Leontief Paradox: A re-Examination for Egypt

Seham H. Negem

***Abstract*—**An empirical test of the H-O model was carried out by Wassily Leontief using his invention called the input-output table for the United States, classified as the most capital abundant nation in all over the world. Therefore, one would expect that the US exports are more capital intensive relative to the US imports. However, Leontief's results showed that the US seemed to export labour intensive goods and import capital intensive ones. A re-examination for Egypt, known to have a higher labour/capital ratio than its trading partners, shows that Leontief statistic for 2007 data of the factor requirements per million dollars of the Egyptian exports and imports is 0.34; less than 1.00 and as a consequence, Egypt seems to be a capital abundant country; contradicting the H-O theory prediction. This result confirms the existence of Leontief paradox in the foreign trade of Egypt. Another investigation was executed using the same data, with excluding the crude oil sector that is characterised by strongly capital intensive in production. Expectedly, the results show that Leontief statistic became 1.29; greater than 1.00, meaning that Egypt seems to be labour abundant country. Our conclusion is that Leontief paradox exists or not relying on the sectors' factor requirements on which an investigation of the H-O model is based. Some sectors confirm the existence of Leontief paradox and others do not within the same country.

***Keywords*—** Leontief Paradox, H-O model, Input-output table, International trade, Labour intensive goods, Capital intensive goods, and Leontief statistic.

I. Introduction

1.1. Theoretical background of the Heckscher-Ohlin Model:

To remedy some of shortcomings of Ricardian model, like there is only one factor of production and everyone wins from trade, both Heckscher (1919) and Ohlin (1933) analysed the effects of factor endowments on international trade, focusing on the relationships between the composition of countries' factor endowments and good trade patterns as well as the consequences of trade liberalisation for the functional distribution of income within countries. Trade liberalisation causes an increase in the factor price of production that is used in the export industry and a fall in the other factor price used intensively in the import competing industry. To be seen as a particular case of the neoclassical model, their model links the trade pattern of a country to its comparative advantage that is determined by international differences in relative factor endowments. Factor endowment is defined by the ratio of capital to labour departing from Ricardian model since there are two factors of production, capital and labour, instead of labour only, i.e. if the labour-capital ratio in country A is greater than in country B, country A is said to be relatively labour-abundant (and capital-scarce), while country B is capital-abundant (and labour-scarce). The similarity of production technologies in both countries is another different respect from the Ricardian model. Also, unlike the Ricardian model, the H-O model forecasts that the prices of factors will be equalised between countries that trade.

With no transportation costs and no policies restricting the movement of goods between countries, the existence of both may prevent goods prices and factor prices from equalising, they assumed, to simplify their analysis, that there are two countries, two homogenous goods, and two homogenous factors of production whose initial levels are fixed and assumed to be relatively different for each country (for more details see Appleyard et al., 2010). It is worth notable that using more than one factor of production affects the production possibilities frontier (PPF) that is no longer a straight line. It is assumed that, technology is identical as stated; i.e., production functions are similar in both countries meaning that there are no productivity differences. Moreover, production is characterised by constant returns to scale technology.

The absence of returns to scale guarantees that only relative factor endowments are important despite one country may possess a larger endowment of each factor than another. A strong assumption of the H-O model is that tastes are identical in the trading nations. When these are not identical, they may cause the prices of the same good to differ. The most important assumption is that the two goods have different relative factor intensities, that is what drives trade patterns between the two countries, and the factors are perfectly mobile within but not across countries. For their analysis, there are no market distortions; that is, perfect competition prevails. According to Krugman and Obstfeld (2012), competition allows factor of production to be paid a competitive wage and allows factors to be used in the industry that pays the highest wage/rate.

Based on the model, in simple context of two-country, two-factor, two-good trade ($(2*2*2)$, the country with abundant (scarce) in labour will export (import) goods that use labour intensively. Moreover, the model predicts that the owners of

Seham H. Negem**,** Faculty of Commerce, Tanta University, Egypt.

abundant factors will gain and the owners of scarce factors will lose from trade. The country is said to be relatively labour abundant if the ratio of labour to that of capital domestically exceeds the corresponding proportion abroad. This is right for capital abundant as well. Also, a good is said to be labour-intensive if the ratio of labour to capital used in its production is high compared to other goods. By focusing on the factor intensities among the goods, the model guides us to who gains and who loses from trade.

