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There is still life in factor proportions model: an evidence from the selected OECD countries

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Abstract

The factor proportions model, also known as the Heckscher-Ohlin model, is the main neoclassical model of international trade theory. It was developed by Swedish economists Eli Heckscher and Bertil Ohlin in 1920s and 1930s. According to the factor proportions model a country should specialize in the production and export of products that make use of its relatively abundant factor of production. The factor proportions model was heavily empirically investigated in the last seventy years. The consensus is that although the model is theoretically simple and sound, it empirically fails when confronted with data. The sign test is one of the instruments for testing the factor proportions model. The sign test compares the expected sign of the relative abundance of production factors intensively used in the production of a specific product with the sign of the normalised trade balance. In some cases, the probability of outcomes achieved on the sign test was no higher than the coin toss. The aim of this paper is to introduce new methodology in testing the factor proportions model, Heckscher-Ohlin-teorem precisely, for 33 OECD countries using the SITC 2 classification of products and sign test for the year 2014. The novelty of this new method is in using the normalized trade balance approach instead of calculating net factor content of trade. The main advantage of this approach is simplicity and easier calculation of results. The results of the analysis have shown that the sign test holds in almost 60% of cases for the selected OECD countries.

JEL classification: F1, F2

Key words: Factor proportions model, Sign test, SITC 2, OECD countries

1. Introduction

The factor proportions model is the main neoclassical model of international trade theory. It was developed by Swedish economists Eli Heckscher and Bertil Ohlin in the second and third decade of the twentieth century. Factor proportions model is also known as the Heckscher-Ohlin trade model, Heckscher (1919) and Ohlin (1924). The factor proportions model continues on classical models of international trade; Adam Smith's theory of absolute advantages and David Ricardo's theory of comparative advantages (Ricardo, 1817). While Ricardo's theory of comparative advantages is based on differences in relative labour productivity, the Heckscher-Ohlin model is based on

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differing relative labour and capital endowments and identical technologies across countries.

According to the Heckscher-Ohlin's model, a labour-abundant country will export a labour-intensive commodity and import a capital-intensive commodity (Ohlin, 1933). Wassily Leontief was the first to test the factor proportions model empirically using input-output matrix data with the help of 1947 input-output tables for the United States, Leontief (1953). He computed the factor content of US trade (the amount of labour and capital required for $1 million worth of the United States's exports and imports). The results have shown that the United States export labour-intensive products and import capital-intensive products, contrary to the factor-proportions model, the conclusion which came to be known as the Leontief paradox.

After the Leontief testing of the Heckscher-Ohlin model, numerous studies have tried to prove or disprove the results of the Leontief testing. An objection to his analysis is that he did not include all existing factors of production, namely human capital. There were further modifications of Leontief's methodology for testing the factor proportions model by allowing for technology differences, intermediate products, intra-industry trade and firm heterogeneity. Vanek (1968) extended the Heckscher-Ohlin model of two countries, two goods and two production factors on many countries, many goods and many production factors model. In the Heckscher-Ohlin-Vanek model there are at least as many goods as production factors while a country can be a net exporter of more products in which is intensively using their abundant production factors. Various empirical tests of the Heckscher-Ohlin-Vanek theorem have failed to find empirical confirmation in data. The frequency of matches achieved on the sign test, a test specifically constructed to measure correct prediction of signs attributed to net exports of products matching with the net factor content of trade, was often lower than expected by the factor proportions model. The direction of trade was correctly predicted no more than 50 percent of cases, matched by a coin toss.

The main reasons why this theoretical model was not empirically verified in practice are the strong restrictive assumptions of the model regarding constant returns to scale, perfect mobility of production factors across industries within a country and immobility across countries, identical (homothetic) preferences among countries, free trade postulate without any market distortions, balanced trade, no factor intensity reversal and Factor Price Equalization (FPE) claim. Alongside Heckscher-Ohlin-Vanek theorem two other important theorems related to the factor proportions model, which are also based on similar assumptions, are the Stolper-Samuelson theorem (Stolper and Samuelson, 1941) and the Rybczynski theorem (Rybczynski, 1955).

The goal of this paper is to test the factor proportions model, more precisely Heckscher-Ohlin-Vanek theorem, in the case of OECD countries using the sign test. The sign test compares the expected sign of normalized trade balance (net exports) for the SITC 2 product classification with the relative endowment of production factors intensively used in the production of a specific product. This is a new methodology or approach for testing the factor proportions model. The difference compared to the previous investigation is in using the SITC 2 product classification instead of calculating the net factor content of trade with the help of input-output tables.

The novelty of this approach in regards to the previous research is implementation of normalized trade balance concept instead of calculating the complex and complicated factor content of trade using input-out output matrix. Similar research in this field was conducted by Cavusoglu and Elmslie (2005) and Cavusoglu (2019) who tested the chain version of the H-O theorem empirically. The similarity with this paper is in constructing the net trade flows while the main difference is that we use sign test as an instrument. On the other side, the aforementioned authors tested HOV theorem relying mainly on capital and labour as the main factors of production and factor intensities while we additionally include in the analysis other factors of production such as natural resources and include technology differences among countries.

