TESTING THE FACTOR PROPORTIONS MODEL FOR CROATIA

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Abstract

The factor proportions model is one of the main models in international trade theory. It was developed by Swedish economists Eli Heckscher and Bertil Ohlin in the early 1920's. Based on the merchandise trade data between Croatia and the countries of the European Union and the world and the relative availability of key factors of production, the factor proportions model was tested in the case of Croatia. The sign test was used for this purpose. It compares the expected sign according to the factor proportions model with the sign of the revealed comparative advantages index (RCA). The results of the analysis showed that the factor proportions model does not apply in the case of Croatia. According to the factor proportions model, Croatia does not use its comparative advantages effectively due to the lack of specialization in the production of products which intensively use the country's relatively abundant factor of production. Limitations of the model are reflected in the fact that some of the assumptions of the factor proportions model are not satisfied.

Keywords: Factor proportions model, Croatia, SITC, sign test

1. Introduction

The factor proportions model (or the Heckscher-Ohlin model) is one of the main models in international trade theory developed by Swedish economists Eli Heckscher and Bertil Ohlin in the early 1920's (Heckscher, 1919; Ohlin, 1924). It leans on Ricardo's theory of comparative advantages (Ricardo, 1817). The Heckscher-Ohlin model is often called the factor proportions model. Some researchers also called it the Heckscher-Ohlin-Samuelson model in recognition of Samuelson's contributions in formulating the Stolper-Samuelson and Factor price equalization theorem[1]. Early studies tested the Heckscher-Ohlin model by comparing the factor content of exports with that of imports and comparing this with the country's factor endowments. The first such study was made by Leontief (1953). Using the 1947 input-output tables for the United States he came to the conclusion that the United States exports labour-intensive products and imports capital-intensive products, which is contrary to the Heckscher-Ohlin theory, popularly known as the Leontief paradox. In response to the Leontief paradox, many economists have tested the Heckscher-Ohlin model for different countries and time periods. Vanek (1968) was the first to formulise this relationship and generalize the model for the many factors and many goods cases. The Heckscher-Ohlin-Vanek theorem states that countries will be net exporters of the services of factors they have in relative abundance.

The goal of this paper is to test the factor proportions model in the case of Croatia using the sign test which compares the expected signs of the factor proportions model with the signs of the revealed comparative advantaged index. The paper consists of six chapters. The first chapter is the introduction, the second explains the theoretical aspects of the factor proportions model and the third presents a historical overview of economic literature on the factor proportions model. The fourth chapter gives the methodology and describes data used in the analysis, the fifth chapter analyses the factor proportions model in the case of Croatia while the last chapter gives the concluding remarks.

2. Theoretical aspects of the factor proportions model

The Heckscher-Ohlin model is a model comprised of two goods, two countries and two factors of production (labour and capital). Assumptions of the model include identical constant returns to scale, identical homothetic preferences across countries, perfect competition with no market distortions, balanced trade, and perfectly mobile goods between countries, while factors are internationally immobile, relative factor endowments differ across countries and there is no factor intensity reversal (Heckscher, 1919). Various researchers have introduced modifications into those rigid assumptions in order to lose them and increase the predictive power of the appropriate tests. Leontief (1953) was the first to confront the Heckscher-Ohlin model with data. He measured the amount of capital and labour required for $1 million worth of US exports and came to the conclusion that US exports labour-intensive products and imports capital-intensive products which is contrary to the factor-proportions theory. Later studies criticise the methodology used by Leontief extending the Heckscher-Ohlin model by allowing for technology differences, intermediate trade, intra-industry trade and firm heterogeneity (Davis et al., 1997; Trefler, Zhu, 2005; Reimer, 2006). The main reasons why Leontief came to the paradox in the Heckscher-Ohlin theory is that he did not use land as a factor of production and underestimated the role of human capital in production. In the expanded Heckscher-Ohlin-Vanek model (Vanek, 1968) there are at least as many goods as factors of production and complete specialization in no more than the number of goods minus the number of factors. There are significant differences between these strict assumptions and real trade flows between countries. Returns to scale in production are mostly decreasing although globalization and the technological revolution have brought increasing returns to scale, product differentiation and economies of scale. Consumer preferences are not homothetic nor identical; there are market distortions in the form of customs, quotas and other trade barriers, while factors of trade can move freely across national borders, although there are some limitations. Almost all empirical tests of the H-O-V theorem have failed to find support in data for this theory (Maskus, 1985; Bowen et al., 1987). Factor endowments correctly predict the direction of trade only 50 percent of the time, equal to a coin toss. The reason for that are mainly strong restrictive assumptions of the model.

3. Economic literature on the factor proportions model

After Leontief's testing of the Heckscher-Ohlin theory many researchers have tried to prove the theorem using empirical data. Travis (1964), Melvin (1968) and Vanek (1968) extended the Heckscher-Ohlin model to allow for more goods and factors. Melvin added a third good in the model, which led to the problem of indeterminacy of production and trade. In that case, a capital-abundant country does not need to export the most capital-intensive good.

Stern and Maskus (1981) included a measure of human capital in their analysis. They excluded services industries, agriculture and natural resource industries when computing the factor endowments. The results indicated that the Leontief paradox was not present using data for the USA for the year 1972. Using data for 79 sectors in 1958 and 1972, Maskus (1985) ranked five factors: high-skilled labour, unskilled labour, other labour, physical capital and human capital. Comparing physical capital with labour, he came to the conclusion that labour is relatively more abundant than physical capital, indicating the existence of the Leontief paradox, contrary to the results of Stern and Maskus. Bowen et al. (1987) tested the traditional Heckscher-Ohlin hypothesis using the multi-dimensional extension of the two countries and conducted the first systematic and complete test of the H-O-V model.

Davis, Weinstein, Bradford and Shimpo (1997) tested the H-O-V model with international and Japanese regional data. In the case of relaxing the

assumptions of universal factor price equalization, the H-O-V model performs remarkably well. Davis and Weinstein (2001) pointed out that differences in factor endowments lead to a breakdown of factor prize equalization. In their view, such a breakdown is due to the systematic correlation between the country's capital abundance and industry input usage in both tradables and non-tradables.

