitivity of export to electricity price is as follows:

Table 4- Results of model estimating for electricity

variable	coefficient	t-statistic	prob
c	-12.8747	-3.8160	0.0002
lvad	1.0994	17.0320	0.0000
lrer	0.6882	2.2375	0.0267
lelecp(A)	-.39914	-4.7203	0.0000
lelecp(B)	-0.09429	-2.0036	0.0469
lelecp(C)	.013853	2.1749	0.0312
			r^2=0.797

As it is evident, all the variables are statistically significant. Coefficients of value-added variable and exchange rate variable are both positive which are in accordance with economic theories. When value-added coefficient is larger than exchange rate coefficient, it is an indication that the former's effect is more than the latter's. In terms of price, as was expected, the variable's coefficient is negative which indicates the reducing effect of increase in price of electricity on manufactured export which, in turn, confirms the H-O theorem. However, the main point in this field is the different sensitivities of the three export groups to energy price. As was explained, the major advantage of manufactured export of Iran is employing inexpensive energy resources, therefore with an increase in energy price; those sectors that export the major part of their production will suffer most. On this basis, it is observed that a 1% change in electricity price reduces the export quantity of group A by 3.9%, this amount is four times as much as that of group B which indicates that the subdivisions of this group, like steel, are energy intensive. In group C, the coefficient of electricity price is positive because of two reasons: the intensity of energy consumption in this group is low, thus because of low dependence on energy its sensitivity to changes in energy price is very small. Second, in the subdivisions of this group, production depends on factors other than energy such as technology, production of medical equipment, or machinery for producing paper goods. In fact, this group does not depend much on energy; therefore, energy price does not have reducing effects on the export quantity of this sector. The findings of estimation model for gas are like this:

Table 5- Results of model estimating for natural gas

variable	coefficient	t-statistic	prob
c	-12.0089	-7.2438	0.0000
lvad	1.0863	19.7458	0.0000
lrer	0.6167	4.5017	0.0000
lelecp(A)	-.26238	-6.5088	0.0000
lelecp(B)	-0.05847	-2.8867	0.0045
lelecp(C)	0.09566	3.6145	0.0004
			r^2=0.801

It is evident that all the variables are statistically significant and have the same sign as the previous model. The estimated coefficients for value-added and exchange rate are very close to estimated coefficients for the previous model. However, the coefficient for the gas price is less than that of electricity price. This difference indicates that manufactured exports are less sensitive to gas price than to electricity price. This is likely to be so due to the dependence of technology on electric equipment. Since the majority of Iran’s machinery and equipment is imported and the greater part of this equipment uses electricity, the sensitivity of sectors to changes in electricity price is higher. Moreover, since 73% of Iran’s export is related to two groups of 24 and 27 and the proportion of electricity consumption in these two groups is increasing constantly (diagram 5), export is expected to fall sharply as the electricity price rises. The third model is concerned with fuel oil, the findings of this model are as follows:

Table 6- Results of model estimating for fuel oil

variable	coefficient	t-statistic	prob
c	-9.4101	-2.9195	0.0040
lvad	1.0384	13.2756	0.0000
lrer	0.3897	1.6348	0.1041
lelecp(A)	-0.20102	-5.8922	0.0000
lelecp(B)	-0.05671	-2.7047	0.0076
lelecp(C)	0.05593	1.8750	0.0627
			r^2=0.810

It can be seen that the coefficients of this model have the same sign as the two previous models. Smallness of coefficient of fuel oil price indicates that among the three factors sensitivity to oil price is the slightest one. This is likely to be due to the small contribution of fuel oil to manufacturing sector in a way that fuel oil contributes only to 7% of energy consumption in manufacturing sector.

4. Conclusion

This study was concerned with this question: do the changes in the price of energy carriers have any effect on manufactured export in Iran? The findings of this study reveal that the intensity of energy consumption in manufacturing sector is high and that in this sector production is highly dependent on energy consumption. The estimation of Regression Model indicates that in Iran manufactured export along with exchange rate and value-added depends on energy price and energy price affects manufactured export negatively. Also, this study points out to the fact that those sectors that export the major part of their production are more sensitive to the changes in energy price and this is due to highness of energy intensity in these sectors. In other words, an increase in exporting produced goods brings about an increase in the energy intensity of production process and, as a result, sensitivity to energy price rises. In those groups that export smaller quantities of their value-added, the export is not negatively affected by energy price. This is probably because in these groups production depends on other factors such as technology. Although these findings are applicable to the three carriers, the proportion of sensitivity to electricity price is higher than other energy resources. This is due to dependence on the imported machinery which is electrically-operated. This research also reveals that the amount of coefficient of energy price is higher than other variables. The highness of the amounts of this negative effect is an indication of high dependence on energy input which confirms this theory that manufactured goods are exported mainly because of using inexpensive energy input.

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