This paper is an extension of the work conducted in Žmuk and Jošić (2021). The advantages of this approach are that it is simpler and easier to calculate the results. The main advantage of this concept is therefore simplification of the calculation process allowing for the larger subset of countries to be included in the analysis. This is improvement on the previous research conducted by Cavusoglu and Elmslie (2005) and Cavusoglu (2019) which analyse the case of only one country, United States of America. The hypothesis of the paper which will be tested states that sign test should correctly predict country's net exports considering dissimilar factor endowments across countries. The percentage of correct predictions achieved on the sign test should be at least equal or higher than 50%. The data for the SITC 2 product classification and production factor's endowments were collected for the last available year 2014.

The paper consists of five chapters. The first chapter is introduction, the second chapter is the literature review relating empirical testing of the factor proportions model. In chapter three methodology and data are provided while in the fourth chapter the factor proportions model in the case of OECD countries, with the help of the sign test, is tested. In the last chapter concluding remarks are provided.

2. Literature review

After the Leontief's (1953) testing of the Heckscher-Ohlin model, various scholars have investigated the validity of the factor proportions model. Therefore, some of the rigid assumptions of the model have been questioned out. Baldwin (1971) followed the Leontief's approach calculating data for 64 sectors using the 1958 input-output tables and 1962 trade data. Like Leontief, Baldwin did not include agricultural and natural resource sectors into the analysis but took into the consideration the human capital. The results have shown that if the ratio of physical capital-labour is considered the Leontief's paradox continues to hold but disappears when human capital was considered.

Leamer (1980) made a criticism of the Leontief's approach implying that it rests on a simple conceptual misunderstanding and states there is no paradox at all. He argues that it is conceptually wrong to suggest that a country is scarce with capital relative to labour if capital per worker embodied in exports is less than capital per worker embodied in imports except in the case of only two goods and balanced trade. Leamer used Leontief's data for the year 1947, Leontief (1954), and found that the net exports of capital and labour were both positive. Bowen, Leamer and Sveikauskas (1987) investigated multicountry and multifactor tests of the factor abundance theory. They computed the amount of each of 12 production factors embodied in the net exports of 27 countries for the year 1967 using the 1966 United States technology matrix. The authors then compared the factors embodied in trade with direct measures of factor endowment in order to determine to which extent the data conforms with the predictions of the Heckscher-Ohlin-Vanek theorem. For eleven out of twelve factors the proportion of signs matching was greater than 50% but higher than 70% for only four of them.

Trefler (1993) reintroduced the technology differences in the Heckscher-Ohlin-Vanek theorem, criticizing the assumption of identical technologies across countries assuming that technology differences are factor-augmenting. He calculated the factor content of trade for 33 countries and ten factors of production in 1983 using the US technology matrix. His method was to calculate the international productivity differences which make the HOV theorem to perfectly fit the data on trade and endowments. He found that labour in the United States is more productive than in other countries, for example Britain's labour productivity level was two-thirds that of the United States's labour productivity. Trefler (1995) allowed for bias in preferences towards domestically produced goods and introduced alternative assumptions on consumption into the Heckscher-Ohlin-Vanek model (Foster and Stehrer, 2010). He used similar dataset as in his 1993 paper, Trefler (1993), but only for nine sectors of production. When performing the Bowen, Leamer and Sveikauskas (BLS) sign test, the proportion of sign matching was just 49.8 percent while predicted net exports were much smaller than those predicted by the HOV model, the so called "mistery of missing trade".

Davis *et al* (1997) tested the HOV model with international and Japanese regional data for the year 1985. The strict HOV model performed poorly but when some of the rigid assumptions of the Factor Price Equalization (FPE) were relaxed, the results improved dramatically. Davis and Weinstein (2001) introduce technological differences, nontraded goods and costs of trade into the analysis, showing the consistency of the HOV model for ten OECD countries. They take into account factor-augmenting productivity differences and estimate regression model for 34 industries from 1970 to 1995 and two factors of production (capital and labour). The authors compared the measured factor content of trade with the predicted factor content of trade and found that they match in 86 percent of cases.

Debaere (2003) developed a factor content of trade prediction for the HOV model on 1983 data on a sample of 32 countries (16 North and 16 South countries). He found that for countries with very different factor endowments there is a clear support for the validity of HOV sign prediction. Instead of North-North and South-South trade the more weight was given to the North-South trade, coming from the essence of the Heckscher-Ohlin theory where trade is happening between countries of different factor endowments. Romalis (2004) derived and examined predictions of the factor proportions model in commodity markets. Romalis introduced transport costs and monopolistic competition into the traditional Heckscher-Ohlin model and found strong support for the quasi-Heckscher-Ohlin and the quasi-Rybczynski effect for the fast-growing economies. He received support from 1988 data for 123 countries that intensively use their abundant factors capturing large shares of world production and trade in commodities. Similar can be said for countries that rapidly accumulate a certain factor of production where their production and export structures shift towards industries intensively using that abundant factor of production.

Nishioka (2005) investigated HOV model for the OECD countries on data from 1987 to 2011. Although previous empirical findings did not find support for HOV predictions for OECD countries, Nishioka found strong support for the strict HOV model on a dataset for fifteen countries. In his model a new factor, knowledge capital (measured by R&D stock), was introduced. This was important because knowledge capital has important role in determining comparative advantages among OECD countries due to specialization in high-tech products. The sign test obtained the correct signs for 14 out of 15 countries using business knowledge and technology-based spillovers. Requena, Castillo and Artal (2008) conducted an empirical study of the HOV model on Spanish regional data for the years 1990 and 1995. Relaxing the assumption of factor price equalization was not enough to improve the performance of the HOV model. The results of the study provided poor support for the strict HOV model but when allowed for the homothetic preferences and productivity-adjusted factor price equalization across regions, the model performed much better.