Trefler and Zhu (2005) argued that developing countries, which have experienced the sharpest increase in wage inequality, have shifted their export shares towards more skill-intensive goods. It can be explained by technological catch-up. Reimer (2006) developed an approach to measure the factor content of trade when intermediate inputs are traded and techniques differ due to factor price differences. Empirical evidence documents the importance of intermediates and they mitigate cross-country differences in the factor content of finished goods.

Lai and Zhu (2007) allowed for country- and industry-specific technology differences deriving testable restrictions relating the factor content of bilateral trade to bilateral differences in technology and endowments. The results of the analysis have shown that the factor content predictions perform best for country pairs with larger endowment differences, as well as for trade between capital-abundant countries. O'Neill Fisher (2010) compared different productivities among countries when countries have different technologies. DeVries, Foster and Stecher (2012) introduced a new method for measuring value added content of trade when traded intermediates are included. This method allows for splitting up value added content of trade and generalizes the applied measures of vertical specialization in international production networks. Fisher and Marshall (2015)[2] computed direct and indirect factor requirements in 48 industries for 33 OECD countries. They strongly reject this Leontief hypothesis; hence tests of the Heckscher-Ohlin-Vanek paradigm cannot be based upon simple modifications that define factors in efficiency units.

4. Methodology

The factor proportions model is tested on the data for Croatia for the year 2013. The model is based on the Heckscher-Ohlin-Vanek theorem (Vanek, 1968) allowing for many countries, many goods and many factors of production in the model. Goods are classified according to product intensity into 5 groups as raw material intensive goods (RMIG), labour-intensive goods (LIG), capital-intensive goods (CIG), easy-to-imitate research-intensive goods (EIRIG) and difficult-to-imitate research-intensive goods (DIRIG). The five-way classification is taken from Yilmaz (2002), inspired by the work of Hufbauer and Chilas (1974)[3]. It has previously been used in the work of Erlat and Erlat (2003), Erlat and Erlat (2006). The three main factors of production are labour, capital and natural resources while differences in technology are presented with (R&D). Products are presented as HS 2 digit (from 01 to 99) harmonised with SITC 2 classification using correlation tables[4].

The relative factor endowment is formulated as the country's capital/labour ratio (K/L) opposed to the world's (K/L) ratio. If the country's (K/L) ratio exceeds the world's, then that country is capital abundant and vice versa. Relative endowment in natural resources is presented as the share of natural resources rents in the country's gross domestic product relative to the world's natural resource rents as percentage of the world's gross domestic product. If the country's natural resources rents exceed the world's, then the country is relatively abundant in natural resources. In order to increase the precision and power of a sign test, the natural resources have been divided into 5 categories: arable land, fishing, forest rents, mineral rents and coil, oil and gas rents. All these types of natural resource rents have been presented in the form of percentages of gross domestic product. Determination of relative factor endowment is presented in equation 1:

$$\left(\frac{K}{L}\right)_i > \left(\frac{K}{L}\right)_w, \left(\frac{NRR}{GDP}\right)_i > \left(\frac{NRR}{GDP}\right)_w \quad (1)$$

where K denotes capital, L is labour force, NRR are natural resource rents, GDP is gross domestic product, i denotes country and w is world.

In order to include productivity differences between countries, the variables agricultural productivity and labour productivity were introduced in the analysis. After allowing for productivity differences, new variables were formed and named as effective arable land and relative effective factor endowment. Allowing for productivity differences is important because productivity differs in various countries and consequently affects determination of factor endowments. Determination of the

relative effective factor endowment is presented in equation 2:

$$\left(\frac{K}{L}\cdot\frac{Q}{L}\right)_{ij} > \left(\frac{K}{L}\cdot\frac{Q}{L}\right)_{wj}, \left(\frac{AGR}{GDP}\cdot\frac{Q}{X}\right)_{ij} > \left(\frac{AGR}{GDP}\cdot\frac{Q}{X}\right)_{wj} \quad (2)$$

where Q is quantity of production, respectively national income or GDP, $\frac{AGR}{GDP}$ is the share of agriculture in gross domestic product, X is the sum of land and labour inputs, j is good, $\frac{Q}{L}$ denotes labour productivity and $\frac{Q}{X}$ is agricultural productivity. Differences in technologies between countries are defined as spending for research and development as a percentage of domestic GDP, $R\,\&\,D$.

$$\left(\frac{R\,\&\,D}{GDP}\right)_{ij} > \left(\frac{R\,\&\,D}{GDP}\right)_{wj} \quad (3)$$

The revealed comparative advantages (RCA) index is presented with equation 4:

$$RCA_{ij} = \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}} \cdot 100 \quad (4)$$

where X_{ij} represents the value of exports product j from country i and M_{ij} is the value of imports product j in country i. The index shows the degree of intra-industry trade and ranks between -100 (there is no export of product j from country i) and 100 (there is no import of product j in country i). In order to test the factor proportions model, a sign test was used. It compares the signs of relative abundance of production factors with the signs of the revealed comparative advantages index.

The sign test is presented with equation 5:

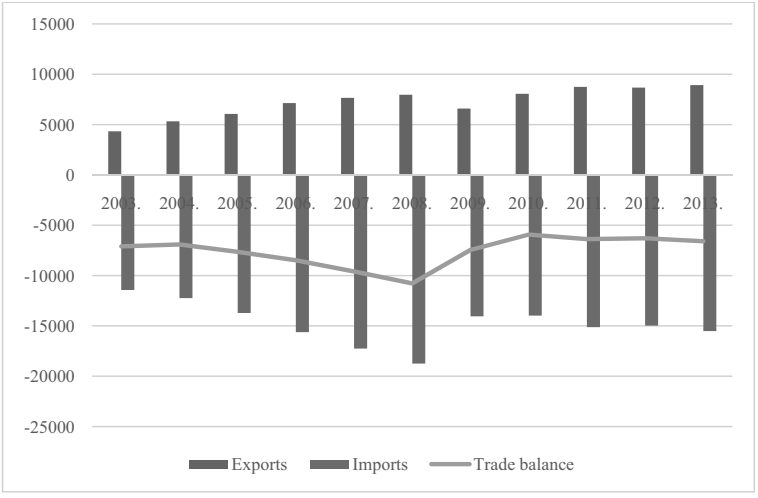
$$sign\left(\frac{\left(\frac{K}{L}\cdot\frac{Q}{L}\right)_{ij}}{\left(\frac{K}{L}\cdot\frac{Q}{L}\right)_{wj}}, \frac{\left(\frac{NRR}{GDP}\cdot\frac{Q}{X}\right)_{ij}}{\left(\frac{NRR}{GDP}\cdot\frac{Q}{X}\right)_{wj}}, \frac{\left(\frac{R\,\&\,D}{GDP}\right)_{ij}}{\left(\frac{R\,\&\,D}{GDP}\right)_{ij}}\right) = sign(RCA_{ij}) \quad (5)$$

The test was made in two ways: for merchandise trade between Croatia and the world, and specifically between Croatia and the EU because Croatia mostly trades with EU countries[5].

