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BILATERAL HECKSCHER–OHLIN THEOREM MODEL AND THE PATTERN OF GREECE'S TRADE WITH THE OTHER EU COUNTRIES

Astract

In this article the Heckscher–Ohlin (H–O) Theorem in its «factor content» version is found to be valid under the existence of non-factor price equalisation conditions in the bilateral trade between two countries, in a model with three countries and many commodities. Further, the H–O Theorem is examined in the trade between Greece and the European Union (EU) countries. It is found that the differences in the pattern of specialisation in the trade between Greece and each of the EU countries is explained by differences in the relative factor endowments. The tests suggest that the H–O Model is valid in the trade between Greece and the EU countries.

JEL classification:

F11, F14

Key Words:

Heckscher–Ohlin Theorem, Greece, EU

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1. Introduction

Most Heckscher–Ohlin (H–O) type models assume that full factor price equalisation conditions exist among countries. As a result of this assumption, the empirical work performed for the test of the H–O Model uses factor intensity production data from a single country for calculation of factor intensities of exports and imports of different countries. However, recent empirical evidence suggests that factor prices are not equalised across a wide sample of countries and hence the use of a technology matrix from a single country is not justified for all countries (Elmslie and Milberg 1992, Treer 1993, Rassekh and Thompson 1993, Tsounis 1996, 2000).

The H–O Theorem, under the assumption of non-factor price equalisation has been proven to be valid in the trade between two countries in a multi-commodity, two-factor, two-country world (Brecher and Choudhri, 1982, 1988) and in the context of a general model with many factors, commodities, and countries in the trade between each country in relation to the rest of the world (Deardorff 1982, Helpman 1984, Clifton and Marxen 1984).

However, the theoretical validity of the H–O Theorem has not been examined in the bilateral pattern of the trade between countries when there are more than 2 countries under the non-factor price equalisation assumption[1].

The aim of the paper is two-fold. One aim is to examine the theoretical validity of the bilateral H–O Theorem and the second aim is to test the theory in the trade between Greece and the other EU countries by linking the factor content of trade with factor endowments, something that it has been recognized as the most appropriate test of the H–O Theorem[2] but is not easily performed in the empirical studies due to data limitations.

The paper proceeds as follows: in Section 2 the theoretical framework is presented. The section examines the validity of the bilateral H–O Theorem in its factor content version under non-factor price equalisation conditions. Section 3 presents empirical test for the validity of the bilateral H–O Model in the trade between Greece and the EU and Section 4 concludes.

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[1] Horiba (1974) has shown that the standard-assumption H-O Model with full factor price equalisation does not hold in the bilateral trade between countries in a three-country, multi-commodity, two-factor model.

[2] A selection of references for a review of the methods of testing H-O Theorem is Deardorff (1984), Courakis and Moura-Roque (1992), Leamer (1993, 1995), James and Elmslie (1996), Tsounis (1992, 1996, 2000), Helpman (1998).

2. Bilateral Trade and the «factor content» version of the H–O theory.

In the standard 2x2x2 «commodity version» of the H–O Model countries tend to export goods which use relatively intensively their abundant factor of production (Heckscher 1919, Ohlin 1933). This model can be expanded to include more countries.The direction of trade of the countries that are not at the end of the chain can be found by introducing demand. Demand conditions break the chain into exporters of the one commodity and exporters of the other. However, when the standard model is expanded to include many commodities, then, as Samuelson pointed out (1953), when there are more commodities than factors, there is an indeterminacy in the structure of production and the direction of trade may not correspond to the predictions of the basic H–O Model. As a result of that problem, attention has been directed from the «commodity» version of the model to the «factor content» version, which says that countries tend to export the services of the factors, in which they are abundant, via the goods they trade.

Vanek (1968) first introduced the «factor content» version of the H–O Theoem (which was implicit in Leontief's studies (Leontief 1953, 1956)) and proved that the country relatively better endowed with the *jth* productive factor relative to another factor *i* could never be a net exporter of productive services of the *ith* factor embodied in international barter exchange (ibid, p.755), in a model with two countries, *n* factors and full commodity-price equalisation.

Bilateral H–O Model in its «factor content» version was elegantly proved by Horiba (1974) to be invalid when more than two countries participate in trade and there is full commodity (and factor) price equalisation. Also, Deardorff (1982) proved that in a general model with many factors – commodities, countries and unequal commodity prices-the pattern of trade of each country relative to the rest of the world would be in accordance to the «factor content» version of the H–O Theorem, if the factor intensity of imports is defined by the technique used to produce them abroad, which may be quite different from those used at home.

