**Is Leontief Paradox Satisfied in Foreign Trade in Iran?**

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In Wassily Leontief’s study of the structure of U.S. foreign trade, he came to conclusion that the United States specializes in labor-intensive lines of production. This is a surprising conclusion for the US developed economy that an average million dollars' worth of exports embodies considerably less capital and somewhat more labor than would be required to replace from domestic production. This subject then became famous as Leontief Paradox in the foreign trade literature. Since Iran is known to have a far higher labor/capital ratio than its trading partners. The question is whether or not the Leontief Paradox is satisfied in foreign trade in Iran? The result may contradict the basic Ohlin model which explains international trade in terms of relative factor endowments. The main data source is a- 91 commodity input-output table and import table for 2001, at the national level. There are two factors: capital and labor.

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1. **Introduction**

International trade countries enable them to participate in and maximize their profit. Each country may have specialized in one or more activities in which have comparative advantage. International trade in terms of comparative advantage factor of endowment was originally developed classical theory of the late eighteenth and the early nineteenth centuries and still constitute the basis of international trade (Leontief 1953). The most famous international trade theory is called Heckcher –Ohlin (H-O) theory.

The H-O theory is most widely understood in , two-good and two- primary factor, and two country with trade and a country will export products which uses intensively its relatively abundant resource and will import products which are intensive in scare resource in that country. In Wassily Leontief’s study of the structure of U.S. foreign trade using H-O model, he came to conclusion that the United States specializes in labor-intensive lines of production (Leontief 1953, 1956). This is a surprising conclusion for the US developed economy that an average million dollars' worth of exports embodies considerably less capital and somewhat more labor than would be required to replace from domestic production. This subject then became famous as Leontief Paradox in the foreign trade literature.

The main aim of this paper is to investigate whether or not the Leontief Paradox is satisfied in foreign trade in Iran? To answer this question, the H-O model is tested for Iranian case. Moreover we also test Heckcher –Ohlin-Vanek model that was suggested by Leamer (1980) and Leamer and Brown (1981) to resolve the Leontief Paradox. In the later, we use a multidimensional extension of twotwo model known as H-O-V model, in which equates the factors embodied in a country’s net exports to the country’s excess supplies of factor endowments. Since Iran is known to have a far higher labor/capital ratio than its trading partners. The result may contradict the basic Heckcher-Ohlin-Vanek model. For this purpose paper is organized as follows: in the next part an overview of Iranian international trade will be explored. In the third part, the theoretical background of international trade in HOV framework is explained. In the fourth section, data base and data adjustment and computations are revealed. In the final section conclusions will be drawn.

1. **Iranian International Trade**

International trade contributes significantly to Iran’s economy and has increased dramatically over the past few years. Iran as one of developing countries appears to be an assumption that has comparative advantage in the production of commodities which in their production uses more labor. Iran also as the second largest oil producer in the Organization of the Petroleum Exporting Countries (OPEC), its oil and gas reserves rank among the world largest. As figures in Table 1- indicate the 1973 oil price bust send the economy spiraling into crisis which has been repeated in 1980 and more or less continued to increase or decrease Iran’s oil export revenue and as a result on its foreign trade. Oil and gas undoubtedly constitute the most important industrial sector to Iran’s economy. As Table 2- shows the oil sector’s share of fixed GDP has declined from 30-40% in the 1970s to 10-20%, largely due to destruction of production facilities during the war and OPEC output ceilings and sanctions. Nevertheless, oil revenue accounts for the majority of export earnings and presents the bulk of government revenue (about 40%). This sector also receives the majority of domestic and foreign investment. The oil and gas sector is heavily state-dominated. While oil export revenues have spiked in recent years due to a surge in oil prices, Iran’s oil output has remained essentially flat.

Iran’s dependence on oil export revenues makes the country highly susceptible to the volatility of international oil prices. The quadrupling of global oil prices since 2002 has given Iran enormous economic leverage. Steadily rising oil export revenues provide a cushion to the extent to which Iran’s economy is affected by international sanctions. Iran also has been working to reduce its dependence on oil export revenues by building up other sectors of its economy. In an attempt to diversify its exports, Iran also is building up its petrochemicals industry. The industry reportedly faces some challenges from state intervention and price-fixing.

