LITHUANIA EXPORTS IN THE FRAMEWORK OF HECKSCHER-OHLIN INTERNATIONAL TRADE THEORY

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Abstract

The paper analyzes the Heckscher-Ohlin model’s fit to predict the Lithuania’s foreign trade flows based on the endowments of capital stock and labour in different exporting kinds of economic activities. Authors use correlation and regression analysis to identify the relationship between country’s exports/imports and capital-to-labour ratios. The results found are consistent with previous researches about Heckscher-Ohlin model being of low predictive power in its basic form. The model’s modifications of research & development, intangible assets and information society indicators inclusion increase the predictive power of the model, but since the improvements are not significant, authors conclude that further studies of comparison of Lithuania’s foreign trade partners’ endowments of capital and labour are needed to analyze in their relationship of exports and imports as analyzed bulk foreign trade data may have a bias of mixed patterns of trade with countries with substantially different production factor endowments.

Keywords: Heckscher-Ohlin model, empirical test, Lithuania, exports, statistical analysis of international trade.

Introduction

International trade is usually defined as one of the major factors of country’s success and ways to prosperity. Its benefits are especially important to the rapid development of emerging countries that Lithuania as a transitional economy is a part of. To maintain the acceptable export and import levels various methods are used by both policy makers and academics.

Heckscher-Ohlin theorem is a mathematical way to predict the patterns of production and commerce among the countries taken into consideration their production factor endowments. The Heckscher-Ohlin-model is based on assumption that each country specializes in production of goods that it has the resources abundant and that the resources rather than technological comparative advantages are the initial reason for both specialisation and foreign trade. The labour-to-capital ratio is the basic measure to divide all the traded products into two major groups: capital and labour intensive industries. The developed countries are thought to be relatively higher in capital to labourers whereas the developing countries are labour abundant. As a result of these divisions, the emerging countries are expected to both produce and export labour intensive goods in return importing capital intensive goods and developed countries should face an opposite flows.

The model was a question of an intense academic debate since its emerge in 1933. Our research problem arises from the fact that proposals of this theory are widely promoted by the politicians whereas the researchers state that in many cases its empirical tests fail to show significant and beneficial results.

The aim of the research – to analyze the case of Lithuania exports in the framework of Heckscher-Ohlin international trade theory and to identify the suitability of Heckscher-Ohlin theorem to predict the international trade patterns of Lithuania.

The object of the research is Lithuania’s exports in the framework of Heckscher-Ohlin model.

Research methods include academic literature review, qualitative, quantitative and comparative statistical analysis of empirical data.

The paper consists of theoretical analysis of Heckscher-Ohlin theorem to explain the initial expectations of the theory and its predictions for the flow of tradable goods among the countries and how the trade patterns should appear in the case of Lithuania. In the literature review various research papers are studied to analyze the empirical significance of the Heckscher-Ohlin theorem and formulate the model of the research, which is fully described in the methodology part of the article.

Even though Lithuania’s competitiveness has been analyzed by a great number of researchers (the two most recent and contributing to our analysis are Bernatonyte & Normantiene (2009) and Saboniene (2009), the empirical analysis towards the question whether Heckscher-Ohlin model is substantially beneficial for Lithuania’s foreign trade pattern identification has never been raised.

The main academic contribution of this paper comes from statistical analysis and its results are expected to define whether the use of Heckscher-Ohlin theorem may be applicable for identification of the comparative and competitive advantages of Lithuania.

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The Theoretical Framework of Heckscher-Ohlin model

The Heckscher-Ohlin international trade model was developed by Swedish economists Eli Heckscher and Bertil Ohlin. The authors created their theorem based on differences in countries’ resources. According to the model, various goods differ by the factors they need to be produced and each country having relatively more resources needed for certain goods becomes exporter in the field because of lower material (labour, land, capital et cetera) costs (Husted & Melvin, 1995).