5. Empirical analysis and discussion

In order to conduct testing of the factor proportions model in Croatia, firstly the Croatian merchandise trade structure was analysed. Data for export and import values of merchandise trade for Croatia were taken from CBS, First Release 2013[6] and the Croatian National Bank[7]. Merchandise imports and exports classified by SITC are taken from the UN Comtrade and the US Service Trade[8]. From Figure 1 it can be noticed that Croatia had a permanent deficit in the total merchandise trade balance in the observed period. The largest deficit in the merchandise trade balance was in the year 2008 amounting to -10,775 million of euros. In 2013, the deficit was -6,587 million of euros, mainly due to a decrease in Croatian imports.

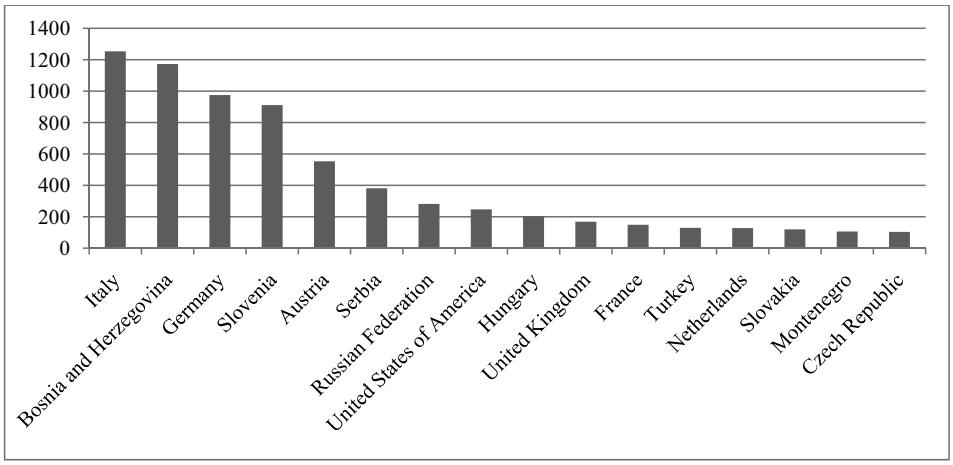
Figure 1 Merchandise trade balance, Croatia (in million of euros, 2003 - 2013)



Source: Author, according to data available at www.hnb.hr

Croatia mainly trades with with neighbouring countries and the EU countries, which is in line with the gravity model of international trade[9]. The main Croatian export markets (with trade of over 200 million of euros) are Italy, Bosnia and Herzegovina, Germany, Slovenia, Austria, Serbia, the Russian Federation, the United States of America and Hungary.

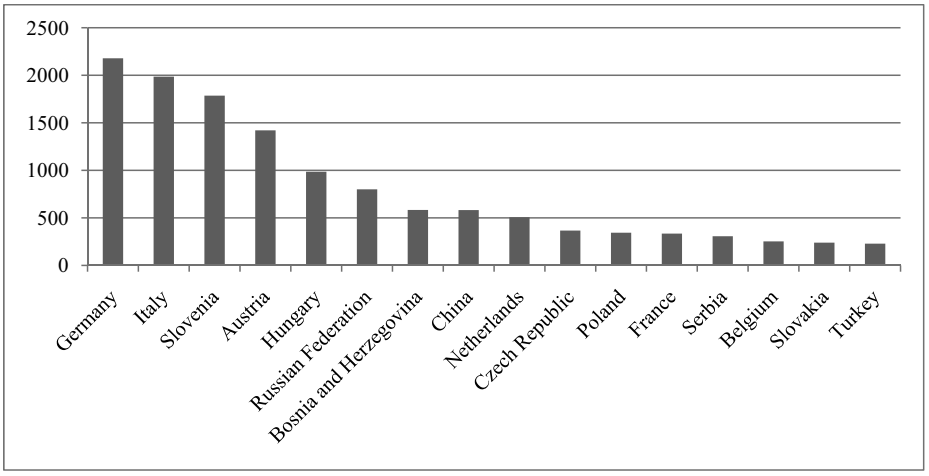
Figure 2 Exports from Croatia by country, in million of euros (2013)



Source: Author, according to CBS, First release, Foreign trade in goods of the Republic of Croatia, March 2014

The main Croatian import markets with trade of over 500 million of euros are Germany, Italy, Slovenia, Austria, Hungary, the Russian Federation, Bosnia and Herzegovina, China and the Netherlands.

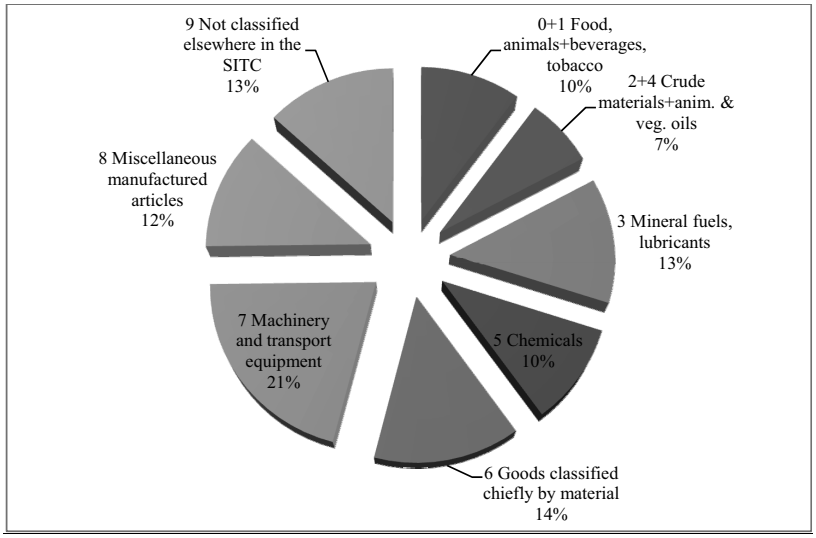
Figure 3 Imports in Croatia by country, in million of euros (2013)



Source: Author, according to CBS, First release, Foreign trade in goods of the Republic of Croatia, March 2014

Croatia is mostly an exporter of machinery and transport equipment, textiles, chemicals, foodstuffs, mineral fuels and lubricants (Figure 4).