Archana (2012) introduced a new method into testing the HOV theorem, an excess supply approach, examining ten manufacturing industries in 46 countries in the year 2009. Factors taken into consideration were primary, secondary and tertiary educated labour, capital stock and arable land. It was proven that comparative advantage creating variables are capital stock, higher education and land. In addition, the HOV theorem was proven to be valid in more than 60% of the cases.

Fisher and Marshall (2014) conducted three tests of the Heckscher-Ohlin-Vanek model; the conventional test, the benchmark test where every country has America's technology and the test in which foreign endowments are converted into international efficiency units. The tests were conducted for thirty-nine countries and five factors in 2005. The first test has shown the best results, there were no statistically significant evidences of missing trade in the second test while the third test accounted for international differences in factor prices and unit input requirements. Archana and Somesh (2014) used partial and complete tests of the HOV hypothesis to analyze the patterns on India's international trade using India's industry level data from the year 1989 to 2008. India was abundant in unskilled labour and capital and scarce in skilled labour, energy and services. The complete test was performed on five factors of production and ten industries using the excess supply approach. The HOV theorem was justified in more than 50% percent of the cases. Jošić (2016) tested the HOV theorem for Croatia using the sign test for the year 2013. The sign test compared the expected sign according to the factor proportions model with the sign of the revealed comparative advantages index (RCA). The results have shown that the factor proportions model does not hold for Croatia, i. e. Croatia does not use its comparative advantages efficiently.

Cavusoglu and Elmslie (2005) tested the chain version of the H-O theorem empirically by using data on capital and labour endowments and capital/labour intensities by sector combined with the export/import data for the United States. The findings of the paper pointed out to the rejection of the model. However, when the gross investments were used as a proxy for productive capital stock and capital/labour ratios were replaced with the investment/labour ratios, there was almost perfect concordance between net trade flows and endowments as predicted by the theory. Cavusoglu (2019) expanded on that study presenting different results using data on capital-labour intensities, exports and imports for ten manufacturing and three service sectors for the United States from 1970 to 2009. The results were robust to different price indices, labour measures and weight measures used to construct net export data. The predictions of the theory were confirmed by the data. However, there was difference in the results between the two studies. That could be explained by the use of different capital stock data as well as the longer time frame of the 2019 study.

This paper follows on Žmuk and Jošić (2021), trying to explain the gap in the existing literature by using normalized trade balance approach (net exports) instead of applying standard net factor content of trade approach. Žmuk and Jošić (2021) introduce new method for testing Heckscher-Ohlin-Vanek theorem by using normalized trade balance approach on the sample of 111 countries worldwide. The results of the sign test have shown that the Heckscher-Ohlin-Vanek theorem holds globally in 55% of cases. The percentage of matched signs was highest for the non-OECD high income countries (75%), equal to 60% for OECD countries and lowest for the lower middle income and low income countries (below 50%). The key finding was that Heckscher-ohlin-Vanek theorem mainly holds in oil-rich economies. One of the reasons for this could be a focus on exports of only one essential product, oil, but according to authors the more detailed analysis should be conducted to validate this result.

3. Methodology and data

In the analysis, data for the Organisation for Economic Co-operation and Development (OECD) member countries are observed. However, due to the lack of the data the following three OECD countries are omitted from the analysis: Czech Republic, Israel and New Zealand. Consequently, in the analysis, data for the following 33 countries are observed. Except for the observed countries, data for the World are collected as well. In order to conduct the analysis the following variables have been taken into account: gross domestic product (GDP) (in USD) – GDP; three different production factors: produced capital (in USD) – PCAP; labour force (number of persons) – LABF and natural resources (a detailed division was made into 6 categories of natural resources: metals and minerals (in USD) – MMIN; forests (in USD) – FOR; oil, coal and natural gas (in USD) – OCNG; pastureland (in USD) – PAST; cropland (in USD) – CROP and fishing (in metric tons) – FISH). Labour force comprises people aged 15 and older who supply labour for a production of goods and services including people who are currently employed but also people who are unemployed but are seeking work as well as first-time job-seekers, World Bank, (2020c). Produced capital includes the value of machinery, buildings, equipment and residential and nonresidential urban land, World Bank (2020).

Natural resources are measured as the value produced, mined, etc., and expressed in USD. An additional variable representing technology differences is research and development (R&D) (number of researchers in R&D per million people) – R&DR. In addition, import and export values for the 97 groups of products given in USD are observed too. The World Bank (2020, 2020a-d) and Trade Map (2020) databases have been used as data sources. The analysis will be based on the most recent available data. Unfortunately, the most recent data available are for 2014. Still, some data were missing for the R&DR variable, so the values from the closest year available were used as an approximation for the 2014 value. Approximations were conducted for Australia (data from 2010), Iceland (data from 2015), Mexico (data from 2013), Switzerland (data from 2015) and for the World (data from 2015).