Heckscher-Ohlin approach implies that different endowments of resources are the initial reason for foreign trade. For HO model to be fully valid the certain assumptions about the world’s economy must be made (Winters, 1994):

1) Consumption functions are identical among the countries and consumers face homogeneous preferences;
2) The production technology is the same among the world countries;
3) The production results in constant returns to scale, whereas the marginal returns to any single factor are diminishing;
4) The products are different in their technical requirements of capital and labour per unit. Furthermore, this results in any combination of factor prices and results in clear division of relatively more labour-intensive and capital-intensive goods;
5) Both resource and product markets are based on perfect competition;
6) The foreign trade faces no limitations (such as tariffs, quotas or transportation costs), but the labour migration or foreign investment into capital assets is impossible;
7) The resources among the countries are homogeneous among the countries and their supply is fixed to a certain measure and does not change.

The definition of country being capital or labour abundant and therefore producing its intensive goods is based on measuring one country’s total stock of capital compared to its labour force in contrast to country’s foreign trade partner’s measures (Husted & Melvin, 1995). If A country is capital abundant against country B, the ratios of capital per employee (K refers to capital stock, whereas L is labour force in each country) can be expressed as:

\[
\frac{K_A}{L_A} > \frac{K_B}{L_B}
\]  
(1)

In contrast, if country A is labour abundant the second formula is used to define the capital to labour ratios:

\[
\frac{K_A}{L_A} < \frac{K_B}{L_B}
\]  
(2)

Since L is the work force in a given country and K is the amount capital (machinery), the analysis of factor abundance and intensity in the process of production of goods states that only relative differences cause the foreign trade and total levels of labour and capital stock in countries are immaterial. As a result, the country is not referred as a labour abundant because of having a larger population without the comparison of capital stock per one labour force unit.

The model suggests that countries tend to specialize in production of export goods as their incentives are based on opportunity costs, the complete specialization of countries is not likely to appear. The limits for specialization are caused by similarities in countries’ resources and absolute specialization is possible only among the trade partners with drastically different endowments in the resources (Dunn & Mutti, 2005)

The foreign trade has effects on relative prices of the resources and according to HO model causes disparities among income distribution of different resource owners. The model and its later modifications predict that owners of abundant factor in the country gain from international trade whereas the owners of other (relatively scarce) factors lose as their earnings diminish (Krugman & Obstfeld, 2000).

If all assumptions of the model held perfectly in the real world, the equalization of labour and capital prices (wages and assets profitability) in all countries would come. In reality the effects of qualitative differences in factors and equipped technology, trade barriers and transportation costs exist and therefore disparities remain (Krugman & Obstfeld, 2000).

Since the Heckscher-Ohlin model is able to provide the essential insights on the wages and prices of other resources, it has an impact of different groups’ view towards globalization and free international trade. The policies towards foreign trade strategies protecting the scarce factors owners are promoted by their interest groups whereas abundant factor owners tend to promote free trade and abolishment of trade barriers for their profit pursue purposes (Husted & Melvin, 1995).
The policymakers tend to use these arguments against free trade as a way to protect the country’s scarce factor owners against the negative impact which should theoretically appear if the Heckscher-Ohlin model is consistent with reality and its assumptions tend to be substantially similar to the real business environment. Even though the predictions of this theory are widely quoted by politicians the empirical tests are needed to evaluate the fit of HO model to the case of Lithuania and whether the country’s exports and imports tend to reflect the model’s prediction and could lead to formation of better trade policies.

**Literature Review**

The very first empirical evaluation of the Heckscher-Ohlin model came in 1954 and analyzed the United States foreign trade data of 1947. The input-output tables were adapted to identify the resources needed to create one million United States dollars worth of value of US imports and exports. This method of research provided not only the resource endowments needed for the final stage of production, but also the initial needs to produce the intermediate products in every industry. The prior assumptions of United states being the most capital abundant country and therefore exporting capital intensive goods were found to be the opposite to reality and in the honour of the researcher is referred as Leontief Paradox (Winters, 1994).