By contrast to Horiba and Deardorff who proved, as mentioned above, that the H–O Theorem does not hold *bilaterally* when full factor-price equalisation is assumed, and that the H–O Theorem holds under *unequal* factor prices in the trade of a country with the «rest of the world», respectively; it will now be examined whether the «factor content» version of the H–O Theorem is valid for the *bilateral* pattern of trade in a model with three countries and many commodities under the assumption that factor prices do not fully equalize between countries.

For the subsequent analysis the following assumptions will be made:

1. There are three countries or group of countries *A, B* and *C*, two production factors, labour (*L*), capital (*K*)[3] and many commodities.

2. Commodity prices do not fully equalise between countries. There is, however, some movement towards commodity price equalisation. (It is not being argued that full price equalisation is impossible but only that in fact it is very rare due to trade impediments, transport costs, etc.; however, none of these will be explicitly introduced into the model examined here).

3. Technologies are the same in each country, but activated techniques of production are not asfactor prices do not fully equalise. This means that industries are producing at different points with the same production functions in different countries and; therefore, the ruling labour-capital ratios of similar industries are not the same in the three countries.

4. Factor intensity reversals are ruled out[4].

5. Constant returns to scale prevail and there is no joint production, so that technique of production can be represented by the amounts of inputs per unit of output of each commodity.

6. Identical homothetic tastes are assumed in all countries.

7. There is full employment of the production factors.

It is further assumed that $\frac{\overline{L^A}}{K^A} < \frac{\overline{L^B}}{K^B} < \frac{\overline{L^C}}{K^C}$ and that, after the introduction of trade, the following inequality is true:

$$\frac{w^A}{r^A} > \frac{w^B}{r^B} > \frac{w^C}{r^C}; \qquad (1)$$

$\overline{L}$ and $\overline{K}$ denote the total endowments of labour and capital, respectively, *w, r* are the prices of *L* and *K*, respectively, and the superscript denotes the country.

[3]Some studies of the H-O Theorem identify more than two factors of production, mainly by considering different types of capital and labour and allowing for the existence of natural resources (e.g. Harkness (1978), who identified 16 different factors of production in his study and James and Elmslie (1996), who identified five production factors). In the present study, only two factors of production have been considered, labour and capital. This was because the precise definition of natural resource industries in the sample of countries included in the empirical study (the EU countries) would be arbitrary and there was no data available for the these countries to permit further dissaggregation of labour and capital. Therefore, the model presented below assumes two factors of production, labour and capital.

[4]Jones's definition of the factor-intensity reversal criterion is adopted, according to which factor-intensity reversals do not occur at any feasible set of factor prices (Jones 1956, p.6).

In the with-trade equilibrium, under full factor-price equalisation conditions the three countries will, due to the assumption of homotheticity of tastes, consume labour and capital in the same proportions, that is:

$$\frac{L_D^A}{K_D^A} = \frac{L_D^B}{K_D^B} = \frac{L_D^C}{K_D^C} = \frac{\overline{L}}{\overline{K}}; \qquad (2)$$

where L_D^j and K_D^j denote total labour and capital consumption in country j respectively, and $\overline{L}$ and $\overline{K}$ denote total labour and capital endowments of the world ($\overline{L} = \overline{L^A} + \overline{L^B} + \overline{L^C}$, $\overline{K} = \overline{K^A} + \overline{K^B} + \overline{K^C}$)[5].

By contrast, in the world where inequality (1) is valid, equilibrium under trade is as seen in Figure 1.

Inequality (1) implies that the three countries, with the same homothetic preferences, do not consume labour and capital in the same proportions. The consumption of productive factors via the consumption of commodities depends on factor prices. Therefore, according to (1) we will have:

$$(\frac{L_D^A}{K_D^A}) < (\frac{L_D^B}{K_D^B}) < (\frac{L_D^C}{K_D^C}). \qquad (3)$$

The diagonal OG represents the factor consumption equal to the overall factor proportions $(\frac{\overline{L}}{\overline{K}})$. The endowments are measured from O to O' for labour and from O to O'' for capital.