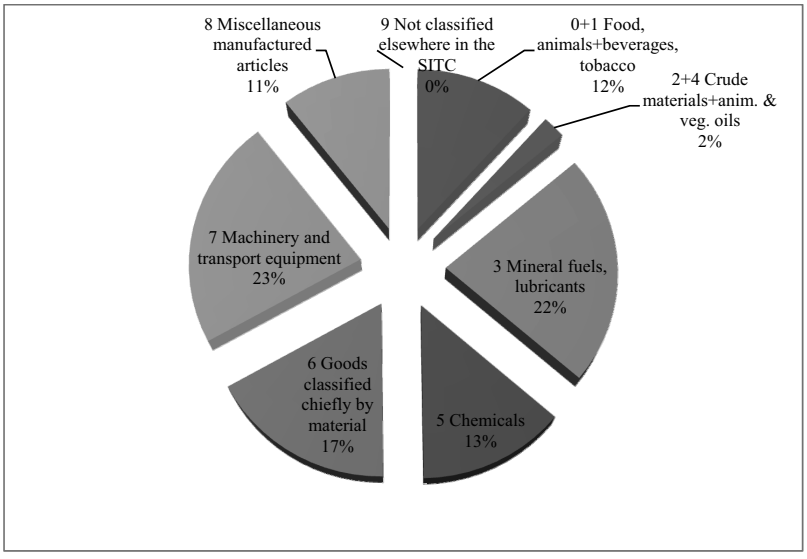
Figure 4 Merchandise exports for Croatia by SITC, 2013



Source: UN Comtrade, International Merchandise Trade Statistics. Yearbook 2014

On the other hand (Figure 5), Croatia is also an importer of machinery and transport equipment, foodstuffs, chemicals, mineral fuels and lubricants, textiles, etc., which indicates a high share of Croatia's intra-industry trade.

Figure 5 Merchandise imports for Croatia by SITC, 2013



Source: UN Comtrade, International Merchandise Trade Statistics. Yearbook 2014

Table 1 Factor endowments data

Country	GFCF (K) (in million US$)	GDP (in million US$)	Labour (L) (in 000)	Natural resources rents (% of GDP)	R&D (% of GDP)	K/L
Austria	95,015	428,698.6	4,429.8	0.4%	2.81%	21.45
Belgium	116,901	521,402.4	4,955.9	0.1%	2.28%	23.59
Bosnia and Herzegovina	3,192	17,841.4	1,490.4	1.9%	0.33%	2.14
Bulgaria	11,609	55,626.3	3,335.3	2.0%	0.65%	3.48
China	4,370,840	9,490,602.6	801,790.6	5.6%	2.01%	5.45
Croatia	**11,171**	**57,770.8**	**1,852.2**	1.7%	0.81%	6.03
Cyprus	4,260	24,057.2	603.8	0.0%	0.48%	7.06
Czech Republic	52,070	208,328.4	5,337.9	0.5%	1.91%	9.75
Denmark	61,547	335,877.5	2,901.6	1.7%	3.06%	21.21
Estonia	6,795	25,246.7	689.7	2.8%	1.74%	9.85
EU 28 (exc. Croatia)	**3,449,948.0**	**17,929,693.5**	**244,340.5**	0.5%	2.02%	14.12
Finland	56,624	269,190.1	2,721.2	1.3%	3.31%	20.81
France	619,955	2,810,249.2	30,030.7	0.1%	2.23%	20.64
Germany	737,993	3,745,317.2	41,981.4	0.2%	2.85%	17.58
Greece	27,154	239,509.8	5,008.2	0.2%	0.80%	5.42
Hungary	26,595	134,401.7	4,388.1	0.6%	1.41%	6.06
Iceland	2,314	15,376.6	190.1	0.0%	2.49%	12.17
India	556,648	1,861,801.6	487,882.1	5.9%	0.81%	1.14
Ireland	35,221	238,259.9	2,184.3	0.1%	1.52%	16.12
Italy	383,198	2,133,539.3	25,474.1	0.2%	1.26%	15.04
Japan	1,068,880	4,919,563.1	65,559.5	0.0%	3.47%	16.30
Latvia	6,324	30,241.6	1,044.1	2.7%	0.60%	6.06
Lithuania	7,517	46,412.1	1,543.7	1.0%	0.95%	4.87
Luxembourg	10,257	61,794.5	260.1	0.1%	1.16%	39.44
Macedonia	2,530	10,767.4	945.8	3.7%	0.44%	2.68
Malta	1,333	9642.8	186.8	0.0%	0.89%	7.13
Montenegro	847	4464.2	251.2	0.9%	0.38%	3.37
Netherlands	155,740	864,169.2	8,998.3	1.0%	1.98%	17.31
Norway	116,071	522,349.1	2,695.1	10.7%	1.66%	43.07
Poland	98,972	524,059.0	18,294.7	1.8%	0.87%	5.41
Portugal	34,419	226,073.5	5,397.2	0.5%	1.37%	6.38
Romania	44,534	191,587.2	9,520.8	2.2%	0.39%	4.68
Russian Federation	450,239	2,079,024.7	76,886.4	18.8%	1.13%	5.86