Yet another influential research was conducted by Keith Maskus in 1985 (Husted & Melvin, 1995). The author analyzed United States data using input-output tables to measure the resource needs for the country’s foreign trade. The findings were highly contradictory to the forecasts of Heckscher-Ohlin model. According to 1958 resource endowment data, United States were relatively most abundant in capital and highly skilled labour force as a second factor. The unskilled labour was found to be the country’s scarce factor. After the calculations were performed, the net exports were highest of goods that were unskilled labour intensive. The second most important factor for exports was found skilled labour and physical capital intensive exports were the least part in exports structure. The similar findings were obtained when using 1972 data of exports and factor endowments (Husted & Melvin, 1995).

The very first tests of Heckscher-Ohlin on global data including a great number of countries and 12 factors of production was performed by Harry P. Bowen, Edward E. Learner, and Leo Sveikauskas in 1987 (Krugman & Obstfeld, 2000). The initial assumption behind the research was that countries trade manufactured goods as an indirect trade of abundant resources for production. In an industrial level this should have resulted in net exports of abundant factor via manufactured goods and net imports of scarce factor intensive products. The researchers measured the ratio of country's endowment of every factor to the world supply of corresponding resource. If the Hechscher-Ohlin theory was consistent with real foreign trade, a country would always export resources which the factor endowment exceeded the income share and import goods that required its scarce factors to be produced. As the authors found, the trade flows were successfully (more or equal to 70% of countries) predicted only in four out of twelve of the production factors. (Krugman & Obstfeld, 2000)

The researches performed by Maskus and Bowen at al. (Husted & Melvin, 1995) aimed to identify the reasons why their tests may have failed to use the Heckscher-Ohlin model to forecast the foreign trade flows between the countries. Consumption patterns and technological differences were taken into consideration as well as analysis of data to check whether it may have had substantial errors and therefore negatively affected calculations. The final conclusion of these causality analyses was that it was an unrealistic assumption of United States industry input-output tables to reflect the foreign countries’ technologies used in the process of production.

The research by Hakura (2000) examined the international technology differences in production processes to explain the failure of Heckscher-Ohlin predictive power. After the development of modified HO model, which abolished the formal requirements of identical production technologies among all countries, the estimation of input-output tables of different countries was used. The modified and initial HO models were then compared in a sense of their predictive power and the researcher found that taking into consideration technological differences significantly improves the forecasting results of the Heckscher-Ohlin model.

The study of similarities between countries’ factor endowments (Dabaere & Demiroglu, 2001) states that Heckscher-Ohlin model predictions towards the specialization holds and that it is primarily based on the fact that resources among different world countries “are too dissimilar for all countries to be able to produce the same set of goods”. Moreover, the authors also stress the fact that OECD countries are significantly similar by their capital and labour endowments and therefore are not motivated to specialize, as no incentives of different endowments that HO model predicts, occur.
The recent major trend in the United States is the endowments caused within-product specialization (Pham, 2008) which is not analyzed by HO model because of limited model assumptions of perfect competition in product markets, but shows the significant impact on usage of endowments to define the pattern of trade. Furthermore, the research takes into consideration the highly skilled and low-wage labour force separately and finds significant correlation between abundance of the factor and exports of the factor intensive goods in the US foreign trade with Japan, Brazil, China and India.

The analysis of trade caused unemployment, where trade results are caused from Heckscher-Ohlin comparative advantage (Dutt, Mitra & Ranjan, 2009), found that the positive HO effect of trade openness on unemployment appears for capital-abundant countries and turns negative for labor-abundant countries. The authors used cross-country data sample to define the trade policy, unemployment and sophisticated techniques to overcome the endogeneity and measurement-error problems. The main contribution of the research is that HO model fits the data when taken into consideration different time gaps: “an unemployment-increasing short-run impact of trade liberalization, followed by an unemployment-reducing effect leading to the new steady state”.