The factor proportions model which will be tested is based on many countries, many factors and many goods, the so called Heckscher-Ohlin-Vanek model. Goods have been classified into five product groups according to their product intensity; 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). This five product group classification of products is taken from Erlat and Erlat (2003). In Table A1 in Appendix the classification of products according to their product intensity is displayed. The standard HOV model equation is presented in Equation 1. A detailed derivation of the HOV theorem can be found in Feenstra (2003):

$$F_i = AT_i = V_i - s_i V_w \tag{1}$$

where F_i is a factor content of trade derived from the invertible matrix A for production of T_i , V_i is country i's factor abundance, s_i is country i's share of the World's GDP and V_w is World's factor abundance. Standard sign tests of the Heckscher-Ohlin-Vanek theorem firstly calculate the trade values (imports and exports) in terms of factors embodied in the production of traded goods. After that the comparison of country's share in World's GDP with the country's share of each factor of production in the total World's endowment is made. This paper follows on Žmuk and Jošić (2021) by imploying new approach to test the validity of the Heckscher-Ohlin-Vanek theorem by using normalized trade balance approach. Precisely, instead of calculating the net factor content of trade using input-output tables, presented on the left side of the Equation 1, the normalized trade balance values were calculated. The sign test of the HOV model is presented in Equation 2.

$$Sign(F_i^k) = Sign(V_i^k - s_i V_w^k) \tag{2}$$

The sign of the factor content of trade should be equal to the difference between country's i factor endowment k and World's factor endowment times country's i share of the World GDP, s_i. We have made a slight modification of the standard sign test based on the factor content of trade. Instead of calculating the net factor content of trade, using input-output tables, we calculated normalized trade balance values presented in Equation 3:

$$TB_{ij} = \frac{E_{ij} - I_{ij}}{E_{ij} + I_{ij}} \tag{3}$$

where TB_{ij} is the trade balance of country i for the product group j, E_{ij} are the exports of country i for product group j and I_{ij} are the imports of country i for the product group j. In case the export value is greater than the import value, the positive sign is assigned to this product group of a certain country. If the import value is greater than the export value, then the trade balance of country i is negative and the negative sign is added to the analysis table. The Equation 3 also assumes identical technology.

The limitation of the normalized trade balance approach is that it could not measure the factor content of trade but it allows for the larger sample of countries to be included in the analysis, Žmuk and Jošić (2021). Our sign test (Equation 4) compares the expected sign of the net exports of the SITC 2 product classification with the relative endowment of production factors intensively used in the production of a specific product. This is new methodology for testing the factor proportions model.

$$Sign(TB) = Sign(V_i^k - s_i V_w^k) \tag{4}$$

Instead of testing HOV theorem using factor content of trade concept, in this paper the HOV theorem was tested using sign test for each good the country trades. For example, if the country i is a capital abundant, it tests whether each good that is produced with the capital intensive technology is (on net) exported. The first step in the analysis includes calculating the shares of each observed country in the whole World value of a certain variable. This procedure was conducted for all factors of production except for the R&DR variable where ratios of the number of researchers in R&D per million people in the observed countries and the average World number of researchers in R&D per million people are calculated. In the second step of the analysis trade balances for the 97 groups of products and for each observed country are calculated. In the following step, the groups of products are associated to the observed nine factors of production whereas the GDP variable was used as a comparison variable.

The products were assigned to the specific groups according to the five product group classification of products taken from Erlat and Erlat (2003). Therefore, we have categorized each SITC 2 product according to its product-intensity group. It has to be emphasized that product group 99, which includes commodities not elsewhere specified, was not associated to any of the observed variables, due to its nature, and therefore it is omitted from the further analysis. Associated factor of production values are then compared to the share of GDP of the observed country in the World's GDP value. If the associated value is lower than the GDP share value, it is assumed that the observed country has a lack of products from that group and therefore it has to import those products. Consequently, the negative sign is assigned to such situations. On the other hand, if the associated values are greater than the GDP shares, the positive signs are assigned. In the final step, the sign test is conducted. In other words, it has been checked whether the trade balance signs and the signs of the differences of associated values and shares of GDP are matched or not. According to the literature review and the research assumption the share of sign matches should be above 50%.

4. Factor proportions analysis and sign tests

In this chapter the factor proportions analysis and sign tests will be conducted. Firstly, descriptive statistics of factors will be presented and elaborated.

4.1. Descriptive statistics of factors

In the first step the values of selected variables regarding factors of production are compared to the World's values. In that way the shares of each observed OECD country in the global value are calculated. However, for the last observed variable, R&DR, the values are compared to the World's average. In other words, if the resulting value for the R&DR variable is higher than 1, the observed country has more researchers in R&D per million people than the World average and vice versa. In Table 1 the main descriptive statistics results of calculated shares for the observed countries are shown.

Table 1. Descriptive statistics of calculated shares for the observed countries in the whole World value, n=33 selected OECD countries, data from 2014

Statistics	Variable									
	GDP	PCAP	LABF	MMIN	FOR	OCNG	PAST	CROP	FISH	R&DR
Average	0.0187	0.0212	0.0056	0.0116	0.0073	0.0041	0.0063	0.0047	0.0051	2.7158
St.Dev.	0.0392	0.0415	0.0091	0.0381	0.0145	0.0115	0.0115	0.0097	0.0077	1.2310
Coeff.Var.	210	195	164	329	199	278	184	208	152	45
Min	0.0002	0.0003	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.1658
1st quar.	0.0029	0.0026	0.0008	0.0000	0.0011	0.0000	0.0010	0.0003	0.0006	1.8132
Median	0.0067	0.0072	0.0015	0.0001	0.0027	0.0001	0.0021	0.0011	0.0014	2.8884
3rd quar.	0.0178	0.0219	0.0076	0.0016	0.0099	0.0015	0.0052	0.0049	0.0053	3.3517
Max	0.2202	0.2271	0.0480	0.2069	0.0833	0.0613	0.0587	0.0531	0.0279	4.9628

Source: authors' calculation.