Iran’s non-oil exports have increased dramatically, which the government cites as a testament to its increased diversification. Non-oil exports, thus, may be able to alleviate economic harm from a future drop in oil prices, although the economy likely would still suffer. Because Iran’s economy is largely dependent on oil export revenues, Iran is developing its natural gas sector in an effort to diversify its economy. In addition, natural gas production would help increase export earnings and help to meet growing domestic consumption demands for electricity.

International trade contributes significantly to Iran’s economy and has increased dramatically over the past few years. As figures in Table-1 shows for some of years the share of total trade was exceeded to more than 90 percent. The highest dependency to the oil export in the last 50 year has been observed in 1973 in international oil price shock period. Similar to other countries in the Middle East and North Africa region, Iran benefitting from high world oil prices. The main aim of all macroeconomic plans has been to reduce the dependency to oil export and increase non-oil exports before and after Islamic revolution. As oil export figures in table1- show, absolute oil export has been increase with the average rate of % 3.6 yearly in fixed price, but its share has been fluctuated. In some years increased and some other decreased, the least share is in 2006 with more than %56 and still there is big gap between aim and implementation.

|  |  |
| --- | --- |
|  | **Table 1**- Export and Import in Fixed Price 1997- billion rials |
| **Year** | **Total Export** | **Oil and Gas** | **Other items** |  **Oil Export share** | **Total Import** | **Net Export** |
| 1959 | 14736 | 13286 | 1450 | 0.902 | 9010 | 5726 |
| 1960 | 16273 | 14953 | 1320 | 0.919 | 9189 | 7084 |
| 1961 | 18245 | 16827 | 1418 | 0.922 | 8753 | 9492 |
| 1962 | 20650 | 19327 | 1323 | 0.936 | 8084 | 12566 |
| 1963 | 22744 | 21360 | 1384 | 0.939 | 7648 | 15096 |
| 1964 | 25568 | 24091 | 1477 | 0.942 | 10729 | 14839 |
| 1965 | 29758 | 27968 | 1790 | 0.940 | 12353 | 17405 |
| 1966 | 33475 | 31864 | 1611 | 0.952 | 14049 | 19426 |
| 1967 | 38903 | 37088 | 1815 | 0.953 | 17456 | 21447 |
| 1968 | 44439 | 42277 | 2162 | 0.951 | 20978 | 23461 |
| 1969 | 52578 | 50327 | 2251 | 0.957 | 23421 | 29157 |
| 1970 | 59253 | 56704 | 2549 | 0.957 | 25228 | 34025 |
| 1971 | 69449 | 66045 | 3404 | 0.951 | 30148 | 39301 |
| 1972 | 79428 | 76103 | 3324 | 0.958 | 35059 | 44369 |
| 1973 | 88541 | 78745 | 9796 | 0.889 | 44523 | 44018 |
| 1974 | 86921 | 77612 | 9309 | 0.893 | 79991 | 6930 |
| 1975 | 78036 | 68364 | 9672 | 0.876 | 120909 | -42873 |
| 1976 | 86522 | 78145 | 8377 | 0.903 | 118229 | -31707 |
| 1977 | 79730 | 71278 | 8453 | 0.894 | 134009 | -54278 |
| 1978 | 58031 | 51135 | 6896 | 0.881 | 93402 | -35371 |
| 1979 | 45219 | 38954 | 6265 | 0.861 | 70413 | -25194 |
| 1980 | 15327 | 11396 | 3931 | 0.744 | 71825 | -56498 |
| 1981 | 13690 | 11737 | 1953 | 0.857 | 68068 | -54378 |
| 1982 | 26467 | 24953 | 1514 | 0.943 | 60733 | -34266 |
| 1983 | 32260 | 30266 | 1994 | 0.938 | 84265 | -52004 |
| 1984 | 25604 | 23784 | 1820 | 0.929 | 57908 | -32305 |
| 1985 | 23190 | 21608 | 1581 | 0.932 | 53889 | -30700 |
| 1986 | 19407 | 18500 | 907 | 0.953 | 46920 | -27513 |
| 1987 | 28327 | 22881 | 5446 | 0.808 | 51612 | -23285 |
| 1988 | 32299 | 27837 | 4462 | 0.862 | 43924 | -11625 |
| 1989 | 34866 | 29339 | 5527 | 0.841 | 52991 | -18125 |
| 1990 | 44290 | 36375 | 7915 | 0.821 | 69743 | -25454 |
| 1991 | 51880 | 39784 | 12096 | 0.767 | 92826 | -40946 |
| 1992 | 53717 | 40782 | 12935 | 0.759 | 84378 | -30661 |
| 1993 | 62002 | 43196 | 18806 | 0.697 | 67809 | -5807 |
| 1994 | 66008 | 39698 | 26310 | 0.601 | 41337 | 24672 |
| 1995 | 52266 | 38389 | 13877 | 0.734 | 40953 | 11313 |
| 1996 | 53562 | 39997 | 13565 | 0.747 | 47816 | 5746 |
| 1997 | 51007 | 37542 | 13465 | 0.736 | 44728 | 6279 |
| 1998 | 56345 | 38107 | 18238 | 0.676 | 44887 | 11458 |
| 1999 | 57516 | 37659 | 19857 | 0.655 | 42521 | 14995 |
| 2000 | 58479 | 39913 | 18566 | 0.683 | 46047 | 12431 |
| 2001 | 57393 | 35538 | 21855 | 0.619 | 54006 | 3387 |
| 2002 | 62206 | 36836 | 25370 | 0.592 | 66566 | -4360 |
| 2003 | 70013 | 42931 | 27082 | 0.613 | 80262 | -10249 |
| 2004 | 69933 | 44635 | 25298 | 0.638 | 90636 | -20703 |
| 2005 | 73664 | 44619 | 29045 | 0.606 | 92645 | -18981 |
| 2006 | 79585 | 46259 | 33326 | 0.581 | 99241 | -19657 |