Besides the statistical fit of the Heckscher-Ohlin model to the real world data, its assumptions are also challenged by academics. The recent researches on use of capital (Reinhold, 2008) and labour suggest the qualitative differences in these endowments between companies and therefore among the different countries. Even though the human capital is not analyzed by HO model, the academics agree of its importance for the efficiency of enterprises (Kumpikaite, 2008; Martinkus et al., 2009; Zeng et al., 2010). Furthermore, the modern theories of human resource management imply significant differences of labour efficiency based on innovative working environment and empowerment of employees (Kazlauskaite et al., 2009).

Methodology of Empirical Research of Lithuania’s Exports in the Framework of HO Model

The empirical data analysis is needed to analyze the fit of Heckscher-Ohlin model to predict Lithuania’s foreign trade dependence on capital-to-labour ratios in different business industries and to fulfill the aim of this research. The primary data was collected from the Department of Statistics of Lithuania database. The annual data of imports and exports was obtained using CPA (Classification of Products by Activity) separation into business sectors, because of the fact that it enabled comparison between enterprises division into sectors by NACE 2 (Statistical Classification of Economic Activities in the European Community) methodology. The total assets of all enterprises in the exporting industry are referred as “capital” and total number of their employees is “labour” in the Heckscher-Ohlin model. The measures were taken in Lithuania’s national currency Lithuanian Litas (LTL).
The model states that developed countries have more capital to labourers whereas the developing countries are labour abundant. As a result of these divisions, Lithuania as the emerging country is expected to both produce and export labour intensive goods in return importing capital intensive. Therefore, the research must find the trend whether Lithuania is an exporter of labour intensive products. Moreover, if Lithuania has more capital stock than its exports partners, it is also be possible that Lithuania’s exports are capital intensive, but in both cases the trend should appear.

The initial test of HO fit to provide insights about the trend of foreign trade in each sector was performed using correlation and regression analysis. The correlation was chosen because of its ability to provide the answer whether the statistical relationship exists, but regression analysis was needed to acquire the function to forecast the foreign trade flows.

The regression analysis was also beneficial in a sense that it enabled to take into consideration more sophisticated variables such as sectors intangible assets per employee (the measure to describe the patents, software and other intangible assets value of the industry) and research and development expenditures per employee in the business sector (higher R&D expenditures are associated with higher value added by each employee). The correlation analysis in this case enabled to find each variables importance for the final outcome whereas the multi-regression analysis measured the outcome of all impacts.

The final modification of HO model involved inclusion of information society indicators (the usage of computers, internet, broadband internet, website by the percentage of companies in the industry and the usage of internet and computer by the individual employees in every sector). For the analysis of information society indicators only correlation analysis was conducted as the cross-sectional data provided by the Department of Statistics of Lithuania was available for insufficient amount of sectors to perform the regression analysis.

In total 19 sectors were analyzed in the basic test of HO model; 14 sectors data was available for capital-to-labour, R&D expenditures and intangible assets analysis and only 5 industries had sufficient data to be analyzed using all the variables.

### Empirical tests of data

The initial test of original HO model resulted in no statistical relationship (correlation coefficient is 0.13; \( R^2 = 0.02 \)) between Lithuania’s export/import ratio and capital-to-labour ratio (Figure 1.). Even though the regression estimates were acquired using ordinary least squares method showing that Lithuania’s exports are relatively more capital intensive, the function would always tend to forecast positive net exports and match the data 8 times of 19 sectors that had export/import ratio and capital-to-labour ratio cross sectional data available. These results can be interpreted as contradictory to HO model and result in model’s weak predictive power.

![Figure 1. Relationship of Lithuania’s Exports/Imports and Capital-to-Labour Ratios](image)

As it is clearly reflected in the graph (Figure 1.), some sectors (Electricity, gas, steam and air conditioning supply \( K/L = 1152 \) and Manufacture of chemicals and chemical products; manufacture of basic pharmaceutical products and pharmaceutical preparations \( K/L = 704 \) thousands LTL per employee) are significantly different because of high capital per employee. Even though these kind of economic activities have a great impact on the trend-line drawn in the graph, drop of them from statistical research have no theoretical justification and this drop does not significantly improve statistical properties of the model (Figure 2.) as \( R^2 \) reaches only 0.15.
However, to be fully capable to judge the HO model deeper analysis must be performed to reflect the intra-trade of industries and the cross-sectional data between sectors and Lithuania’s foreign trade partners. The previously mentioned issues are beyond the scope of this research, but such analysis would provide with insights that may improve the predictive power of the HO model in the framework of modern markets.