The H-O trade theory, referred to as the factor proportions theory, is criticised for its restriction to the low dimensionality represented by two countries, two factors of production, and two commodities with world markets that are full of many commodities. Another criticism concerns with the highly simplified assumptions on which the model is based upon like perfect competition and same technology, etc. It is notable that the significant percentage of world trade that is carried out by large corporations that work on the basis of monopoly and oligopoly (not on perfect competition). Also, based on the new trade theory, it is assumed that all varieties of a certain type of product are produced using the same factor proportions ruling out the H-O theory to explain trade patterns, unless, these varieties differ in quality; meaning that each variety could differ in factor requirements. Recently, it is argued that a large fraction of the world trade is that among developed countries rather than between developed and less developed or developing countries (who have very different endowments). Given that, the H-O theory seemed to be inconsistent with empirical evidence.

1.2. H-O empirically estimated test of Leonteif:

However, an empirical test of the H-O model, the principal normative setting for the general equilibrium theory of international trade, was carried out by Leontief using his invention called the input-output table for the United States. This table describes the actual flow of goods and services among all the different parts of a country's economy. On the basis of its statistical information, we can determine the effect of any given increase or decrease in the level of output in any one sector of the economy upon the rate of production in all the other sectors (for more details, see Leontief, 1953).

It is known that the US is classified as the most capital abundant nation relative to the rest of the world. So, according to the H-O model, one would expect that the US exports are more capital intensive relative to the US imports (positive net import of man-hours). This expectation could be evaluated as to its validity using the Leontief statistic that is defined as follows:

$$\frac{(K/L)_M}{(K/L)_X}$$

Where, $(K/L)_M$ refers to the capital/labour ratio used to produce imports (for leontief test, import-competing or substitutes goods) and $(K/L)_X$ refers to the same ratio used to produce exports. Based on the H-O model, this statistic might be with a value less than 1.0 and a consequence, a country would be a relatively capital abundant (as the denominator would be larger than the numerator). On the other hand, the leontief statistic might be greater than 1.0. In this case, the country would be a relatively labour abundant.

Leontief analysis was based on a 200 industry 1947 input-output table of the US which was broken down into fifty sectors, (38) of which their products were traded directly on the international market. The capital and labour embodied within the exports and imports replacements goods were computed using the mentioned year data. His estimation procedure started by pointing out the matrix constituting of vectors labour (L) and capital (K) requirements per unit of output as follows:

$$D = \begin{bmatrix} L \\ K \end{bmatrix} = \begin{bmatrix} L_1, L_2, \ldots\ldots L_n \\ K_1, K_2, \ldots K_n \end{bmatrix} \text{ Where, n=1,2,3,……50}$$

This *D* matrix can be multiplying by the direct and indirect requirement matrix $(I-A)^{-1}$ to yield, say, Y matrix through which the total direct and indirect labour and capital requirements can be computed as a result of multiplying the row vectors of exported and imported goods to Y matrix. Another detailed version for the computation process, based on Leontief, can be stated (for more details see Bazzazan, 2012). With the final demand vector, an equation was pointed out by leontief in the context of the input-output table as follows:

$$\begin{bmatrix} I-A & -x \\ -r & I \end{bmatrix} \begin{bmatrix} Y \\ X \end{bmatrix} + \begin{bmatrix} m \\ -1 \end{bmatrix} M - \begin{bmatrix} d \\ d_m \end{bmatrix} = 0 \quad (1)$$

Or,

$$\begin{bmatrix} Y \\ X \end{bmatrix} = \begin{bmatrix} I-A & -x \\ -r & I \end{bmatrix}^{-1} \left\{ - \begin{bmatrix} m \\ -1 \end{bmatrix} M + \begin{bmatrix} d \\ d_m \end{bmatrix} \right\} \quad (2)$$

Where, *Y* is the column vector of outputs of the *n* sectors of the economy, 5 for our study, *X* is the value of total export of all *n* sectors in money unit, *M* is the value of total competitive imports into all *n* sectors, *A* is a square matrix of input coefficients, *x* is a column vector of export coefficients, *m* is a column vector of competitive import coefficients, *r* is a row vector of non competitive import input coefficients, *d* is a column vector of final demand, and finally d_m is that part of total non competitive import which is allocated to final uses. So, the total direct and indirect labour and capital requirements can be computed using the row vectors of exported and imported goods as shown in both equations 3 and 4.

$$[K\ 0]\begin{bmatrix} Y \\ \\ X \end{bmatrix} = [K\ 0]\begin{bmatrix} I-A & -x \\ \\ -r & I \end{bmatrix}^{-1}\begin{bmatrix} m \\ \\ -1 \end{bmatrix}M + \begin{bmatrix} d \\ \\ d_m \end{bmatrix} \quad (3)$$

$$[L\ 0]\begin{bmatrix} Y \\ \\ X \end{bmatrix} = [L\ 0]\begin{bmatrix} I-A & -x \\ \\ -r & I \end{bmatrix}^{-1}\left\{\begin{bmatrix} m \\ \\ -1 \end{bmatrix}M + \begin{bmatrix} d \\ \\ d_m \end{bmatrix}\right\} \quad (4)$$

Where, *K* and *L* are the domestic capital requirements and labour capital requirements, respectively, for both exports and competitive import replacements.