According to the results presented in Table 1, it can be concluded that there are huge differences in the shares among countries for all observed variables. The highest differences can be found for the MMIN (coefficient of variation = 329%), OCNG (coefficient of variation = 278%) and GDP (coefficient of variation = 210%) variables. On the other side, the lowest variation level is present for the R&DR variable (coefficient of variation = 45%). Huge differences between the observed countries are easy to notice by comparing the lowest and the highest values. For example, the country with the lowest GDP, among the observed OECD countries, has a share of 0.02% in the World's GDP (Iceland) whereas the country with the highest GDP has a share of 22.02% in the World's GDP (United States).

Table 2. Ranks of the observed OECD countries according to observed variables values, data from 2014

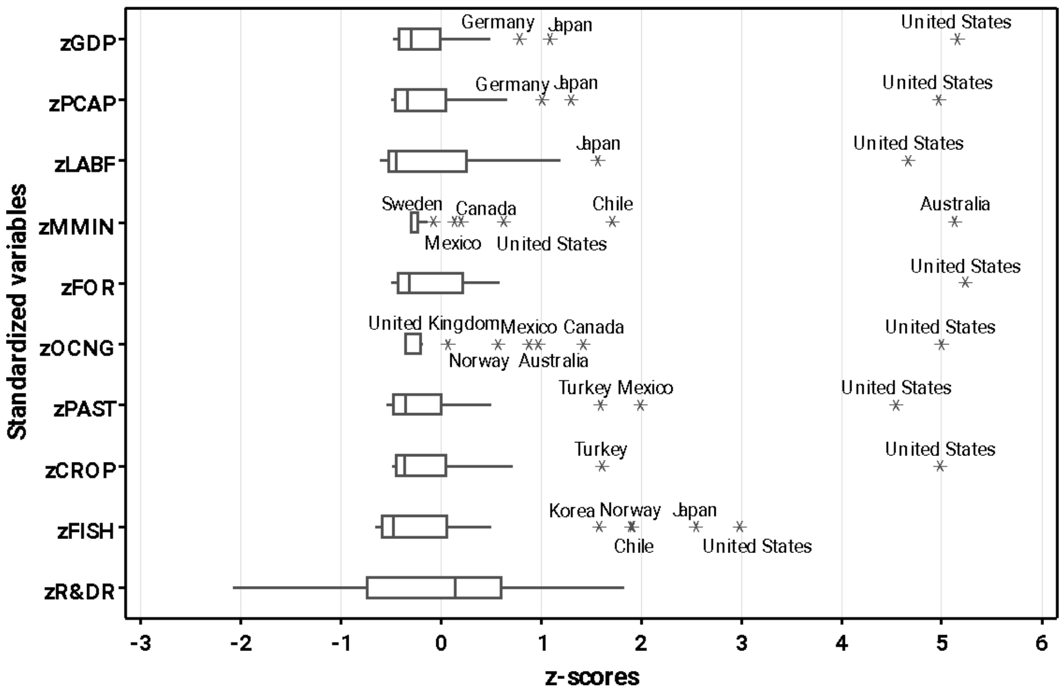
Country	Variable									
	GDP	**PCAP**	**LABF**	**MMIN**	**FOR**	**OCNG**	**PAST**	**CROP**	**FISH**	**R&DR**
Australia	8	8	13	1	2	3	5	9	18	12
Austria	19	16	22	14	15	18	16	21	29	9
Belgium	17	15	18	25	25	26	24	19	27	13
Canada	7	7	11	4	4	2	8	7	9	11
Chile	22	25	15	2	3	14	23	14	3	32
Denmark	20	19	23	25	28	10	22	20	11	1
Estonia	32	32	31	25	19	23	31	30	26	22
Finland	21	22	26	9	10	26	21	25	20	2
France	5	4	6	21	8	15	6	4	12	19
Germany	3	3	4	19	6	9	4	8	17	16
Greece	24	21	19	12	30	13	19	15	23	26
Hungary	26	26	21	22	23	17	27	17	28	25
Iceland	33	33	33	25	33	26	32	33	8	5
Ireland	23	24	27	17	29	25	12	27	15	15
Italy	6	6	9	25	24	11	9	5	16	29
Japan	2	2	2	15	12	19	10	10	2	7
Korea	9	10	8	16	18	20	17	11	5	4
Latvia	31	29	30	25	14	26	29	28	25	30
Lithuania	30	31	28	25	20	24	26	23	24	23
Luxembourg	28	30	32	18	32	26	33	32	33	10
Mexico	11	11	3	5	7	4	2	3	6	33
Netherlands	13	12	14	25	31	8	14	16	14	14
Norway	18	17	24	13	22	5	20	29	4	6
Poland	16	20	12	7	9	7	13	12	19	28
Portugal	25	23	16	11	16	26	25	18	22	21
Slovakia	27	27	25	20	17	22	30	26	31	24
Slovenia	29	28	29	25	26	21	28	31	32	20
Spain	10	9	10	10	13	16	11	6	7	27
Sweden	15	14	17	6	5	26	18	22	21	3
Switzerland	14	13	20	24	27	26	15	24	30	8
Turkey	12	18	7	8	11	12	3	2	13	31
United Kingdom	4	5	5	23	21	6	7	13	10	18
United States	1	1	1	3	1	1	1	1	1	17

Source: authors' calculation.