Source: www.cbi.ir, National Accounts

As figure 1- shows, the share of foreign trade share has been reduced in the last 60 years from the highest share %97 in 1975 to %38 in 2006, the lowest share is %33 in 2000, the degree of openness in the economy has been reduced and the oil exports share is also have reduced sharply after 1979.

**Figure 1**- Export, Foreign trade, and Oil Export Shares

When we look at the export and import separately, after oil as most of the export items, the basic export items are: pistachios, liquefied propane, methanol (methyl alcohol), hand-woven carpets and automobiles are the core items of Iran's non-oil exports. Iran's exports of technical and engineering services in 2007–08 were $2.7 billion of which 40% of technical services pertained to Central Asia and the Caucasus, 30% ($350 million) to Iraq, and close to 20% ($205 million) to Africa. [Iranian firms](http://en.wikipedia.org/wiki/List_of_Iranian_companies) also have implemented projects in different fields such as energy, pipelines, irrigation, dam construction and power generation in different countries. The country has made the development of non-oil exports a priority and has the advantage of a broad domestic industrial base, an educated and motivated workforce as well as a favorable location, which gives it access to an estimated population of some 300 million people in [Caspian](http://en.wikipedia.org/wiki/Caspian_Sea) markets, Persian Gulf states and some [ECO countries](http://en.wikipedia.org/wiki/Economic_Cooperation_Organization) further east. But the combination of imports is different. Capital and consumer goods imports decreased after the 1979 Revolution, with capital goods falling from 30 percent of total imports in 1979 to 15 percent by 1982. Import of luxury goods was restricted to conserve foreign currency and preserve the balance of payments. Food imports increased despite the emphasis on agricultural self-sufficiency. Food imports in early 1986 consumed as much as 20 percent of total foreign exchange. Iran had become one of the largest per capita purchasers of wheat in the world, buying 3.4 million tons annually. The nation spent about US$3 billion per year on food items such as wheat, rice, meat, vegetable oil, eggs, chicken, tea, and sugar. By December 1986, Iran's imports of meat and dairy products alone exceeded the value of the country's entire industrial output.