By using the 1947 input-output structure of the US economy, as stated above, Leontief expected to find that US export capital intensive goods and import labour intensive goods, the results showed the opposite trend. The US seemed to export labour intensive goods and import capital intensive ones; contradicting of the H-O theory prediction. More precisely, the US exports were less capital-intensive and were 30% more labour-intensive than the US imports substitutes (replacements). This was labelled Leontief paradox. Further test used the 1951 US trade data carried out by leontief as well. Its results showed that the US imports were 6% more capital-intensive, reducing the magnitude of the previous paradox. The results of leontief paradox can be showed using the following table.

TABLE 1
CAPITAL AND LABOUR REQUIREMENTS IN THE US EXPORTS AND IMPORT SUBSTITUTES

Year for input-output Structure (I-O) and trade pattern	Factor requirements per million dollars of product	Exports	Competitive imports	Ratio imports to Exports (Leontief Statistic)
1947	Capital stock	$2550789	$3091339	
	Labour (person-years)	182	170	
	Capital/labour ratio	$14010	$18180	18,180/14,010= 1.3 0 >1.00

From the above table, it is clear that the US exports goods use only $14010 of capital per man-year of labour while the imported ones require $18180 of capital per man-year, indicating that the exports of the US was labour-intensive goods in return for capital-intensive goods.

To explain his results, Leontief (1953) argued that the US is abundant in labour measured in what is called productivity equivalent workers. He claimed that the US labour was far more productive than that of the US exporters (countries from which the US import). As such, if input of the US labour was adjusted by a factor of two or three, the US would be classified as a labour abundant. According to Verma, this claim was not accepted. It was 1947 where the US labour and Capital both were more productive than those were in the other countries. Therefore, the US were still to be ranked as a highly capital-intensive country.

It is said that adding the human capital component to the physical capital, which the US labour embodies more than foreign labour and was ignored in Leontief's calculations, would make the US exports more capital-intensive relative to US import substitutes. Also, an important consideration in determining the patterns of the US trade is knowledge capital (R&D). This was not considered by Leontief in his study. As a defence, it is said that the usage of two-sector model by Leontief might have been a source of bias because a good might be intensive in natural resources so that classifying it as either capital or labour intensive would be inappropriate. Leontief type tests for the other countries have been re examined; taking into consideration the natural resources (for more details, see Vanek, 1963 and Baldwin, 1971).

Here, it is clearly known that Egypt has higher labour/capital ratio than is its trading partners; such as Italy and the US. The primary purpose of our paper is to answer the question that is: does Leontief paradox exist for international trade of Egypt? It tries to empirically test the H-O model of the capital and labour intensity using the Egyptian trade data and thereby examine the leontief paradox in this regard. According to Schluter and Lee (1978, 165), some of the investigators of Leontief paradox phenomenon involved making new empirical tests on the basis of new data, different data, or both.

Given that an investigation is examined for Egypt in 2007. This investigation concerns the applicability of the H-O model using the leontief statistic. Top five commodities (sectors), exported and imported by Egypt, are used to re examine the test. For this, the remainder of this paper is organised as follows: Section 2 introduces an overview of the foreign trade policy framework of Egypt, illustrating the developments of both Egyptian Exports and imports and indicating the most important partners for the exports of Egypt. In section 3, data and test computations are presented, with discussing the main findings. Finally, section 4 concludes.

II. FOREIGN TRADE POLICY FRAMEWORK OF EGYPT: AN OVERVIEW

This section introduces the Egyptian trade policy framework, with concentrating on the year after 1974 (the period of *El infitah* and serious steps to liberalise trade). From the 1970s Egypt attempted to move away from a highly centrally planned and controlled economy, towards one based on market principles and openness (Morley and Perdikis, 2000). The modernisation process, initiated in 1974 was an attempt to address the obstacles facing industrial development in Egypt, such as the limited capacity for import due to foreign exchange shortage, the poor productivity of labour and capital as a result of inefficiency of industrial management, scarcity of skills and qualified manpower and infrastructural bottlenecks (El Din, 1986). In addition, there was strong emphasis on the absence of competitive market practices and the way this undermined the efficiency of public sector companies, which

had a monopolistic position in the domestic market in the period 1960-1970 (for more details, see Negem, 2008).