Country	GFCF (K) (in million US$)	GDP (in million US$)	Labour (L) (in 000)	Natural resources rents (% of GDP)	R&D (% of GDP)	K/L
Serbia	8,634	45,519.6	3,128.4	3.3%	0.73%	2.76
Slovakia	19,975	98,033.8	2,736.1	0.5%	0.83%	7.30
Slovenia	9,461	47,675.8	1,017.2	0.3%	2.59%	9.30
Spain	257,993	1,369,261.6	23,419.9	0.1%	1.24%	11.02
Sweden	128,379	578,742.0	5,118.4	1.1%	3.30%	25.08
Switzerland	160,510	684,919.2	4,700.9	0.0%	3.13%	34.14
Turkey	167,070	823,242.5	27,354.7	0.6%	0.94%	6.11
United Kingdom	440,107	2,712,296.2	32,761.2	1.0%	1.63%	13.43
United States of America	3,244,300	16,768,053.0	159,851.2	1.3%	2.80%	20.30
World	**18,316,400**	**75,467,070.0**	**3,312,265.0**	4.9%	1.80%	5.53

Source: World Bank, IndexMundi and author's calculations

Table 1 presents factor endowment data for Croatia, the EU-28 (excluding Croatia), selected countries and the world. Variable labour refers to the total labour force and is taken from the World Bank database[10]. Variable capital refers to gross fixed capital formation (investments) at current US$ and is provided from IndexMundi[11]. Variable gross domestic product (in million US dollars) is taken from the World Bank database[12]. Variable total natural resources rents (as percentage of GDP) are also taken from the World Bank database[13] as well as R&D (as percentage of GDP)[14].

According to Table 1, Croatia is relatively labour-abundant in relation to the European Union and slightly capital-abundant in relation to the world (K/L in Croatia is 6.03, 14.12 in the EU and 5.53 in the world). Croatia invests a relatively small share of amounts into R&D as a percentage of the GDP (0.81%) in relation to the EU (2.02%) and the world (1.8%). The investments in R&D are very low compared to similar countries by income per-capita. Croatia also lags behind some countries that recently joined the EU, like Slovenia (2.59%), the Czech Republic (1.91%) and Hungary (1.41%). If natural resources rents as a percentage of the GDP are viewed, Croatia is relatively abundant in natural resources (1.7%) compared with the EU (0.5%) but is scarce with this factor of production in relation to the world (4.9%). In order to include productivity differences between countries, labour productivity is included in the analysis as it is shown in equation 2 in chapter four. The determination of effective K/L is presented in Table 2:

Table 2 Determination of effective capital-labour ratio

Country/Region	Labour force (in 000)	Capital (in million of US$)	K/L	Labour productivity (GDP/per person employed)	Effective K/L
Croatia	1,852.2	11,171.0	6.03	22,816.0	2.64
EU-28	244,340.5	3,449,948.0	14.12	41,845.0	3.37
World	3,312,265.0	18,316,400.0	5.53	19,294.5	2.87

Source: World Bank, IndexMundi, UN and author's calculations

Labour productivity for Croatia, the EU and the word is presented with variable GDP per person employed provided by World Development Indicators[15]. If effective K/L is calculated and compared, it can be seen that Croatia is relatively labour-abundant in comparison to the EU and the world. Natural resource rents are divided into five categories: arable land, fishing, forest rents, mineral rents and coil, oil and gas rents. Data about various types of natural resources are collected from the World Bank Database Wealth accounting[16] and presented in Table 3:

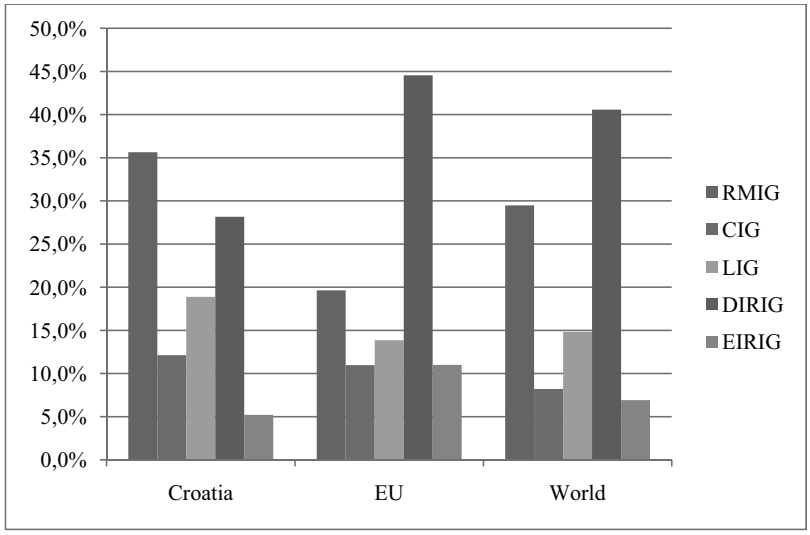
Table 3 Natural resources in Croatia, the EU-28 and the world in 2013

Country/ Region	Arable land (ha *p.c.*)	Agricultural productivity (value added per worker in US$)	Effective arable land	Fishing (% of GDP)	Forestry (% of GDP)	Minerals (% of GDP)	Coil, oil and gas rents (% of GDP)
Croatia	0.21	23,091.0	4,849.11	0.2-0.7	0.83	0.00	0.89
EU-28	0.21	33,333.3	6,999.98	0.1	0.12	0.02	0.35
World	0.20	11,657.0	2,331.40	0.5	0.33	1.67	3.83

Source: World Bank, UN, IndexMundi, FAO[17], Ministry of agriculture[18] and author's calculations

When variable arable land (ha *p.c.)* is compared for Croatia, the EU and the world it can be noticed they are on a similar level (around 0.2 ha p.c.). If agricultural productivity (value added per worker in US$) is multiplied with the variable arable land, variable effective arable land is created. Croatia is relatively abundant with arable land compared to the world but scarce in it in relation to the EU. Data for agriculture productivity are used from the World Bank database[19]. Croatia is relatively abundant in fishing and forestry in relation to both EU and the world but is relatively scarce in minerals. Also, Croatia is relatively abundant in coil, oil and gas rents compared with the EU but scarce with it in relation to the world.

Figure 6 Factor-intensity of exports for Croatia, the EU and the world in 2013



Source: Author's calculations based on ITC Trade Map database[20]

Figure 6 displays the factor-intensity of exports for Croatia, the EU and the world in 2013. It can be noticed that Croatia mostly exports raw material-intensive goods and falls short in exports of easy and difficult-to-imitate research-intensive goods.