The total volume of imports to Iran rose by 189% from $13.7 billion in 2000 to $39.7 billion in 2005 and $55.189 billion in 2009. Iran is among the few countries that has maintained positive GDP growth despite the [2008 global financial crisis](http://en.wikipedia.org/wiki/Financial_crisis_of_2007%E2%80%932010). Iran's major commercial partners are [China](http://en.wikipedia.org/wiki/People%27s_Republic_of_China_%E2%80%93_Iran_relations), [India](http://en.wikipedia.org/wiki/India%E2%80%93Iran_relations), [Germany](http://en.wikipedia.org/wiki/Iran-Germany_relations), South Korea, [Japan](http://en.wikipedia.org/wiki/Iran%E2%80%93Japan_relations), [France](http://en.wikipedia.org/wiki/Iran-France_relations), [Russia](http://en.wikipedia.org/wiki/Iran-Russia_relations) and [Italy](http://en.wikipedia.org/wiki/Iran-Italy_relations). From 1950 until 1978, the [United States](http://en.wikipedia.org/wiki/United_States-Iran_relations) was Iran's foremost economic and military partner, playing a major role in the modernization of its infrastructure and industry. Since the mid 90's, Iran has increased its economic cooperation with other [developing countries](http://en.wikipedia.org/wiki/Developing_country) in "[south-south integration](http://en.wikipedia.org/wiki/South-South_Cooperation)" including [Syria](http://en.wikipedia.org/wiki/Iran%E2%80%93Arab_relations), India, China, [South Africa](http://en.wikipedia.org/wiki/Iran-South_Africa_relations), [Cuba](http://en.wikipedia.org/wiki/Cuba%E2%80%93Iran_relations) and [Venezuela](http://en.wikipedia.org/wiki/Iran%E2%80%93Venezuela_relations). Iran's trade with India passed the $13 billion mark in 2007, an 80% increase in trade volume within a year. Iran is expanding its trade ties with [Turkey](http://en.wikipedia.org/wiki/Iran-Turkey_relations) and [Pakistan](http://en.wikipedia.org/wiki/Iran-Pakistan_relations) and shares with its partners the common objective to create the [ECO](http://en.wikipedia.org/wiki/Economic_Cooperation_Organization), a single economic market in West and Central Asia.

Since 2003, [Iran](http://en.wikipedia.org/wiki/Iran) has increased investment in the economic development and reconstruction of neighboring countries such as Iraq and Afghanistan. In [Dubai](http://en.wikipedia.org/wiki/Iran%E2%80%93Arab_relations#United_Arab_Emirates), [UAE](http://en.wikipedia.org/wiki/UAE), it is estimated that [Iranian expatriates](http://en.wikipedia.org/wiki/Iranian_citizens_abroad) handle over 20% of its domestic economy and account for an equal proportion of its population., and geared towards providing Iran and other countries with required consumer goods. It is estimated that one third of Iran's imported goods and exports are delivered through the [black market](http://en.wikipedia.org/wiki/Black_market), underground economy, and illegal jetties and there can be characterized their items. According to Business affair and ministry of trade report the basic combination of imported items since 1973, can be classified in three periods that is shown in table 3. As table 3- shows the consumption goods share have not been changed in two periods 1985-1995 and 1996-2006. But the share of capital goods have been increase sharply in the 1996-2007 period and the share of intermediate goods decreased during three periods. After a brief study of the composition of exports and imports the question about capital or labor intensity of export and import remained unanswered. To answer to this question in the following section we review the theoretical background of the international trade theory and, in the next section we empirically test it in the Iranian case.

**Table 3**- Basic Imported Items: Capital, Intermediate and Consumption Goods Shares in 1973-2006 periods

|  |  |  |  |
| --- | --- | --- | --- |
| 1996-2006 | 1985-1995 | 1973-1984 | Items |
| 74/31 | 06/24 | 24/23 | Capital Goods |
| 03/52 | 61 | 04/65 | Intermediate Goods |
| 08/14 | 69/14 | 31/19 | Consumption goods |

Source: Balanced Sheet of Central Bank of Iran (1973-2006)

1. **Theoretical background**

For application of a general equilibrium approach to the explanation of the level of composition of the trade between a country and the rest of the world, we would have to possess concrete quantitative information about:

* The endowment of the trading countries with detailed primary factors of production;
* The shape of the production functions, *i.e.,* of the input-output relationships which explain how each country transform the primary resources into various goods and services;
* Preference choice among alternative bundles of finished commodities through alternative combination of domestic production and foreign trade.