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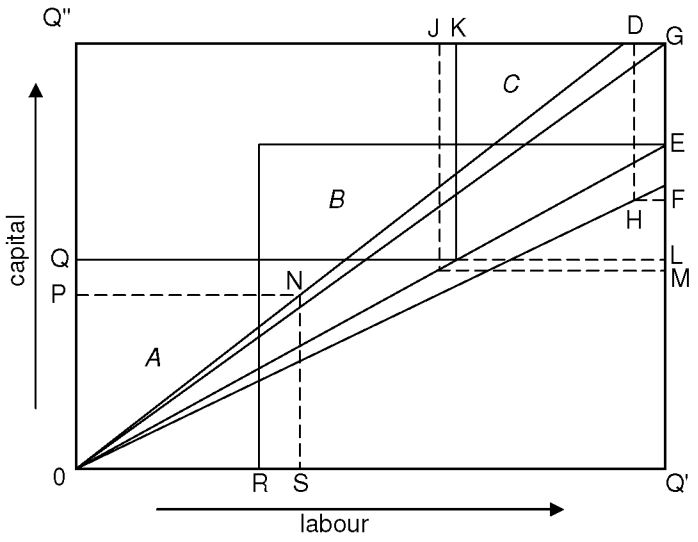
[5] L_D^j and K_D^j are defined as $\sum_i l_i^j C_i^j$ and $\sum_i k_i^j C_i^j$ respectively; l_i and k_i are the amounts of labour and capital, respectively, needed for the production of one unit of the *ith* commodity at a certain factor-price ratio. C_i^j is the consumption of commodity i in country j. Since all countries have the same homothetic preferences, the consumption of every country would be proportional to every other, so, $C_i^A = \pi_1 C_i^B$, $C_i^A = \pi_2 C_i^C$ and $C_i^B = \pi_3 C_i^C$, where π_1, π_2 and π_3 are the factors of proportionality, $(\pi_3 = \frac{\pi_2}{\pi_1})$. Also, since there is full factor-price equalisation $L_D^A = \sum_i l_i C_i^A = \sum_i l_i \pi_2 C_i^C = \pi_2 L_D^C$. Accordingly, $K_D^A = \sum_i k_i C_i^A = \sum_i k_i \pi_2 C_i^C = \pi_2 K_D^C, L_D^B = \pi_3 L_D^C$ and $K_D^B = \pi_3 K_D^C$. The total labour and capital endowments are $\overline{L} = L_D^A + L_D^B + L_D^C$ and $\overline{K} = K_D^A + K_D^B + K_D^C$. Therefore, $\overline{L} = \pi_2 L_D^C + \pi_3 L_D^C + L_D^C = (1 + \pi_2 + \pi_3) L_D^C$ and $\overline{K} = \pi_2 K_D^C + \pi_3 K_D^C + K_D^C = (1 + \pi_2 + \pi_3) K_D^C$. It follows that $(\frac{\overline{L}}{\overline{K}}) = (\frac{L_D^C}{K_D^C}) = (\frac{L_D^B}{K_D^B}) = (\frac{L_D^A}{K_D^A})$.

Figure 1:

Exchange of Factor Services between Countries



In the case of Figure 1

$$\frac{L_D^A}{K_D^A} < \frac{\overline{L}}{\overline{K}} < \frac{L_D^B}{K_D^B} < \frac{L_D^C}{K_D^C} \qquad (4)$$

Deardorff proved that in a world with unequal commodity and (consequently factor) prices, countries tend to export the services of those factors which they have in relative abundance. In Figure 1 countries A and C are clearly capital and labour abundant with respect to the rest of the world. Country B can be found to be labour or capital abundant with respect to the rest of the world. In the case of Figure 1, country B is labour abundant. Therefore, the following inequalities can be written:

$$(L_D^A - \overline{L^A}) > 0,\ (K_D^A - \overline{K^A}) < 0, (L_D^B - \overline{L^B}) < 0, (K_D^B - \overline{K^B}) > 0, (L_D^C - \overline{L^C}) < 0, (K_D^C - \overline{K^C}) > 0;$$

where the superscripts denote countries, the bar denotes overall endowments and the subscript *D* denotes domestic consumption.

Equilibrium will depend on the labour-to-capital consumption ratio of each country, which in turn depends on its factor-price ratio. According to (4), in Figure 1, countries B and C will consume labour relative to capital in a greater ratio than the overall world endowment ratio and therefore, their post-trade equilibrium would be to the right of the diagonal OG; while country *A* will consume capi-

tal relative to labour in a greater ratio than the overall endowment ratio and therefore, its post-trade equilibrium would be to the left of the diagonal OG.