In the period of "*El Infitah*", which means openness, increasingly, liberal foreign trade and cooperation with international economic institutions attracted private and foreign capital and foreign military and economic aid, as well as rising tourism revenues and an inflow of workers' remittances, making the 1970s a period of unprecedented growth. Moreover, the government encouraged international oil companies to expand exploration in Egypt. The exploitation of natural gas made it possible to release more oil for export. Despite the attempts from the 1970s to reduce restrictions on trade, in the early 1990s, Egypt seriously dismantled restrictions on trade when the Egyptian government adjusted the exchange rate to reflect market forces and broadened access to foreign exchange. Egypt has gradually moved towards a more liberal trade regime. It began to adopt the harmonized code system in February 1994.

Egypt is deeply interested in the WTO agricultural negotiations as both a net food importer and as a country which has substantial potential in exporting fruits and vegetables. In sectors where Egypt has a competitive advantage, WTO negotiations on market access for agricultural products should take into account market access preferences provided by existing or future bilateral trade agreements between Egypt and major trade partners. Furthermore, Egypt is interested in those bilateral trade agreements that provide for better market access to Egyptian exports products to major markets.

The Egyptian textiles and clothing sector wishes to have a sound assessment on the impact of the phasing out of quotas, the accession of China to the WTO, and the outcome of the WTO negotiations on market access and trade remedies. Egypt is convinced that a right orientation of the sector in those matters and the lowering of trade barriers will help in the structural changes in the sector. And there will be an acceleration of customs clearance, both in Egypt and the importing countries, which is expected to have a positive impact on trading activities. The Egyptian service sector has substantial potential for both exports and the domestic market. A crucial factor for the development of export activities is that the sector acquires an improved understanding of the WTO rules on service. Another important sector is pharmaceutical production. This sector is interested in any changes resulting from the full implementation of the WTO TRIPS agreement after 2005.

Another source of concern is the pressure on the sector to accept TRIPS-plus disciplines. Finally there are serious impacts of the multilateral trade negotiations of the Doha Round on the Egyptian activities in all sectors like agricultural, services, textiles and clothing and pharmaceuticals. Under Egypt's trade liberalization program and in accordance with its World Trade Organization (WTO) obligations, Egypt has made progress in reducing tariffs. The Egyptian customs started to implement the invoice-based system for the assessment of import duties on 1st July 2001. On this date the government of Egypt began implementing phases two and three of General Sales Tax Law 11 of 1991, extending value added tax (VAT) to the wholesale and retail levels. The government collects sales tax from merchants either monthly or quarterly, depending upon turnover. The only industries exempted from full immediate implementation are the gold, woodworking, and spinning & weaving industries. The taxes on these industries, which were also treated separately under the previous tax regime, were phased in over 6-12 months. Egypt has lowered its import tariff rates. In 1998, it reduced the maximum tariff rate for most imports by 50% to 40%.

However, Egypt's tariff rates are still relatively high by international standards, with average weighted tariff rates of 27.5%. Most tariff rates are within the range of 10-40 %; toys, watches, and clocks have the highest (40%). The Egyptian government applies high import tariff rates on products which compete with domestic products and threaten related industries. For example, imported vehicles with engines larger than 1,600cc are subject to a 135% tariff rate. Also, for protection of Egypt's clothing industries, specific duties are levied. For example, the import duty for a man's suit is about 1,000 Egyptian pounds. A sales tax ranging from 5% to 25% is imposed on the final customs value of the imported items, besides customs tariffs. On most imports, a service fee is levied based on the value of imported items in return for inspecting, listing, classifying and re-examining these items. The rate charged is 3% for commodities liable for customs duties of 5-30% and 6% for those liable for duties over 30%.

2.1. Exports of Egypt

Concerning exports, Egypt is an exporter of agricultural products, light manufactures (including textiles) and petroleum. Egypt is also developing an export capacity of natural gas. Petroleum and natural gas contribute significantly to the economy, accounting for 8% of GDP in 2002/03 and nearly 40% of merchandise of exports. The following table illustrates Egypt's merchandise exports.