The immediate objective of the original inquiry is to determine the amounts of capital and labor required for the production in the country under study to produce a unit worth of two alternative composite commodities, one defined as the country exports and the other as the country competitive import. In a real national economy the amount of capital or labor required for the production for export or final domestic use can be determined through the summation of as many separate capital and labor inputs as there are distinct sectors in the economy. Each industry participate direct or indirect in the production process of commodities, consequently contribute at least some part of its own capital and labor to the total quantities of these factors used by system as a whole for the production of final output. So, the total direct and indirect, dependence of the output of each industry on the final demand for product of any other industry is determined by the input-output structure of all sectors of the economy. The original input-output table shows the direct input requirements of the each industry for the products of other industries. This can be transformed into the new table called Leontief Inverse. Each array of Leontief Inverse show how much the total output of each sector would be raised to satisfy direct and indirect requirements corresponding one unit money worth of additional deliveries to final demand.

To reach to capital and labor requirements, given the quantities of capital, labor or any other factor employed by each industry per unit of its output called capital or labor direct coefficients. Then these coefficients can be multiplied by the appropriate rows of the Leontief inverse. A column-by-column summation of the entries in each of these tables yields the quantities of the respective factor absorbed through the economy as a whole per money unit worth of final deliveries made by each of its productive sectors.

To consider international (foreign) trade into the calculations, in the input-output structure, export show how much money worth of final output of each industry are exported. Total quantity of Labor and capital factors requirement for export are obtained as weighted sum of the corresponding requirements of each of its many separate components. There are two types of import: competitive and non-competitive imports. The first type is competitive imports or comparable imports for which there are direct domestic substitutes. The other type import is non-competitive imports or non-comparable imports for which there are not direct domestic substitute. To replace one unit of money’s worth of competitive imports we would have to raise the output of the corresponding industries. If competitive imports assumed to be cut proportionally all along the line, the domestic production would have increase by the amounts equal to reduction in the imports. Such domestic production for replacing imports would mean additional direct and indirect capital and labor requirements. To compute the total amount of capital requirements to produce domestically the amount of imports would have to multiply the competitive import vector by the corresponding capital coefficients requirement in the production process in the country. An analogous calculation yields the corresponding labor requirements.

In the input-output system with foreign trade (export and import) in the final demand vector Leontief pointed out equation (1),

  (1)

Or 

which;

 is column vector of outputs of the  sectors of the economy,

 is the value of total export of all  sectors in money unit,

is the value of total competitive imports into all  sectors,

 is a square matrix of input coefficients,

 is a column vector of export coefficients,

 is a column vector of competitive import coefficients

 is a row vector of non-competitive import input coefficients,

 is a column vector of final demand.

is that part of total non-competitive imports which is allocated to final uses.

The computation of capital and labor requirements per money unit of competitive import replacements can be calculated through the below equations:

Capital requirements can be calculated by equation (3),

 (3)

Labor requirements also is possible to calculate through equation (4):

  (4)

In which  and  are row matrices of direct capital and labor coefficients respectively. Leontief (1953) found that domestic capital and labor requirements per million dollars of US export and of competitive import replacement of average 1947 prices composition are as follow:

 Exports Import Replacements

Capital (dollars, in 1947 prices)  

Labor (man years)  

These figures can be interpreted as follows: on the basis of the relative quantities of capital required for their production,  units of export could be substituted in the output of US country for each unit of competitive imports. In terms of labor costs the corresponding ratio is  units of export for each unit of competitive import. First rate is larger than the second which means that an increase in the supply of capital would tend to reduce, and alternatively a rise in supply of labor to expand the volume of the US foreign trade. The substitution rate of exports for competitive imports expressed in terms of their comparative capital requirements which is larger than corresponding substitution rate based on the comparative labor costs i.e.



 exceed 1.  can be identified as an index of comparative capital-labor intensity in the production of competitive import and export goods. When  then the country is labor intensive, otherwise when  the country is capital intensive. These figures show that average million dollars’ worth of US export embodies considerably less capital and somewhat more labor than would be required to replace from domestic production an equivalent amount of competitive imports. The US economy compared with the rest of the world is characterized by a relative surplus of capital and relatively shortage of labor, this result proves to be wrong and opposite is true. This result in the international trade showed that the conventional trade theory- the two-factor Hecksher-Ohlin model does not provide an accurate explanation of the composition of US trade. Since then is known as “Leontief paradox” in the international trade literature.