Assume that country C is in equilibrium after trade at point H. At that point the budget equation is valid:

$$w^C\overline{L^C} + r^C\overline{K^C} = w^C L_D^C + r^C K_D^C$$

or

$$w^C(L_D^C - \overline{L^C}) + r^C(K_D^C - \overline{K^C}) = 0$$

In terms of Figure 1 $(\frac{w^C}{r^C})\ DG = EF$.

Also, country *B* at equilibrium would export JK quantity of labour and import *LM* quantity of capital. The budget equation for country *B* would be: $w^B L^B + r^B K^B = w^B L_D^B + r^B K_D^B$ or $(\frac{w^B}{r^B})\ JK = LM$.

Finally, country *A* would be in equilibrium at point N where $w^A\overline{L^A} + r^A\overline{K^A} = w^A L_D^A + r^A K_D^A$ or $(\frac{w^A}{r^A})\ RS = QP$. Note also that because $\frac{w^A}{r^A} > \frac{w^B}{r^B} > \frac{w^C}{r^C}, \left(\frac{QP}{RS}\right) > \left(\frac{LM}{JK}\right) > \left(\frac{EF}{DG}\right)$.

With full employment:

$$QP = EF + LM \text{ and } RS = JK + DG. \quad (5)$$

Since country *A* is the only net exporter of capital services and countries *B* and *C* are net exporters of labour services, (5) implies that *A's* net labour exports to *B* and *C* would be non-positive and its net capital exports to each one of these countries non-negative.

If X_n^{ij} are the exports of commodity *n* from country *i* to country *j* and l_n^j, k_n^j are the labour and capital input coefficients of commodity *n* in country *j*[6], then:

$$\sum_{z=1}^{s} l_z^B X_z^{BA} - \sum_{z=s+1}^{n} l_z^A X_z^{AB} > 0 \quad (6)$$

[6] l_n^j, k_n^j are the amounts of labour and capital required for the production of one unit of the *nth* commodity in country *j*.

$$\sum_{z=1}^{s} k_z^B X_z^{BA} - \sum_{z=s+1}^{n} k_z^A X_z^{AB} < 0 \qquad (7)$$

$$\sum_{z=1}^{f} l_z^C X_z^{CA} - \sum_{z=f+1}^{n} l_z^A X_z^{AC} > 0 \qquad (8)$$

$$\sum_{z=1}^{f} k_z^C X_z^{CA} - \sum_{z=f+1}^{n} k_z^A X_z^{AC} < 0 \qquad (9)$$

Commodities 1 to *s* are country *A's* imports from *B* and *s + 1* to *n* are its exports to *B*, while commodities 1 to *f* are *A's* imports from *C* and *f+1* to *n* are its exports to *C*. Expression (6) is the distance *JK* in Figure 1, expression (7) is the distance *LM*, (8) is the distance *DG* and (9) is the distance *EF*.

Inequalities (6) to (9) are valid because of inequality (1) of the relative factor prices. For each unit of embodied capital that country *A* exports, it expects to receive fewer units of labour than countries *B* and *C* are willing to pay for the acquisition of one unit of embodied capital, since labour is more expensive in the capital abundant countries. This pattern of trade is feasible because it is permitted by the relative factor prices. In a with-trade situation, country *A* will export capital to countries *B* and *C* and import labour from them. Also, since $(\frac{w^B}{r^B}) > (\frac{w^C}{r^C})$, if there will be any trade between *B* and *C*, *B* will export capital and import labour from *C*. Country *A* will not import capital from *B* or *C* and export labour to these countries because for each unit of labour it exports, it expects to receive more units of capital than country *B* or *C* is willing to pay and trade will not take place in this direction. The same applies between countries *B* and *C*.

Expressions (6) and (8) can be written as:

$$\sum_{z=1}^{s} \theta_z^B (l_z^B X_z^{BA}) > \sum_{z=s+1}^{n} \theta_z^A (l_z^A X_z^{AB}) \qquad (10)$$

$$\sum_{z=1}^{f} \theta_z^C (l_z^C X_z^{CA}) > \sum_{z=f+1}^{n} \theta_z^A (l_z^A X_z^{AC}) \qquad (11)$$

where $\theta_i^j \equiv \frac{l_i^j}{k_i^j}$. Also, from (7) and (9) we have that:

$$\sum_{z=1}^{s} \theta_z^B (k_z^B X_z^{BA}) < \sum_{z=s+1}^{n} \theta_z^A (k_z^A X_z^{AB}) \qquad (12)$$

and

$$\sum_{z=1}^{f}\theta_z^C(k_z^C X_z^{CA}) < \sum_{z=z+1}^{n}\theta_z^A(k_z^A X_z^{AC}) \qquad (13)$$