The natural gas sector is expanding rapidly due to the major recent discoveries. The production in this sector increased over 30 percent between 1999 and 2011. This production is sourced in the Nile delta region and in Western desert. According to the *Journal of the Oil and Gas*, Egypt's estimated proven gas reserves stand at 58.5 trillion cubic feet; this represents 1 percent of world reserves. As a result, natural gas has become the primary growth engine of Egypt's energy sector for the foreseeable future and Egypt has become a leading supplier of natural gas through the Mediterranean region.

Regarding the most expansive export project, we can say that it is the Arab Gas Pipeline that currently connects Egypt to Syria and Jordan. Egypt exported 32.2 billion cubic feet in 2008, raised to 77.3 billion cubic feet in 2013. An agreement between Turkey, which was described as an ideal market for Egypt's gas exports, and Syria to connect this pipeline to the Turkish grid, signed in 2008, extending the pipeline into

Europe for export to Austria, via Bulgaria, Romania, and Hungary. Recently, Libya agreed to build a natural gas pipeline between Alexandria and the Eastern Libyan city Tobruk, to import gas from the Nile Delta region.

TABLE II
MERCHANDISE EXPORTS OF EGYPT (1987 $MILLION)

	Value of all merchandise exports	Merchandise export (% GDP)
1980	4,248	10.48
1981	4,097	10.11
1982	3,723	9.190
1983	3,687	9.101
1984	3,450	8.517
1985	1,947	4.806
1986	2,285	5.641
1987	2,037	5.029
1988	2,041	5.039
1989	2,440	6.024
1990	2,281	5.631
1991	3,106	7.668
1992	2,524	6.231
1993	3,110	7.677
1994	3,480	8.591
1995	3,450	8.517
1996	3,540	8.739
1997	3,920	9.677
1998	3,130	7.726
1999	3,560	8.788
2000	4,690	11.58
2001	4,750	11.72
2002	4,910	12.12
2003	5,213	12.86
2004	5,120	12.63
2005	5,340	13.18
2006	5,430	13.40
2007	19,224	15.21
2008	26,223	15.82
2009	23,062	19.06
2010	26,438	11.72
2011	30,528	5.76
2012	28,034	5.18
2013	27,526	4.99

-Source: Own calculations based on IMF and International Financial Statistics.
- From 1993 to 2000, World Development Indicators, 2002, World Bank and from 2001-2013, Ministry of Industry and Trade of Egypt. Note: U.S. GDP deflator used to convert to 1987 Dollars.

It is worth mentioning that, economically, the Egyptian government made a great mistake when signing an agreement in 2005 to export natural gas to Israel for 20 years (60 bcf per year) for a price less than the average price, wasting this vital source of energy without the approval of parliament. Also, Egypt's government is renegotiating the price that France and Spain pay. As a result, no new contracts to export natural gas were signed until the Egyptian government thinks that world prices have stabilized. However, there is a debate about the effect of this ban on the share of Egyptian natural gas due to foreign companies working in Egypt. Currently, Egypt has no direct export subsidies. Under its commitments to the World Bank, the Egyptian government has increased energy and cotton procurement prices and reduced indirect subsidization of exports like subsidized inputs, credit facilities, and customs rates.

The exports of commodities of interest, for some selected recent years, are indicated in the following table:

TABLE III
TOP 5 PRODUCTS EXPORTED BY EGYPT FOR RECENTLY SELECTED YEARS
(VALUE IN MILLION US$)

Exports	2009	2010	2011	2012	2013	gr%	GR%
1- Crude oil and its products	6935	7597	9237	8850	7553	8.91	-(23)
% of TX	**(29.9)**	**(27.8)**	**(29.1)**	**(30.4)**	**(26.5)**		
2- Agriculture products without Cotton	2819	2872	2751	2494	2796	-0.81	(2)
% of TX	**(12.1)**	**(10.6)**	**(8.9)**	**(8.5)**	**(9.8)**		
3- Food stuffs	758	1355	1330	1220	1412	86.28	(0)
% of TX	**(3.5)**	**(5.1)**	**(4.1)**	**(4.1)**	**(4.9)**		
4- Metal products	2117	2807	3161	2501	2590	22.34	-(30)
% of TX	**(9.1)**	**(10.3)**	**(10.1)**	**(8.5)**	**(9.1)**		
5- Chemicals	2550	3166	3740	3532	3553	39.33	(19)
% of TX	**(11.3)**	**(11.7)**	**(11.7)**	**(11.9)**	**(12.5)**		

Source: The Central Agency for Public Mobilization and Statistics (CAPMS).
Notes: - TX refers to total exports.
- Numbers between brackets are own calculations based on tables 3 and6.
- GR is the growth rate for each commodity based on a comparison between quarterly data of 2013 and 2014 (from Jan-Mars) obtained from the CAPMAS.
- gr% is own calculations of the growth rates from the start to the end of the period from 2009-2013.