 In Leontief (1956) and Kreinin (1965) attempt have been made to find an interpretation for such results, they explained that the productivity of labor in US is three times more than the rest of the world *i.e.* regardless of technological type, in any combination with a given quantity of capital, one American labor is equivalent to three man years of foreign labor, so the total number of American labor must multiply by three which would increase US labor. In direction of resolving “Leontief paradox”, other scholars Hardness and Kyle (1974), attempted to measure the simultaneous impacts of a variety of factors in the determination of US comparative advantages using logit analysis for industries in the 1958 US input-output table. They found that capital-intensity has a significantly positive impact on the comparative advantage of the US manufacturing industries. Although their results are reasonable, but H-O hypothesis test by using a regression of trade of many commodity on their factor input requirements for single country were continued by many scholars such as: Balswin 1971, Branson and Monoyios 1977, Hardness 1978, 1983, Stern and Maskus 1981, Leamer and Bowen 1981, they shown that this model is also inappropriate inference in a multifactor world since there is no guarantee that the signs of the regression coefficients will reveal the abundance of a resource.

Leamer 1980 and Bowen *et. al. (1987*), Leamer and Bowen (1981*)* reconsidered Leontief paradox by using Heckscher-Ohlin-Vanek (HOV) model of trade. They pointed out that H-O hypothesis twotwo model required three pair-wise comparisons: trade, factor input requirements, and factor endowment. So they used a multidimensional extension of the twotwo model known as the Heckscher-Ohlin-Vanek (HOV) theorem, which equates the factors embodied in a country’s net exports to country’s excess supplies of factor endowments. They argue that the basic test of H-O hypothesis (Leontief 1953) does not reveal the relative abundance of capital and labor in multifactor world, because he uses data on trade and factor input requirements but not factor endowments for a single country (US). In Leamer (1980), HOV model are explained fully and here we define briefly: HOV model shows a country is revealed to be relatively well endowment in capital compared with labor if and only if one of the following three conditions holds,



 (5)



Where,,,, and  are capital and labor embodied in net exports and consumption. He believes that the computation by Leontief in the form of  is theoretically inappropriate and Leontief used nonetheless false proposition (Leamer 1980). He also believe that the true proposition is if the NET export of labor services is the opposite sign of the net export of capital services, but when both are positive as Leontief’s study, the proper comparison is between the capital per man embodied in net exports and the capital per man embodied in consumption. He mentioned that such consideration of the Leontief paradox rests on the Heckscher-Ohlin-Vanek theorem that was proved by Vanek in 1968. So the Leontief paradox has been solved by Leamer’s computation, those are shown in Table 4.

**Table 4**- Capital Intensity of Consumption, Production, and Trade US 1947

|  |  |  |  |
| --- | --- | --- | --- |
|  Factor | Production | Net Exports | Consumption |
| Capital ($million) | 328.519 | 23.450 | 305.069 |
| Labor (million man-years) | 47.273 | 1.99 | 45.28 |
| capital/labor | 6.949 | 11.783 | 6.737 |

Source: Leamer 1980

According to the HOV model of Leamer’s computation on Table 4- the US is revealed to be capital abundant case and there is no paradox. In a very comprehensive study, Leamer (1984) examined trade patterns for over hundred countries and found that actual patterns could be explained fairly well by endowment-based model with ten factors, including capital, several types of natural resources and land, and three skill classes of labor. A few years later Bowen *et. al.* (1987) computed the amount of twelve factors embodied in the net exports for twenty-seven countries on the basis of 1967 US input-output table of total input requirements. These factors were then compared with the relative factor abundance of twenty- five countries. Their results show there was no correspondence between the two, contradicting the HOV model.