By dividing (10) by (12) and (11) by (13) we get:

$$\sum_{z=1}^{s}\theta_z^B\left(\frac{k_z^B X_z^{BA}}{\sum_{z=1}^{s} k_z^B X_z^{BA}}\right) > \sum_{z=s+1}^{n}\theta_z^A\left(\frac{k_z^A X_z^{AB}}{\sum_{z=s+1}^{n} k_z^A X_z^{AB}}\right) \qquad (14)$$

$$\sum_{z=1}^{f}\theta_z^C\left(\frac{k_z^C X_z^{CA}}{\sum_{z=1}^{f} k_z^C X_z^{CA}}\right) > \sum_{z=f+1}^{n}\theta_z^A\left(\frac{k_z^A X_z^{AC}}{\sum_{z=f+1}^{n} k_z^A X_z^{AC}}\right) \qquad (15)$$

Inequalities (14) and (15) say that the weighted average of the labour-capital ratios of *A's* imported commodities from *B* must be higher than the weighted average of the labour-capital ratios of *A's* exported commodities to *B* and the weighted average of labour-capital ratios of *A's* imported commodities from *C* must be higher than the weighted average of the labour-capital ratios of *A's* exported commodities to *C*, with the weights being given by the relative amounts of labour absorbed by each group.

(14) and (15) show that in a world with unequal factor prices the H–O Theorem in its «factor content» version holds bilaterally and if there is any trade between two countries this would be in accordance to their factor endowments.

3. The Validity of Bilateral H–O Model in the Trade between Greece and the EU

The present section will provide empirical evidence for the bilateral test of the validity of H–O Theorem in the trade of Greece *vis-a-vis* the EU countries for 1988. The choice of this specific year was made by taking into account the data available in Greece and the EU necessary for performing the test.

Let it be assumed in terms of inequality (14) that country *A* represents the 11 EU countries and country *B* is Greece.

In order to calculate the weighted average of the labour-capital ratios of *A's* imported commodities from *B* and the labour-capital ratios of *A's* exported commodities to *B* the input-output tables from Greece and from each of the EU countries was used. For Greece the most recent input-output table was available for 1988 (Mylonas, forthcoming). Input-output tables from the EU countries were not available for 1988 but for 1985 (Eurostat,1990).

It was decided to use the technical input coefficients of the EU countries for 1985 under the assumption that it would have no structural break in production between 1985 and 1988.

3.1. Data Description

The input-output tables for 1985 for all the EU countries except for Greece are reported in the Eurostat publication (1990). The data for the Greek input-output table were prepared by Mylonas (*op. cit.).*

The net export coefficients for 1988 were calculated from the external trade database of Eurostat (Eurostat, 1988a).

To examine whether the findings of this study are in accordance with the predictions of the H–O Theorem, the total capital to labour endowment ratio for each of the EU countries for the year 1988 was compared with that of Greece for the same year. For the calculation of the total capital endowment of each country, total gross capital investment data were collected for each country for the period 1960–1988 (UN 1963–1989, O.E.C.D. 1960–1989). They were expressed in 1980 prices and exchange rates (U.N. 1977–1984, Eurostat 1985–1990) and a 4% rate of depreciation was allowed for the calculation of the capital stock (Leamer 1984, Nehru and Dhareshwa 1992, Polychronopoulos *et.al.* 2001). The problems with this procedure for measuring capital stock are, first, a constant depreciation rate of capital through the years has been assumed which might be an unrealistic assumption. Second, and more important, it has been assumed that there is a common rate of depreciation in different sectors of the economy. It might be unrealistic to assume that the capital employed in different sectors of different economies is depreciated at the same rate. However, since data on depreciation rates of capital in individual sectors are not available despite its theoretical disadvantages, this was the only feasible solution.

For the calculation of the labour endowment of each country the total number of working persons of the economy for each year was extracted from Eurostat (1988b). Again, this approach overlooks the problem of labour heterogeneity but, in the absence of non-arbitrary measures of weighting labour endowments among countries, this is the only alternative.

The ratio of the capital to labour endowments for each country for 1988 was found by dividing the total capital stock, calculated according to the above-described procedure with the total number of working persons of the economy. The values are in ECUs and they are reported in Table 1. As it can be observed, Greece is the most relatively labour abundant country after Portugal in the EU.