From the above table, Table 3, the export shares of individual sectors under consideration from 2009-2013 are shown. We find that the exports of crude oil and its products rose from 2009 to 2013 by 8.91%. As a result of the rising in domestic consumption, this rising turned into the negative trend in the first quarter of 2014 (see the last column of the table). The agriculture exports fell by 0.81% and rose compared with the first quarter of 2014. This fall might happen as a result of excluding the exports of raw cotton. Exports of food stuffs achieved the greatest growth rate for the period stated. It was 86.28%; however it was no change compared with the first quarter of 2014. Also, the exports of metal products rose by 22.34 %; however, they fell by 30% in the first period of 214 and finally, exports of chemicals achieved higher growth rate, 39%, and kept going up for the period January-March 2014.

Concerning the most important partners for the Egyptian exports in the beginning of the 21st century, the following table indicates them.

From this table, it is obvious that Italy continues to represent the greatest market for Egyptian exports. It is worth notable that, along the last years, Spain, Holland, France, and UK did not be listed at the top of Egyptian export destinations; while Turkey was listed as one of the top Egyptian export partners in 2013.

This is an overview of the developments of exports, but what about the imports?

TABLE IV
THE MOST IMPORTANTMARKETS FOR EGYPTIAN EXPORTS FOR SELECTED YEARS(% TX)

TP	2001	2002	2003	2004	2007	2008	2009	2011	2012	2013
Italy	2.4	3.1	4.8	6.2	16.8	8.0	9.4	9.7	7.9	7.9
U.S.	2.2	2.5	3.3	3.7	5.8	7.9	7.1	4.9	6.9	6.8
Spain	1.9	0.9	1.8	2.7	7.9	-	6.1	-	-	-
Holland	1.8	1.3	1.4	2.5	-	-	-	-	-	-
India	1.6	2.6	3.0	2.4	11.3	6.4	6.2	6.3	6.9	6.9
KSA	0.8	0.9	1.1	1.4	-	4.6	4.6	4.8	5.1	6.2
Turkey	-	-	-	-	-	-	-	-	-	5.3
France	1.1	0.8	1.1	1.0	-	-	-	-	-	-
U.K	0.6	0.5	0.9	0.9	-	-	-	-	-	-
Germany	0.6	0.6	0.8	0.9	11.9	4.7	4.5	-	-	-
Libya	0.3	0.4	0.7	0.4	-	-	-	-	-	4.9

Source: Central Agency for Public Mobilization and Statistics of Egypt (CAPMS)
Notes: - TX refers to total export. -2001, 2002, 2003, 2004, & 2007 own calculations based on CAPMS.
- 2009, 2011, 2012, &2013 own calculations based on CAPMS and Table 6

2.2. Imports of Egypt

For some selected recent years, the imports of commodities, on which our test is based, are indicated in the following table.

TABLE V
TOP 5 PRODUCTS IMPORTED BY EGYPT FOR RECENTLY SELECTED YEARS
(VALUE IN MILLION US$)

Imports	2009	2010	2011	2012	2013	gr%	Growth rate %
1. Crude oil and its products	4476	7119	9281	13034	9264	106.97	-(56)
% of TM	**(10.0)**	**(15.8)**	**(20.5)**	**(29.0)**	**(20.7)**		
2. Agriculture products without Cotton	4234	5329	7956	8311	7550	78.31	-(5)
% of TM	**(7.9)**	**(10.0)**	**(15.1)**	**(15.7)**	**(14.4)**		
3. Food stuffs	1266	1808	2797	3084	2716	114.53	(9)
% of TM	**(2.1)**	**(2.9)**	**(4.5)**	**(5.0)**	**(4.3)**		
4. Metal products	7323	7120	8052	8886	8344	13.94	(0)
% of TM	**(10.5)**	**(10.2)**	**(11.6)**	**(12.8)**	**(12.0)**		
5. Chemicals	3792	4393	5147	5819	6085	60.47	-(5)
% of TM	**(5.8)**	**(6.7)**	**(7.7)**	**(8.8)**	**(9.2)**		

Source: The Central Agency for Public Mobilization and Statistics (CAPMS).
Notes: - TM refers to total imports.
- Numbers between brackets are own calculations based on tables 5 and6
- GR is the growth rate for each commodity based on a comparison between quarterly data of 2013 and 2014 (from Jan-Mars) obtained from the CAPMAS.
- gr% is own calculations of the growth rates from the start to the end of the period from 2009-2013.