As HOV theorem works under certain assumptions: all factors are perfectly immobile and all commodities are freely mobile internationally, all individuals have identical homothetic preferences, production functions are the same and exhibit constant return to scale for all countries. Factor prices are equalized across countries. Trefler (1993) criticized to the HOV assumptions and pointed out to three elements: a) equalization of price factors, b) identical of technology, and c) no productivity differences. He has explored more Leontief’s original productivity explanation and could correct the productivity differences. His results show that in 1947 the US was labor abundant and Leontief was right, contrast with Leamer (1980) approach. Since 1980, HOV model have been tested empirically by many scholars. As the base of HOV theorem developed by 1968 by Vanek was according to the international trade and factor abundant of multi-countries, in most of the studies it is used for many countries (for example; Maskus 1985, Bowen *et. al.* 1987, Brecher and Choudhri 1988, Kohler 1991, Trefler *et. al.* 2010, Trefler and Chun 2000, Trefler 1993, Maskus and Shuichiro 2009). Iran as country of study has not been considered. Moreover, Wolf (2004) tested the continuation of the Leotief paradox in the United States for the period of 1947-1996 and found that imports are more capital – and equipment- intensive than are exports, but the difference in intensity between the two has fallen over the time. Several studies of the Leontief Paradox have also been conducted on inter regional (such as Polenske 2001 using Japan data) or cross industry (such as Leamer 1980 and Leamer and Bowen 1981 for a single country). In this study we apply single country HOV model for Iranian trade case.

1. **Data Base and Results**

In this section the Leontief Paradox is investigated for 2001 Iranian case. in the empirical part the attempt has been made to answer to the main question of this study. For this purpose two data sources are applied. The first, a 1919- industry of 2001 input-output table, that has been constructed by Statistical Centre of Iran (SCI 2007), and the second and the third sets of our statistical data capital and labor inputs are collected as follows: a) direct capital requirements of each industry from capital consumption in the value added matrix 19-industry input-output table as the ratio of capital/output by industry have not been prepared yet. b) Direct labor requirement is collected from SCI site. For purpose of our computation we also consider the total import in the value added matrix as competitive import, because is not possible to separate non-competitive and competitive imports, that is not exactly match with special theoretical assumptions of the model.

|  |
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| **Table 5-** Capital and Labor Requirements per Million Rials of Iranian Export and Import Replacements, 2001 |
|  **Sector** | Exports per million rials of total export |  Imports per million rials of otal import | Requirements per Million rials of Exports and Imports Replacements | Comparison of exports and imports requirements |
| Capital | Labor (Man) |
| exports | import replacement | exports | import replacement | capital  | labor (Man) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Total** | **1,000,000** | **1,000,000** | **9,936,033** | **12,696,231** | **1,085,531** | **2.362.562** | $$<$$ | $$<$$ |
| **1. Agriculture** | 51,444 | 87,383 | 403,669 | 828,245 | 406,801 | 834,670 | $$<$$ | $$<$$ |
| **2. Mining** | 663,660 | 9,038 | 3,699,885 | 327,150 | 69,012 | 6,102 | $$>$$ | $$>$$ |
| **3.Food, Drink, and Tobacco** | 10,441 | 82,404 | 50,944 | 234,794 | 14,590 | 67,241 | $$<$$ | $$<$$ |
| **4.Textile** | 28,687 | 35,303 | 380,026 | 1,446,915 | 73,471 | 279,732 | $$<$$ | $$<$$ |
| **5.Covering and Leather**  | 9,687 | 54,542 | 13,663 | 60,835 | 24,848 | 110,639 | $$<$$ | $$<$$ |
| **6.Wood and wood products** | 447 | 2,318 | 6,395 | 22,686 | 5,653 | 20,054 | $$<$$ | $$<$$ |
| **7.Paper** | 327 | 19,420 | 31,526 | 253,225 | 5,134 | 41,235 | $$<$$ | $$<$$ |
| **8.Chemical industry** | 73,202 | 158,011 | 499,114 | 964,309 | 44,218 | 85,430 | $$<$$ | $$<$$ |
| **9.Non-metal industry** | 6,699 | 11,438 | 69,637 | 137,574 | 15,296 | 30,218 | $$<$$ | $$<$$ |
| **10.Basic and metal industry** | 15,841 | 98,450 | 149,842 | 879,890 | 28,450 | 167,060 | $$<$$ | $$<$$ |
| **11.Machinery**  | 8,969 | 347,236 | 50,574 | 1,146,214 | 6,817 | 154,505 | $$<$$ | $$<$$ |
| **12.Other manufacturing** | 929 | 2,292 | 6,149 | 20,208 | 5,276 | 17,340 | $$<$$ | $$<$$ |
| **13.Water, electricity, and gas** | 5,212 | 1,040 | 639,758 | 1,102,791 | 19,337 | 33,332 | $$<$$ | $$<$$ |
| **14.Construction** | 1 | 0 | 13,452 | 19,656 | 11,332 | 16,559 | $$<$$ | $$<$$ |
| **15.Wholesale and retail sale** | 44,387 | 5,909 | 254,308 | 395,939 | 155,621 | 242,290 | $$<$$ | $$<$$ |
| **16.**Transportation and Communications  | 65,216 | 54,261 | 2,646,061 | 3,075,048 | 159,332 | 185,163 | $$<$$ | $$<$$ |
| **17. Finance, Banking, insurance** | 7,961 | 15,730 | 752,689 | 1,308,459 | 13,383 | 23,265 | $$<$$ | $$<$$ |
| **18.Public services and defense** | 6,688 | 14,287 | 251,783 | 441,909 | 21,939 | 38,506 | $$<$$ | $$<$$ |
| **19.Other services** | 199 | 938 | 16,560 | 30,383 | 5,025 | 9,219 | $$<$$ | $$<$$ |