In Table 2 the ranks of the observed OECD countries according to the calculated share values are presented. The lower the rank a country has, the higher is the variable value. The Table 2 reveals that the United States have the largest relative share for 8 observed variables (GDP, PCAP, LABF, FOR, OCNG, PAST, CROP, FISH). Australia has the highest relative share for the MMIN variable whereas Denmark has the highest share regarding the R&DR variable. On the other hand, Iceland is on the bottom regard to most variables (GDP, PCAP, LABF, MMIN, FOR, OCNG, CROP). In Tables A2 and A3 (In Appendix) the best five and the worst five, respectively, observed OECD countries with regard to each variable separately, are listed. For easier comparison the corresponding share values are presented as well.

The results provided in Tables A2 and A3 confirmed that there are quite large differences in values for all observed variables. Therefore, it has been checked whether some outliers are present on the observed variables. The values of variables have been also standardized and shown in Figure 1 by using box-plot diagrams. Only for the last variable, the R&DR variable, the box-plot diagram suggests that no outliers are present. On the other hand, for all other variables outliers are outlined. In all observed cases of outliers, countries are observed as outliers when their share in value is significantly higher than the other observed OECD countries. Despite the presence of outliers, it has been decided that none of the observed countries will be excluded from the further analysis.

Figure 1. Box-plot diagrams of the observed variables, standardized variables, data from 2014



Source: authors'.

In the next step of the analysis, normalized trade balances are calculated by using Equation 3. Trade balances are calculated for each country separately and within each country according to the observed groups of products. The full list of observed product groups is provided in Table A4 in Appendix. Due to the lack of space, the descriptive statistics of normalized trade balances values are not provided here but are available upon request.

4.2. The sign test

In order to simplify the presentation of the results, the grouping of products according to their intensive production factor is given in Table A4, in Apendix. Normalized trade balances are calculated for each country and for the each observed groups of products. The emphasis was not on the values of the calculated trade balances, instead their signs are in the focus of the analysis. In the final step of the analysis, the matching of trade balance signs and signs of the differences of associated values and shares of GDP is checked. The sign test was conducted for the each observed country and for each product group separately. In Table 3 the results of conducted sign tests on the country level are presented.

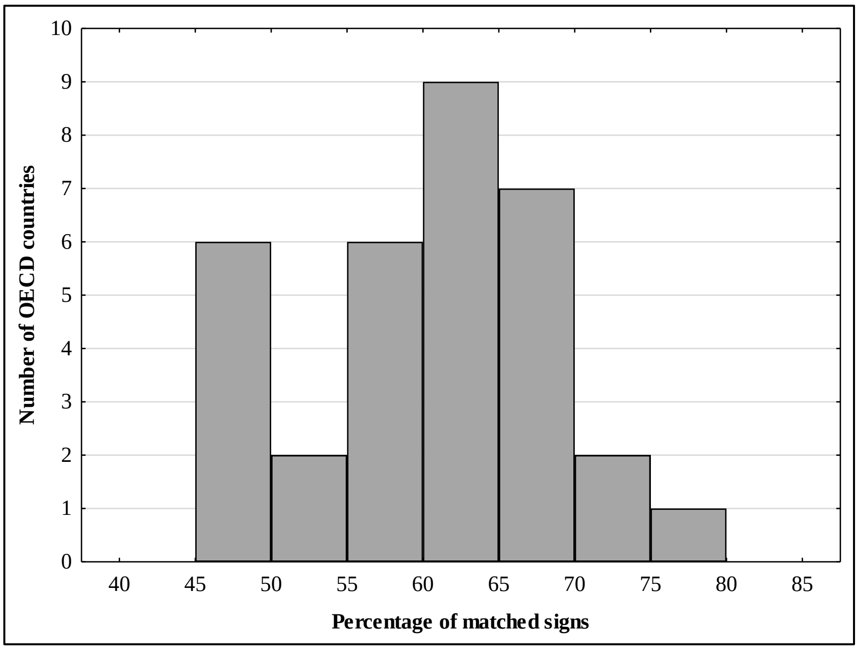
It is expected that the signs are matched in more than 50% of cases. The results provided in Table 3 reveal that in 59.91% of cases the trade balance signs and the signs of the differences of associated values and shares of GDP are the same. The sign matching results on country level suggest that the best results were achieved for the Chile (77.08%), Japan (70.83%) and for the United Kingdom (70.83%). On the other hand, the lowest percentage of sign matching was achieved for Portugal (45.83%), Italy (45.83%), Spain (46.88%) and Hungary (46.88%). The histogram of the distribution of sign matching, given in Figure 2, clearly shows that the benchmark value of the proportion of sign matching is disrupted for only six countries.