From the above table, Table 5, the imports of the same individual sectors from 2009-2013 are shown. We find that the crude oil and its products imports rose by more than 100 % and so did the food stuffs. The agriculture imports without cotton rose by 78.31%. Also, imports of metal products by 13.94% and finally, imports of chemicals rose by 60.47%. For the period from the first quarter of 2013 to the same quarter of 2014, the imports of the crude oil and its products, agriculture, and chemicals fell by 56, 5, and 5 percent, respectively. However, the imports of food stuffs rose by 9 %, with no change for the imports of metal products.

The behaviour of exports, imports, and GDP of Egypt is depicted for selected years starting from 1970 in the following table.

TABLE VI
TRADE INDICATORS AND GDP OF EGYPT (SELECTED YEARS).

	GDP (US$ billion)	Exports of G&S* (U.S$) billion	Exports of G&S(%of GDP)	Exports of G&S(annual% growth)	Imports of G&S(U.S $ billion)	Imports of G&S(% of GDP)	Imports of G&S (annual %growth)
1970	7.68	1.09	14.2	9.89	1.44	18.8	14.3
(1974)	13.1	1.85	20.5	**3.97**	3.36	37.2	**37.2**
1975	13.4	2.31	20.2	**23.3**	4.72	41.3	**20.7**
1980	22.9	6.99	30.5	17.0	9.82	42.9	8.13
1985	35.9	6.91	19.9	4.1	11.1	32.0	2.98
1990	43.1	8.65	20.0	7.14	14.1	32.7	3.66
(1991)	43.9	10.3	27.8	**3.33**	13.2	35.8	**1.18**
1992	46.2	12.2	29.0	**12.9**	13.3	31.8	**-4.65**
1996	67.7	13.7	20.2	1.57	17.6	26.0	1.56
2000	98.7	15.9	16.1	10.3	22.4	22.7	2.48
2009	121.0*	23.1	19.1	28.8**	44.9	37.1	23.7**
2010	225.6*	27.3	12.1	18.2	52.9	23.5	18.2
2011	529.7	31.6	6.0	15.8	62.3	11.8	15.8
2012	541.5	29.3	5.4	-7.3	69.8	12.9	-7.3
2013	551.4	28.7	5.2	-10.0	66.2	12.0	-12

Source: Own calculations based on World development indicators 2002, World Bank.
Notes: - G&S is goods and services.
- 2009, 2010, 2011, 2012, &2013: Own calculations based on CAPMAS.
- * own calculations using GDP per capita and population of the same years.
- Numbers in bold indicate the years of trade reforms in Egypt and one year later.

** are the annual % growth of both exports and imports, respectively, for nine years based on CAPMAS.

We concentrate on the years after the 1974, as stated, and 1991 reforms. It is worth noting that the reforms had positive effects on trade terms in the year following the reforms, represented in increase in the export growth rate, but not continuous, and decrease in import rate. Export growth rate rose from 3.97 in 1974 to 23.3 in 1975 and from 3.33 in 1991 to 12.9 in 1992. Imports growth rate fell from 37.2 in 1974 to 20.7 in 1975 and from 1.18 in 1991 to -4.65 in 1992. It seems that the reforms of 1974 and 1991 had more effect on imports than on exports. Also, it is notable that the growth rates of total exports and imports have negative trends after the 2011 revolution.

III. Data, Test Computations and Findings

This section introduces an investigation of Leontief Paradox for 2007 Egyptian factor requirements of both exports and imports based on the multi commodity world. Top five commodities (sectors), crude oil, agriculture, food stuffs, metal products, and chemicals, exported and imported by Egypt, are used to re examine the test for Egypt. Another investigation is executed by excluding the crude oil sector that is characterised by strongly capital intensive of production. To construct input-output table for the mentioned sectors, our data are based mainly on knoema site for National Accounts, Input-Output table& technical coefficients matrix. The source of the original data of this site is the Central Agency for Public Mobilisation and Statistics of Egypt found at http://www.capmas.gov.eg/pages_ar.aspx?pageid=1475, updated by knoema at knoema.com/EGNAIOBP2007/national-accounts-input-output-table-at-basic-current-prices-technical-coefficients-Matrix-for-interm.The computations for capital and labour requirements of Egyptian foreign trade are based on Leontief work stated in details in the subsection titled H-O empirically estimated test of Leonteif. We calculate domestic capital and labour requirements to produce one unit of money's worth of Egyptian export and import. It is worth mentioning that, while Leontief used data on import substitutes, the US produced versions of import goods, since data on factor intensity of US imports was not available, this paper uses the data on factor intensity of the Egyptian actual imports (total). The results of computations are reported in table 7.