Furthermore, Greece relatively to all the EU countries taken together is more labour abundant. The capital to labour endowment ratio of Greece is 26,777.8 ECU per working person and that of all the EU countries is 58,669.2 ECU per working person. The EU countries are on average 2.19 times relatively more abundant in capital than Greece.

Table 1:

Relative Factor Endowments[7]

Country	Capital to labour endowment ratio (values in ECUs in 1980 prices and exchange rates)	Relative capital endowment of the EU country over relative capital endowment of Greece
France	75462	2.8180670
Belgium	70734	2.6415196
Netherlands	95702	3.5739188
Germany	73080	2.7291414
Italy	45817	1.7110140
United Kingdom	44898	1.6767031
Ireland	49807	1.8600271
Denmark	63485	2.3708202
Portugal	19315	0.7212917
Spain	43228	1.6143141
EU	58669	2.1909690
Greece	26778	

3.2. Indicator Analysis Results

The total capital and labour content per million drachmas' worth of Greek net exports to the EU countries for the year 1988 were found to be 137,628.8 and 615,305.2 respectively. The total direct and indirect capital and labour content of net export content of the EU countries to Greece are calculated using factor intensities from the countries of origin for the same year were found to be 142,394.2 and 498,140.5, respectively. The Leontief index, that is the capital-labour input ratio for net exports divided by the same ratio for net imports, is less than unity and has the value of 0.7824893. It shows that an average million drachmas' worth of Greek net exports to the EU countries embodies more labour and less capital than that embodied in an average million drachmas' worth of net imports from the EU countries.

These findings accord with the prediction of the H–O Theorem since the relative capital-labour endowment ratio of the EU over the same ratio of Greece is 2.19 and the Greek net exports to the EU require relatively more labour than its net imports from the EU (the capital to labour ratio of net exports of Greece to the EU over the capital to labour ratio of net imports of Greece from the EU is 0.7824893). Greece is specialising within the EU in labour intensive lines of production.

[7] Sweden, Finland and Austria were not included in this work because they were not EU members in 1988 (they become EU members on 1-1-1995).

Table 2:

Factor Content of Bilateral Trade of Greece and EU Countries

Country	(a)	(b)	(c)	(d)	(e)	(f)	(g)
France	162710.6	560567.1	0.2902607	128142.5	643293.7	0.1991975	0.6862712
Belgium	119040.2	315503.2	0.3773027	141966.3	503848.8	0.2817637	0.7467843
Nether-lands	142496.3	528232.5	0.2697605	107851.1	512015.7	0.2106402	0.7808000
Germany	132068.6	531468.3	0.2484977	131527.0	635814.0	0.2068639	0.8324583
Italy	148172.5	447092.3	0.3314137	146368.3	501504.7	0.2918583	0.8806460
United Kingdom	147519.2	527146.7	0.2798447	190307.2	737446.9	0.2580623	0.9221622
Ireland	131149.1	491948.5	0.2665910	137397.8	525837.6	0.2612933	0.9801277
Denmark	143382.6	593968.5	0.2413976	138860.7	599608.8	0.2315855	0.9593528
Portugal	178049.4	554612.6	0.3210339	183222.0	555793.6	0.3296582	1.0268644
Spain	147849.5	537404.0	0.2751179	134875.9	537779.7	0.2508013	0.9116140

(a): Capital content of net imports (in drachmas), (b): Labour content of net imports (in drachmas), (c): (a)/(b), (d): Capital content of net exports (in drachmas), (e): Labour content of net exports (in drachmas), (f): (d)/(e), (g): Leontief index (f)/(c)

3.3. Regression Analysis Results

In this section the factor content of Greek trade with each of the EU countries will be examined. The data used were described in section 3.1. To find the factor content of net exports the data from the Greek I–O table were used; and to find the factor content of Greek net imports from a specific EU country, the I–O table from that country was used. Furthermore, net import and net export weights have been adjusted to correspond to a million drachmas' worth of net exports and imports from each EU country under examination.

The factor content of bilateral net exports and net imports to and from each EU country is reported in Table 2.

The results show that Greece exports relatively more labour than capital, than it imports from each EU country except from Portugal to which exports relatively more capital than it imports. If the aforementioned factor intensities of trade flows are compared with the endowment ratios of Table 1, they suggest that the H–O Theorem holds bilaterally in the trade between Greece and the EU countries because Greece is relatively more labour abundant than each of the EU country except Portugal, and relatively more capital abundant than Portugal.