Table 3. Results of the sign tests according to the observed OECD country, data for 2014

Country	Sign matching		Share of sign matches
	Yes	No	
Australia	57	39	59.38%
Austria	58	38	60.42%
Belgium	47	49	48.96%
Canada	54	42	56.25%
Chile	74	22	77.08%
Denmark	49	47	51.04%
Estonia	57	39	59.38%
Finland	64	32	66.67%
France	59	37	61.46%
Germany	51	45	53.13%
Greece	54	42	56.25%
Hungary	45	51	46.88%
Iceland	57	39	59.38%
Ireland	66	30	68.75%
Italy	44	52	45.83%
Japan	68	28	70.83%
Korea, Rep.	64	32	66.67%
Latvia	54	42	56.25%
Lithuania	58	38	60.42%
Luxembourg	61	35	63.54%
Mexico	60	36	62.50%
Netherlands	62	34	64.58%
Norway	65	31	67.71%
Poland	47	49	48.96%
Portugal	44	52	45.83%
Slovakia	59	37	61.46%
Slovenia	58	38	60.42%
Spain	45	51	46.88%
Sweden	63	33	65.63%
Switzerland	63	33	65.63%
Turkey	64	32	66.67%
United Kingdom	68	28	70.83%
United States	59	37	61.46%
Total	1898	1270	59.91%

Source: authors' calculation.

Figure 2. Histogram of distribution of sign matches, 33 observed OECD countries, data from 2014



Source: authors'.

The countries for which the percentage of sign matching is below 50% are: Italy, Portugal, Hungary, Spain, Belgium and Poland. Most of observed OECD countries, nine of them, have a percentage of signs matching between 60% and 65%. Results from the Table 3 and Figure 2 point out to the conclusion that the proportion of sign matching on a country level can be observed as a satisfactory one.

In Table 4 the results of the conducted sign tests on the variable level are shown. For seven out of nine observed variables the percentage of sign matching is above the 50%. Only for PCAP (44.59%) and R&DR (40.46%) variables the percentage of sign matching was below the benchmark value. If the percentage of sign matching is observed on the groups of products (see table A5 in Appendix), it can be concluded that for 64 groups of products, or 66.67% of them, the percentage of sign matching is above 50%.

Table 4. Results of the sign tests on the variable level, data for 2014

Country	Variable																	
	PCAP		LABF		MMIN		FOR		OCNG		PAST		CROP		FISH		R&DR	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Australia	6	8	3	30	2	1	1	3	1	0	5	3	6	8	1	1	14	3
Austria	9	5	14	19	1	2	1	3	0	1	3	5	2	12	0	2	8	9
Belgium	6	8	20	13	1	2	2	2	0	1	5	3	7	7	0	2	8	9
Canada	7	7	3	30	3	0	2	2	1	0	6	2	5	9	1	1	14	3
Chile	6	8	2	31	1	2	1	3	0	1	3	5	8	6	0	2	1	16
Denmark	10	4	9	24	1	2	2	2	0	1	5	3	8	6	2	0	10	7
Estonia	10	4	6	27	2	1	2	2	0	1	3	5	4	10	0	2	12	5
Finland	9	5	5	28	1	2	2	2	0	1	3	5	2	12	0	2	10	7
France	9	5	7	26	0	3	0	4	0	1	3	5	7	7	0	2	11	6
Germany	7	7	18	15	2	1	0	4	0	1	6	2	7	7	1	1	4	13
Greece	12	2	5	28	2	1	0	4	0	1	2	6	3	11	1	1	17	0
Hungary	12	2	12	21	0	3	1	3	0	1	7	1	9	5	1	1	9	8
Iceland	12	2	2	31	0	3	1	3	0	1	6	2	1	13	0	2	17	0
Ireland	4	10	6	27	2	1	2	2	0	1	2	6	2	12	2	0	10	7
Italy	8	6	25	8	0	3	1	3	0	1	3	5	7	7	0	2	8	9
Japan	8	6	12	21	0	3	0	4	0	1	1	7	0	14	0	2	7	10
Korea, Rep.	8	6	13	20	0	3	0	4	0	1	1	7	1	13	0	2	9	8
Latvia	10	4	5	28	1	2	2	2	0	1	4	4	3	11	1	1	16	1
Lithuania	3	11	9	24	1	2	2	2	0	1	5	3	6	8	1	1	11	6
Luxembourg	4	10	6	27	0	3	2	2	0	1	4	4	3	11	0	2	16	1
Mexico	4	10	8	25	1	2	0	4	1	0	7	1	9	5	1	1	5	12
Netherlands	3	11	10	23	1	2	1	3	0	1	7	1	7	7	1	1	4	13
Norway	9	5	2	31	1	2	1	3	0	1	1	7	0	14	1	1	16	1
Poland	9	5	13	20	0	3	3	1	0	1	5	3	9	5	1	1	9	8
Portugal	11	3	18	15	2	1	1	3	0	1	3	5	2	12	1	1	14	3
Slovakia	3	11	12	21	2	1	2	2	0	1	2	6	4	10	0	2	12	5
Slovenia	11	3	11	22	1	2	3	1	0	1	2	6	0	14	1	1	9	8
Spain	6	8	14	19	1	2	4	0	0	1	6	2	8	6	1	1	11	6
Sweden	8	6	7	26	2	1	2	2	0	1	3	5	1	13	0	2	10	7
Switzerland	10	4	9	24	0	3	0	4	0	1	2	6	4	10	0	2	8	9
Turkey	4	10	13	20	2	1	0	4	0	1	4	4	4	10	2	0	3	14
United Kingdom	8	6	5	28	0	3	0	4	0	1	2	6	0	14	0	2	13	4
United States	10	4	7	26	1	2	1	3	0	1	6	2	4	10	0	2	8	9
Total	256	206	311	778	34	65	42	90	3	30	127	137	143	319	20	46	334	227

Source: authors' calculation.