TABLE VII
CAPITAL AND LABOUR REQUIREMENTS PER MILLION DOLLARS OF EGYPTIAN EXPORTS AND IMPORT REPLACEMENTS, 2007

Sector	Exports per million dollars of total exports	Imports per million dollars of total imports	Requirements per million dollars of exports and import replacements				Comparison of exports and imports requirements	
			Capital		Labour			
			Exports	Import replace.	Exports	Import replace.	Cap.	Lab.
Total	**1,000,000**	**1,000,000**	**5,093,131**	**3,528,423**	**614259**	**1,266,003**	>	<
1. Crude oil	401522	218242	4036238	356891	75286	6657	>	>
2. Agriculture	263565	195079	440366	903540	443783	910549	<	<
3. Food stuffs	52157	28133	55575	256139	15916	73354	<	<
4. Metal products	92083	421301	163464	959880	31036	182247	<	<
5. Chemicals	190870	137245	544488	1051973	48238	93196	<	<

Note: own calculations using equations 3 and 4 based on data collected from knoema and CAPMAS

The requirements per million dollars of exports and import replacements as a total are used to obtain Leontief statistic. The results are shown below.

TABLE VIII
TOTAL CAPITAL AND LABOUR REQUIREMENTS PER MILLION DOLLARS OF 2007 EGYPTIAN EXPORTS AND IMPORTS

	Exports	Imports
Capital, $	5,093,131	3,528,423
Labour (thousands man-years)	614259	1,266,003
Capital/Labour	8.291	2.787

Based on the results shown in table 8, Leontief statistic = $\frac{(K/L)_M}{(K/L)_X} = \frac{2.787}{8.291} = 0.34 < 1$, so Egypt seems to be capital intensive country. This outcome of leontief statistic is not the result expected from the Heckscher- Ohlin theory; rather it confirms the existence of the Leontief paradox in Egyptian foreign trade. The capital requirements per million dollars of exports were greater than imports, $ 5,093,131 versus $ 3,528,423, and labour requirements of imports were doubly greater than that embodied in exports, meaning that an average million dollar's worth of Egypt's exports embodies more capital and less labour than would be required to replace an equivalent amount of exports from domestic production. As a consequence, Egypt's trade exchange with the rest of the world is based on specialising in capital intensive goods. That is unrealistic since the Egyptian economy is characterised by a surplus of labour and a shortage of capital. A re examination was carried out using the same data, with excluding the crude oil sector (strongly capital intensive sector). The results are reported in table 9.

TABLE IX
TOTAL CAPITAL AND LABOUR REQUIREMENTS PER MILLION DOLLARS OF 2007 EGYPTIAN EXPORTS AND IMPORTS (EXCLUDING CRUDE OIL SECTOR REQUIREMENTS)

	Exports	Imports
Capital, $	1,056,893	3,171,532
Labour (thousands man-years)	538973	1,259,346
Capital/Labour	1.96	2.52

Leontief statistic = $\frac{(K/L)_M}{(K/L)_X} = \frac{2.52}{1.96} = 1.29 > 1$. So, Egypt seems to be labour abundant country. In this case, Leontief paradox does not exist in the Egyptian Foreign trade when excluding the crude oil sector. Our findings conclude that it is just are the sectors' factor requirements on which our investigation is based. Some sectors confirm the existence of Leontief paradox and others do not within the same country. If Leontief chose to test the H-O model for agricultural trade of the US, examined later by Schluter and Lee in 1978, his paradox would not certainly have existed.

IV. Concluding Remarks

Designed to ascertain the structural basis of the Egyptian trade with its trading partners, this paper has addressed the capital and labour intensities of the Egyptian trade and thereby tested the applicability of the Leontief paradox in Egyptian trade. On the basis of an empirical testing of the model with input-output data, it is found that the Egyptian exports were more capital-intensive while imports were more labour intensive. This condition is more in the line with Leontief paradox and not in line with the expected characteristics of the Egyptian trade given its relative labour and capital endowments. However, by excluding the crude oil sector, strongly capital intensive in production, the results show the opposite. The exports of Egypt seemed to be more labour intensive and its imports seemed to be capital intensive. This is not in line with Leontief paradox; rather it is in line with the H-

O model and the facts about the Egyptian factor intensities. Therefore, our findings conclude that some sectors confirm the existence of Leontief paradox and others do not within the same country. It depends mainly on the factor requirements for each sector.

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