Moreover, a proper test of the H–O Theorem should include variables representing factor abundances, factor intensities and trade flows. For testing this three-way relationship using regression analysis, the ratio of the capital/labor ratio of exports to that of imports was regressed on the capital to labor endowment ratio of the EU country in question to the capital to labor endowment ratio of

Greece. The dependent variable represents the factor content differences found in the trade flows between Greece and other EU countries while the factor endowment ratios represent the differences in the factor endowments between Greece and other EU countries.

The hypothesis tested is that the differences in the pattern of specialisation in the trade of Greece with each EU country can be explained by differences in the factor endowment ratios.

The estimated equation was:

$$FCT_j = \alpha + \beta INDOW_j; \qquad (16)$$

where j indicates EU country j, $j = 1;...; 10$[8], $FCT = \left(\frac{K}{L}\right)^{X_j} / \left(\frac{K}{L}\right)^{M_j}$ and $INDOW = \left(\frac{\overline{K}}{\overline{L}}\right)^{j} / \left(\frac{\overline{K}}{\overline{L}}\right)^{GR}$.

The Breush–Pagan test for heteroskedasticity was performed to test for the presence of heteroskedasticity in the residuals. It was found that the residuals of (16) were not subject to heteroskedasticity ($X^2 = 1.180 < X_1^{2\,0.05} = 3{:}841$). Therefore, it was not necessary to use a two-step squares procedure for the correction of heteroskedasticity. The estimation results were found to be the following:

$$FCT_j = 1.1002 - 0.1048 INDOW_j$$
$$(15.95^*) \quad (3.50^*)$$

$\overline{R}^2 = 0.5553$; $F_{1,8} = 12.237^*$; $n = 10$, t – values in parentheses; the asterisk denotes statistically significantly different from zero coefficients at 5% level of statistical significance.

The *INDOW* coefficient is statistically significantly different from zero at 5% level of statistical significance. Further, the coefficient is of the expected sign since the variable representing the relative capital endowment of the EU countries in respect to the Greek relative capital endowment is negatively correlated to the relative capital intensity of Greek exports. The factor intensity of trade flows is in accordance with the relative factor endowments of the EU countries.

The statistically significant coefficient of the INDOW variable suggests that the factor content version of the H–O Theorem holds in the bilateral trade of Greece with the other EU countries.

[8] Data from Luxembourg is reported together with the data from Belgium.

4. Conclusion

In the present work the factor content version of the Heckscher–Ohlin Theorem is examined under the existence of non-factor price equalisation conditions in the bilateral trade between two countries in a model with three countries and many commodities.

It was found out that in a world with unequal factor prices the H–O Theorem in its «factor content» version holds bilaterally and if there is any trade between two countries this would be in accordance to their factor endowments.

Furthermore, empirical evidence for the test of the validity of the bilateral H–O Theorem is provided for the trade of Greece with other EU countries. It was found using both indicator and regression analysis that the differences in the pattern of specialisation in the trade between Greece and the EU countries is explained by the differences in the factor-endowment ratios. The empirical findings of this article suggest that the H–O Model is valid in the trade between Greece and the EU countries.

5. References

1. Brecher, A. – Choudhri, EU (1982), «The Factor Content of International Trade without Factor-Price Equalisation», Journal of International Economics, 12: 277–283.
2. Brecher, A. – Choudhri, EU (1988), «The Factor Content of Consumption in Canada and the United States: A Two-Country Test of the Heckscher–Ohlin–Vanek Model», in Feenestra,R.C., (eds), Empirical Methods for International Trade, MIT Press: Cambridge Mass.
3. Clifton, D. S. – Marxsen, W. B. (1984), «An Empirical Investigation into the Heckscher–Ohlin Theorem», Canadian Journal of Economics, 17: 32–38.
4. Courakis, A. S – Moura-Roque, F. (1992), «Comparative Advantage and Structural Change in the Portuguese Pattern of Trade in Manufactures», in Amaral, J. F.- Lucena, D. – Mello, A. S. (eds), The Portuguese Economy Towards 1992, Kluwer Academic Publishers: Dordrecht, pp. 233–255.
5. Deardorff, A. V. (1982), «The General Validity of the Heckscher–Ohlin Theorem», American Economic Review, 72: 683–964.
6. Deardorff, A. V. (1984), «Testing Trade Theories and Predicting Trade Flows», in Jones, R. W. – Kenen, P. B. (eds), Handbook of International Economics, Elsevier, vol. I, pp. 467–517.
7. Elmslie, B. – Milberg, W. (1992), «International Trade and Factor Intensity Uniformity: An Empirical Assessment», Weltwirtschaftliches Archiv, 128: 464–486.