The analysis of R&D expenditures and intangible assets in HO model improved the prediction success of foreign trade flows (the model predictions coincided with the actual data 8 times out of 14) and the function did not have the bias to forecast the same outcome as the intercept’s value and its importance decreased. Despite the better prediction rates, its statistical significance did not increase (although $R^2$ reached 0.25, the $R^2$-adjusted remained as low as 0.03 resulting in regressions prediction success increase only because of involvement of more variables and not its actual fit to the data). The deeper insight comes from R&D correlation with exports/imports ratio analysis. Even though the correlation coefficient is low (-0.34), its negative sign suggests that Lithuania’s exports tend to be technically less sophisticated than imports and that countries strengths currently lies within mechanical production rather than high-added-value industries.

The tests of basic HO model and its modification with inclusion of R&D and intangible assets are consistent with the results found by other authors that HO model without significant modifications lead to low practical use of it and its assumptions become highly questionable in the real markets.

The final analysis of information society indicators consist with the findings of R&D analysis. Although the statistical relationship between percentages of companies using IT services has no impact on industries exports/imports ratio, the measures for employee involvement in high-tech work using computers and internet at their workplace tend to have a very negative impact on sectors exports. Even though it does not necessarily mean that Lithuanian enterprises of highly skilled workers are not competitive (products of these sectors can be consumed locally), but leads to understanding that currently Lithuania’s comparative advantages do not lie in the most advanced sectors of economy and confirms the findings of recent researches on Lithuania’s exports (Saboniene, 2009) and Lithuanian government have not yet reached success with strategic orientation towards high-value added sectors.

Conclusions

1. The other researchers find little Heckscher-Ohlin model’s fit with real world foreign trade data, but modified versions of the model in some cases significantly increased models predictive abilities and yet no clear justification about the possibilities to adapt model successfully cannot be drawn.
2. Our research found of no significant relationship between the capital to labour ratio and Lithuania’s exports to imports ratio. Even though the modifications of HO model enabled to improve model predicting power, these results are affected by decreased data sample and therefore further research is needed to provide the information of the effects of research and developments and usage of intangible assets to competitiveness of Lithuanian goods in global market.
3. The information society indicators were not found as a way to increase global competitiveness and altogether with R&D data proposes that Lithuanian capital and labour intensive exports are more important in the exports structure rather than high-tech and high-added value goods and confirms earlier findings.
From the policy-making aspect, even though the wage and factor prices equalization were not analyzed
in the paper, we found of HO model’s mixed empirical data fit and therefore the negative aspects and
harm to scarce factor (capital) owners could not be identified.
5. The limitations of the research include the lack of cross-sectional statistical information even though the
flow of information to test the Heckscher-Ohlin model substantially increased in recent years. Moreover,
the statistical information lacks data related to technological levels of companies and therefore the factual
situations consistency with the model’s assumptions of technological levels homogeneity cannot be valued.
6. Further research in the field could include managerial and qualitative capital and labour force measures
to reflect the differences of countries and their impact on competitiveness of Lithuanian goods in global
market.
7. Since it remains unclear whether model fails to successfully predict Lithuania’s exports because of
model being unfit for real life foreign trade flows of this emerging economy (for instance, the
technologies used may be outperformed by the ones used in foreign markets) or the fact that Lithuania
trades with countries having very different endowments of labour and capital (in contrast to empirical
studies of 1940s-1980s where United States was clearly capital abundant), the exports to different
countries must be analyzed to avoid the effect of capital and labour intensive goods exports bias in the
data sample.

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