Table 4 Sign test for the factor proportions model in Croatia (2013)

HS 2 digit	Industry	Product intensity	RCA Cro-World	Exp. sign	FPM holds	RCA Cro-EU	Exp. sign	FPM holds
01	Live animals	RMIG	-27.3	+	No	-79.5	-	Yes
02	Meat and edible meat offal	RMIG	-77.0	+	No	-87.8	-	Yes
03	Fish, crustaceans, molluscs, aquatic invertebrates nes	RMIG	23.9	+	Yes	14.1	+	Yes
04	Dairy products, eggs, honey, edible animal product nes	RMIG	-59.0	+	No	-84.7	-	Yes
05	Products of animal origin, nes	RMIG	-28.9	+	No	-20.9	-	Yes
06	Live trees, plants, bulbs, roots, cut flowers, etc.	RMIG	-90.2	+	No	-92.2	-	Yes
07	Edible vegetables and certain roots and tubers	RMIG	-82.3	+	No	-79.6	-	Yes
08	Edible fruit, nuts, peel of citrus fruit, melons	RMIG	-75.9	+	No	-65.9	-	Yes
09	Coffee, tea, mate and spices	RMIG	-78.5	+	No	-84.8	-	Yes
10	Cereals	RMIG	46.3	+	Yes	45.4	-	No
11	Milling products, malt, starches, inulin, wheat gluten	RMIG	-23.3	+	No	-76.3	-	Yes
12	Oil seed, oleagic fruits, grain, seed, fruit, etc. nes	RMIG	28.6	+	Yes	21.3	-	No
13	Lac, gums, resins, vegetable saps and extracts nes	RMIG	-97.4	+	No	-88.0	-	Yes
14	Vegetable plaiting materials, vegetable products nes	RMIG	-83.8	+	No	-55.2	-	Yes
15	Animal, vegetable fats and oils, cleavage products, etc.	RMIG	-61.4	+	No	-72.1	-	Yes
16	Meat, fish and seafood food preparations nes	RMIG	27.5	+	Yes	-12.9	+	No
17	Sugars and sugar confectionery	RMIG	-2.7	+	No	35.6	-	No
18	Cocoa and cocoa preparations	RMIG	-39.9	+	No	-78.7	-	Yes
19	Cereal, flour, starch, milk preparations and products	RMIG	-31.6	+	No	-46.6	-	Yes
20	Vegetable, fruit, nut, etc. food preparations	RMIG	-55.1	+	No	-69.0	-	Yes
21	Miscellaneous edible preparations	RMIG	-1.7	+	No	-43.3	-	Yes
22	Beverages, spirits and vinegar	CIG	-1.7	-	Yes	-37.7	-	Yes
23	Residues, wastes of food industry, animal fodder	RMIG	-59.1	+	No	-80.6	-	Yes

HS 2 digit	Industry	Product intensity	RCA Cro-World	Exp. sign	FPM holds	RCA Cro-EU	Exp. sign	FPM holds
24	Tobacco and manufactured tobacco substitutes	CIG	5.2	-	No	-31.6	-	Yes
25	Salt, sulphur, earth, stone, plaster, lime and cement	RMIG	39.4	-	No	39.9	-	No
26	Ores, slag and ash	RMIG	-34.6	-	Yes	68.4	-	No
27	Mineral fuels, oils, distillation products, etc.	RMIG	-45.5	-	Yes	-21.4	-	Yes
28	Inorganic chemicals, precious metal compound, isotopes	EIRIG	-66.7	-	Yes	-35.2	-	Yes
29	Organic chemicals	EIRIG	-66.2	-	Yes	-89.1	-	Yes
30	Pharmaceutical products	EIRIG	-21.3	-	Yes	-53.3	-	Yes
31	Fertilizers	RMIG	39.5	+	Yes	48.9	-	No
32	Tanning, dyeing extracts, tannins, derivs, pigments, etc.	CIG	-54.4	-	Yes	-77.7	-	Yes
33	Essential oils, perfumes, cosmetics, toiletries	CIG	-33.5	-	Yes	-79.1	-	Yes
34	Soaps, lubricants, waxes, candles, modelling pastes	CIG	-39.0	-	Yes	-81.1	-	Yes
35	Albuminoids, modified starches, glues, enzymes	EIRIG	-82.5	-	Yes	-91.8	-	Yes
36	Explosives, pyrotechnics, matches, pyrophorics, etc.	EIRIG	-23.0	-	Yes	-63.7	-	Yes
37	Photographic or cinematographic goods	DIRIG	-87.3	-	Yes	-96.1	-	Yes
38	Miscellaneous chemical products	EIRIG	-70.6	-	Yes	-81.7	-	Yes
39	Plastics and articles thereof	DIRIG	-51.3	-	Yes	-56.2	-	Yes
40	Rubber and articles thereof	RMIG	-81.1	+	No	-84.2	-	Yes
41	Raw hides and skins (other than fur skins) and leather	RMIG	-46.4	+	No	-62.7	-	Yes
42	Articles of leather, animal gut, harness, travel goods	LIG	16.7	+	Yes	-10.2	+	No
43	Fur skins and artificial fur, manufactures thereof	RMIG	2.7	+	Yes	-34.8	-	Yes
44	Wood and articles of wood, wood charcoal	RMIG	57.0	+	Yes	49.2	+	Yes
45	Cork and articles of cork	RMIG	-96.0	+	No	-97.4	+	No
46	Manufactures of plaiting material, basketwork, etc.	LIG	-24.9	+	No	-17.6	+	No
47	Pulp of wood, fibrous cellulosic material, waste etc.	RMIG	46.1	+	Yes	64.1	+	Yes
48	Paper & paperboard, articles of pulp, paper and board	LIG	-48.5	+	No	-51.6	+	No