8. Eurostat (1988), External Trade Data-Nace Classification, External Trade Statistics: Brussels–Luxemburg.

9. Eurostat (1988), Main Economic Indicators, Luxemburg.

10. Eurostat (1985–1990), Industrial Trends, Luxemburg.

11. Eurostat (1990), Input–Output Tables 1985, National Accounts ESA, Brussels–Luxemburg.

12. Harkness, J. (1978), «Factor Abundance and Comparative Advantage», American Economic Review, 68: 784–800.

13. Heckscher, E. (1919), «The Effect of Foreign Trade on the Distribution of Income», Ekonomisk Tidskrift, 21: 1–32.

14. Helpman, E. (1984), «The Factor Content of Foreign Trade», Economic Journal, 94: 84–94.

15. Helpman, E. (1998), «Explaining the Structure of Foreign Trade: Where Do We Stand?», Weltwirtschaftliches Archiv, 134: 573–589.

16. Horiba, Y. (1974), «General Equilibrium and the H–O Theorem of Trade: The multi-country case», International Economic Review, 15: 440–449.

17. James, A. M. – Elmslie, B. (1996), «Testing Heckscher–Ohlin–Vanek in the G-7», Weltwirt-schaftliches Archiv, 132: 139–159.

18. Jones, R. W. (1956), «Factor Proportions and the Heckscher–Ohlin Theorem», Review of Economic Studies, 24: 1–10.

19. Leamer, E. (1984), Sources of International Comparative Advantage, MIT Press: Cambridge, Mass.

20. Leamer, E. (1993), «Factor-Supply Differences as a Source of Comparative Advantage», American Economic Review, 83: 436–439.

21. Leamer, E. (1995), «The Heckscher–Ohlin Model in Theory and Practice», Princeton Studies in International Finance, No 77, Princeton University, pp. 1–50.

22. Leontief, W. W. (1953), «Domestic Production and Foreign Trade; The American Capital Position Re-examined», American Philosophical Society: Papers and Proceedings, 97: 332–349.

23. Leontief, W. W. (1956), «Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis», Review of Economics and Statistics, 38: 386–407.

24. Mylonas, N. A. (forthcoming), Analytical Input–Output Tables of the Greek Economy – Year 1988, Ministry of National Economy, National Accounts Division: Athens.

25. Nehru, V. – Drareshwa, A. (1992), «A New Database on Physical Capital Stock: Sources, Methodology and Results», World Bank working papers.

26. O.E.C.D. (1960–1989), Detailed Tables, National Accounts, Paris.

27. Ohlin, B. (1933), Interregional and International Trade, Harvard University Press: Cambridge, Mass.

28. Polychronoloulos, G. – Korres, G. – Rigas, G. (2001), «Globalisation, Direct Investment and Productivity Growth», 51 International Atlantic Economic Conference, Athens.

29. Rassekh, F. – Thomson, H. (1993), «Factor Price Equalisation: Theory and Evidence», Journal of Economic Integration, 8: 1–32.

30. Samuelson, P. A. (1953{54), «Prices of Factors and Goods in General Equilibrium», Review of Economic Studies, 21: 1–20.

31. Treffer, D. (1993), «International Factor Price Differences: Leontief was Right», Journal of Political Economy, 101: 961–985.

32. Tsounis, N. K. (1992), The Effects of European Economic Integration on the Greek Economy and the Pattern of Greek International Trade, Unpublished Ph.D. Thesis submitted to the University of Manchester.

33. Tsounis, N. (1996), «The Factor Content of Greek Trade with Other EU Countries», Greek Economic Review, 18: 1–22.

34. Tsounis, N. (2000), «Testing the Heckscher–Ohlin Theory in the Trade between Greece and the EU International Review of Economics and Business, 47: 295–315.

35. Vanek, J. (1968), «The Factor Proportions Theory: the N-Factor Case», Kyklos, 21: 749–756.

36. United Nations (1963–1989), Industrial Statistics Yearbook, New York.

37. United Nations (1977–1984), Yearbook of National Accounts Statistics, International Tables, New York.