Sources: SCI input-output table 2001, employment SCI site: www.SCI.ir,

The principal numerical results of computations designed to calculate the quantities of domestic capital and labor required to produce one unit of money’s worth of Iran export or alternatively, to replace an equivalent amount of competitive imports (here total import), the results are summarized in table 5 using (3) and (4) equations.

As table-5 shows the comparison of input requirements for export and import for all sectors are the same i.e. net capital requirement and net labor requirements are negative except for mining sector in which includes mainly oil sector. The principal findings of the quantitative factual analysis are aggregated and summarized in Table 6. In table-6 total domestic capital and labor requirements per million rials of Iran’s exports and imports replacement are shown. In table 6- figures show that an average million rial’s worth of exports embodies considerably more capital and somewhat less labor than would be required to replace from domestic production an equivalent amount of imports. Therefore, Iran’s participation in the international trade is based on its specialization on capital intensive, which is not true. Iran’s economy is known by a relative surplus of labor especially educated labor and relative shortage of capital. The meaning of this result is that there exists a comparative surplus of capital and scarcity of labor in this country. As table-6 shows for 18 sectors out of 19 net export is negative and only one sector with positive and highly positive net export (oil sector). Oil sector is strongly capital intensive sector, that could play significant role for the $α$ measure in table 6 to be less than unit.

|  |
| --- |
| **Table 6 –** TotalFactor Intensity of 2001 Iran’s Exports and Imports (Lenotief index) |
|   |  Export  |  Import  |
| Capital (million Rials in 2001 price) |  9936033 | 12696231 |
| labor (thousands man-years) |  1085531 |  2362562 |
| capital/labor |  9.153 |  5.373 |

According to the results on table 6- , so the country is capital intensive according to the Leontief index of HO model.

In contrast with HO Leontief model, in which the comparison is between the capital per man embodied in a million worth of exports with the capital per man embodied in a million dollars worth of imports, leamer 1980 showed this comparison does not reveal the relative abundance of capital and labor in multifactor world. His approach is discussed in detail in section three, and in this part we test it for Iranian economy in 2001. The computations were made according to the equations (5) and their results are shown in Table 7.

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| --- |
| **Table 7**- Capital Intensity of Consumption, Production, and Trade Iranian case (Test of HOV equations) |
|  Factor | Production | Net exports | Consumption |
| Capital (billion Rials) |  81800 |  (-2760) |  84560 |
| Labor (thousands man-years) |  12368 |  (-1277) |  13645 |
| (Thousands) Rial capital/labor (man-year) |  6614 |  2161 |  6197 |

Table 7- reports the information on the performance of HOV models and indicates that Iran in 2001 was a net importer of both capital services and labor services, and since net exports are more labor intensive than consumption, so Iran is revealed by its trade to be relatively well endowed in capital compared with labor.

1. **Conclusions**

In this paper we investigated the Leontief paradox for Iranian economy. Since Iran is known to have a far higher labor/capital ratio than its trading partners. In this direction attempt has been made to answer to this question: whether or not the Leontief Paradox is satisfied in foreign trade in Iran? Answer is YES. Testing HO Lenotief index and HOV model for the 2001 in the 19-sector input-output table, for both the Leontief paradox was satisfied and Iran export is capital intensive.

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