HS 2 digit	Industry	Product intensity	RCA Cro-World	Exp. sign	FPM holds	RCA Cro-EU	Exp. sign	FPM holds
49	Printed books, newspapers, pictures etc.	LIG	-8.9	+	No	-27.2	+	No
50	Silk	LIG	-92.8	+	No	-88.8	+	No
51	Wool, animal hair, horsehair yarn and fabric thereof	LIG	-84.6	+	No	-93.1	+	No
52	Cotton	LIG	-61.4	+	No	-52.3	+	No
53	Vegetable textile fibres nes, paper yarn, woven fabric	LIG	-91.2	+	No	-90.3	+	No
54	Manmade filaments	LIG	-44.2	+	No	-29.7	+	No
55	Manmade staple fibres	LIG	-38.8	+	No	-58.3	+	No
56	Wadding, felt, nonwovens, yarns, twine, cordage, etc.	LIG	-26.2	+	No	-27.4	+	No
57	Carpets and other textile floor coverings	LIG	-94.4	+	No	-95.7	+	No
58	Special woven or tufted fabric, lace, tapestry, etc.	LIG	-44.8	+	No	-47.8	+	No
59	Impregnated, coated or laminated textile fabric	LIG	-71.7	+	No	-85.4	+	No
60	Knitted or crocheted fabric	LIG	-92.7	+	No	-92.6	+	No
61	Articles of apparel, accessories, knit or crochet	LIG	2.4	+	Yes	13.2	+	Yes
62	Articles of apparel, accessories, not knit or crochet	LIG	-30.7	+	No	-15.1	+	No
63	Other made textile articles, sets, worn clothing, etc.	DIRIG	-64.9	-	Yes	-49.6	-	Yes
64	Footwear, gaiters and the like, parts thereof	LIG	-11.3	+	No	8.8	+	Yes
65	Headgear and parts thereof	LIG	33.7	+	Yes	4.0	+	Yes
66	Umbrellas, walking-sticks, seat-sticks, whips, etc.	LIG	-17.5	+	No	36.4	+	Yes
67	Bird skin, feathers, artificial flowers, human hair	LIG	-93.4	+	No	-98.6	+	No
68	Stone, plaster, cement, asbestos, mica, etc. articles	LIG	11.2	+	Yes	12.3	+	Yes
69	Ceramic products	LIG	-34.8	+	No	-67.6	+	No
70	Glass and glassware	LIG	14.5	+	Yes	1.9	+	Yes
71	Pearls, precious stones, metals, coins, etc.	LIG	63.8	+	Yes	42.3	+	Yes
72	Iron and steel	CIG	-44.6	-	Yes	-57.8	-	Yes
73	Articles of iron or steal	CIG	-19.6	-	Yes	-26.5	-	Yes
74	Copper and articles thereof	CIG	-38.1	-	Yes	-29.0	-	Yes

HS 2 digit	Industry	Product intensity	RCA Cro-World	Exp. sign	FPM holds	RCA Cro-EU	Exp. sign	FPM holds
75	Nickel and articles thereof	CIG	-81.9	-	Yes	-90.9	-	Yes
76	Aluminium and articles thereof	CIG	-1.9	-	Yes	22.1	-	No
78	Lead and articles thereof	CIG	3.7	-	No	15.7	-	No
79	Zinc and articles thereof	CIG	-74.9	-	Yes	-77.5	-	Yes
80	Tin and articles thereof	CIG	-77.8	-	Yes	-83.7	-	Yes
81	Other base metals, cermets, articles thereof	CIG	-75.3	-	Yes	-7.2	-	Yes
82	Tools, implements, cutlery, etc. of base metal	LIG	-59.6	+	No	-67.4	+	No
83	Miscellaneous articles of base metal	LIG	-49.2	+	No	-54.2	+	No
84	Boilers, machinery, nuclear reactors, etc.	DIRIG	-24.4	-	Yes	-38.7	-	Yes
85	Electrical, electronic equipment	DIRIG	-18.5	-	Yes	-16.9	-	Yes
86	Railway, tramway locomotives, rolling stock, equip.	DIRIG	48.0	-	No	30.5	-	No
87	Vehicles other than railway, tramway	DIRIG	-65.6	-	Yes	-69.0	-	Yes
88	Aircraft, spacecraft, and parts thereof	DIRIG	28.7	-	No	2.6	-	No
89	Ships, boats and other floating structures	DIRIG	44.4	-	No	-44.4	-	Yes
90	Optical, photo, technical, medical, etc. apparatus	DIRIG	-43.5	-	Yes	-50.6	-	Yes
91	Clocks and watches and parts thereof	DIRIG	-82.4	-	Yes	-87.5	-	Yes
92	Musical instruments, parts and accessories	LIG	-60.0	+	No	-84.8	+	No
93	Arms and ammunition, parts and accessories thereof	LIG	70.8	+	Yes	-61.9	+	No
94	Furniture, lighting signs, prefabricated buildings	LIG	6.6	+	Yes	8.4	+	Yes
95	Toys, games, sports requisites	LIG	-70.5	+	No	-83.1	+	No
96	Miscellaneous manufactured articles	LIG	-46.1	+	No	-81.7	+	No
97	Works of art, collectors' pieces and antiques	LIG	1.4	+	Yes	21.2	+	Yes
99	Commodities not elsewhere specified	N.A.	91.7	N.A.	N.A.	-10.1	N.A.	N.A.

Source: Author's calculations

The sign test for the factor proportions model in Croatia for the year 2013 is formulated and implemented in Table 4. Products are classified according to HS 2 digit into five product intensity groups as raw material intensive goods (RMIG), labour-intensive goods (LIG), capital-intensive goods (CIG), easy-to-imitate research-intensive goods (EIRIG) and difficult-to-imitate research-intensive goods (DIRIG). Additional distribution of raw material intensive goods is on mineral products (H2 25, 26,

27), wood (forestry) products (HS 44, 45, 47), fish products (HS 3, 16), and agriculture products (all other products classified as RMIG). The sign test compares the expected sign according to the factor proportions model with the sign of the revealed comparative advantages index (RCA). The expected sign predicts that a country will export a product intensively using its relatively abundant factor of production. Input data for calculating the index of revealed comparative advantages were provided from the ITC Trade Map. The sign test for the factor proportions model is made in two ways; for merchandise trade between Croatia and the world and for merchandise trade between Croatia and the EU countries because Croatia mostly trades with EU countries. Relative effective values of the K/L ratio and effective arable land were used in the analysis. The results of the sign test have shown that the factor proportions model (FPM) holds only in 46.8% cases for merchandise trade between Croatia and the world and in 62.5% of cases for merchandise trade between Croatia and the EU[21].

It can be concluded that Croatia did not specialize according to the factor proportions model and that it does not use its comparative advantages well. The reason for that is the fact that Croatia net exports only 22 out of 96 HS 2 digit products to EU countries and 23 out of 96 HS2 products to the world[22] so there can be no discussion about any kind of specialization in exports. Future investigations can be carried out in the direction of expanding the analysis to HS 4 or HS 6 digit and more precise division of production factors (for example division of labour into unskilled and skilled labour). Limitations of the model are associated with the statement that some of the assumptions of the factor proportions model are not satisfied when confronted with merchandise trade data, namely the assumptions of constant returns to scale, identical homothetic preferences across countries, perfect competition with no market distortions, balanced trade, perfectly mobile goods between countries, while factors are internationally immobile, relative factor endowments that differ across countries and no factor intensity reversal assumption. It undoubtedly affected the results of the analysis and final conclusion whether the factor proportions model holds in the case of Croatia.

6. Conclusion

The factor proportions model is based on the expanded Heckscher-Ohlin-Vanek theorem and tested for Croatia using data for the year 2013. There are three main factors of production included in the analysis (labour, capital and natural resources). In order to test the factor proportions model the sign test was used. It compared the expected sign according to the factor proportions model with the sign of the revealed comparative advantages index (RCA). The sign test for the factor proportions model was made in two ways; for the merchandise trade between Croatia and the world and for the merchandise trade between Croatia and EU countries because Croatia mostly trades with EU countries. The results of the sign test have shown that the factor proportions model holds only in 46.8% cases for the merchandise trade between Croatia and the world and in 62.5% cases for the merchandise trade between Croatia and EU.

According to the factor proportions model, it can be concluded that Croatia did not specialize and that it does not use its comparative advantages well. Limitations of the model are reflected in the strictness of the model assumptions and in the fact that some of the model assumptions were not satisfied. Future investigations can be carried out in the way of increasing the precision and predictive power of the sign test with the extension of analysis to HS 4 and HS 6 digit and a more precise division of production factors.

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(Endnotes)

1 There are four main theorems in the Heckscher-Ohlin theory: the Heckscher-Ohlin theorem, the Stolper-Samuelson theorem (Stolper and Samuelson, 1941), the Rybczynski theorem (Rybczynski, 1955) and the Factor price equalization theorem.

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3 Details of this classification are given in the Appendix.

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21 According to Bowen et al. (1987), the sign tests are correct about 60% of the time, which is often no better than a coin toss.

22 The plus sign of the RCA index indicates net exports while the minus sign indicates net imports.

Appendix

Raw Material Intensive Goods

SITC 0 Food and Live Animals
SITC 2 Crude Material, Inedible, Except Fuels (excluding 26)
SITC 3 Mineral Fuels, Lubricants and Related Materials (excluding 35)
SITC 4 Animal and Vegetable Oils, Fats and Waxes
SITC 56 Fertilizers (Other Than Those of Group 272)

Labour-Intensive Goods

SITC 26 Textile Fibres (Other Than Wool Tops and Other Combed Wool) and Their Wastes (Not Manufactured Into Yarn or Fabric)
SITC 6 Manufactured Goods Classified Chiefly by Material (excluding 62, 67, 68)
SITC 8 Miscellaneous Manufactured Articles (excluding 88, 87)

Capital-Intensive Goods

SITC 1 Beverages and Tobacco
SITC 35 Electric Current
SITC 53 Dyeing, Tanning and Colouring Materials
SITC 55 Essential Oils and Resinoids and Perfume Materials; Toilet, Polishing and Cleansing Preparations
SITC 62 Rubber Manufactures, n.e.s.
SITC 67 Iron and Steel
SITC 68 Non-Ferrous Metals
SITC 78 Road Vehicles (Including Air-Cushion Vehicles)

Easy-to-Imitate Research-Intensive Goods

SITC 51 Organic Chemicals
SITC 52 Inorganic Chemicals
SITC 54 Medicinal and Pharmaceutical Products
SITC 58 Plastics in Non-Primary Forms
SITC 59 Chemical Materials and Products, n.e.s.
SITC 75 Office Machines and Automatic Data-Processing Machines
SITC 76 Telecommunications and Sound-Recording and Reproducing Apparatus and Equipment

Difficult-to-Imitate Research-Intensive Goods

SITC 57 Plastics in Primary Forms
SITC 7 Machinery and Transport Equipment (excluding 75, 76, 78)
SITC 87 Professional, Scientific and Controlling Instruments and Apparatus, n.e.s.
SITC 88 Photographic Apparatus, Equipment and Supplies and Optical Goods, n.e.s.; Watches and Clocks

Hrvoje Jošić

TESTIRANJE MODELA FAKTORSKIH PROPORCIJA NA PRIMJERU REPUBLIKE HRVATSKE

Sažetak

Model faktorskih proporcija jedan je od temeljnih modela u teoriji međunarodne trgovinske razmjene. Razvili su ga švedski ekonomisti Eli Heckschera i Bertila Ohlina početkom 20-ih godina prošloga stoljeća. Na temelju trgovinskih podataka između Republike Hrvatske i zemalja Europske unije i svijeta te relativne raspoloživosti temeljnih faktora proizvodnje, model faktorskih proporcija je testiran na primjeru Republike Hrvatske. U tu je svrhu korišten test predznaka. On uspoređuje očekivani predznak prema modelu faktorskih proporcija s predznakom indeksa otkrivenih komparativnih prednosti (RCA). Rezultati analize su pokazali da model faktorskih proporcija ne vrijedi na primjeru Republike Hrvatske. Republika Hrvatska ne koristi učinkovito svoje komparativne prednosti uslijed izostanka specijalizacije u proizvodnji proizvoda koji intenzivnije koriste proizvodni faktor kojim Republika Hrvatska relativno obiluje. Ograničenja modela su vezana uz činjenicu da pojedine pretpostavke modela faktorskih proporcija nisu zadovoljene.

Ključne riječi: model faktorskih proporcija, Republika Hrvatska, SITC, test predznaka