The highest percentage of sign matching was achieved for the following group of products: Bird skin, feathers, artificial flowers, human hair (96.97%) and Silk (93.94%). On the other hand, the lowest percentage of sign matches is achieved for the following group of products: Other made textile articles, sets, worn clothing etc. (15.15%) and for

Clocks and watches and parts thereof (18.18%). It can be concluded that factor proportions model passes on the sign test in almost 60% of cases for the OECD countries. Therefore, the hypothesis of the paper which stated that the sign test can correctly predict countries' net exports throughout different factor endowments across countries cannot be unambiguously accepted. However, the percentage of correct signs is more than coin toss or 50% of cases. The sign test held for 27 out of the 33 countries, e.g. 82% of them having the percentage of correct predictions achieved on the sign test which is higher than 50% threshold.

According to Žmuk and Jošić (2021) the percentage of correct predictions achieved on the sign test for non-OECD countries was even higher (75%). On the other side, upper and lower middle income countries had lower percentage of sign matching achieved on the sign test, 55% and 45% respectively, pointing out to the conclusion that rich countries have higher matching rates than poor countries. This finding was explained with the more efficient use of country's comparative advantages and the specialization in production and export for the rich countries in relation to the poor countries. In this analysis the sign test held for 66% of the 97 specific product groups and seven out of nine production factors. In order to provide conclusions what are the common characteristics among products for which the test holds or not, as well as for the production factors, the additional investigation should be made. In addition, we have further checked the results of the analysis by taking into account other years than the years mentioned in the approximations. The outcome results were same for us. The resulting coefficients had identical signs and were generic in nature, meaning that they did not simply apply to a particular sample and year. It can be explained by the fact that, for instance, Australia is a country that invests heavily in research and development compared to other nations, making it impossible to make significant changes in only a few short years. It can be said that using data from various years for all four of the countries had no impact on the analysis's findings.

5. Conclusion

The goal of this paper was to test the factor proportions model in the case of 33 OECD countries. For this purpose, a sign test was constructed for nine factors of production for the year 2014. The sign test compared the expected signs of trade balance (net exports) according to the SITC 2 product classification with the relative endowment of production factors intensively used in the production of a specific product. The results of the sign test revealed that in almost 60% of cases the trade balance signs and the signs of the differences of associated values and shares of GDP are the same. At country level the best results were achieved for Chile (77.08%), Japan (70.83%) and the United Kingdom (70.83%). The countries for which the percentage of sign matches was below 50% are Italy, Portugal, Hungary, Spain, Belgium and Poland. When the percentage of sign matches was observed in regards to the seven production factors, the percentage of sign matching was above 50%, only for produced capital (44.59%) and R&DR (40.46%) it was below 50%. Lastly, if the percentage of sign matching was observed on the products groups, for 64 product groups (out of 97) the percentage of sign matches was above 50%. The limitations of the model are related to the fact that some assumptions of the model were not met as well as the missing data for some countries and the World (the value for the closest year 2015 was taken). That does not affect the overall results of the analysis significantly, implying that factor proportions model still holds. However, further analysis should be made on a new data in order to confirm or disprove general results of this paper. Further investigations could be carried out in a way to take into account additional production factors, effective factor endowment, more detailed product classification, grouping countries into clusters with similar characteristics, etc.

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Appendix

Table A1 Classification of products according to their product intensity

	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

Source: Erlat and Erlat (2003)

Table A2. Top five observed OECD countries according to observed variables values compared to the World level, data for 2014

Variable	Statistics	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
GDP	Country	United States	Japan	Germany	United Kingdom	France
	Value	22.0236%	6.1296%	4.9166%	3.8200%	3.6043%
PCAP	Country	United States	Japan	Germany	France	United Kingdom
	Value	22.7124%	7.5085%	6.3199%	4.8865%	4.1179%
LABF	Country	United States	Japan	Mexico	Germany	United Kingdom
	Value	4.7954%	1.9861%	1.6456%	1.2741%	0.9946%
MMIN	Country	Australia	Chile	United States	Canada	Mexico
	Value	20.6947%	7.6907%	3.5579%	1.9232%	1.6990%
FOR	Country	United States	Australia	Chile	Canada	Sweden
	Value	8.3325%	1.5913%	1.5002%	1.3633%	1.3016%
OCNG	Country	United States	Canada	Australia	Mexico	Norway
	Value	6.1331%	2.0386%	1.5288%	1.4179%	1.0735%
PAST	Country	United States	Mexico	Turkey	Germany	Australia
	Value	5.8695%	2.9150%	2.4658%	1.2138%	1.0897%
CROP	Country	United States	Turkey	Mexico	France	Italy
	Value	5.3081%	2.0235%	1.1673%	0.8968%	0.8516%
FISH	Country	United States	Japan	Chile	Norway	Korea. Rep.
	Value	2.7944%	2.4586%	1.9748%	1.9584%	1.7125%
R&DR	Country	Denmark	Finland	Sweden	Korea. Rep.	Iceland
	Value	4.9628	4.7594	4.6688	4.6542	3.9968

Source: authors' calculation.

Table A3. The last five observed OECD countries according to observed variables values compared to the World level, data for 2014

Variable	Statistics	Rank 33	Rank 32	Rank 31	Rank 30	Rank 29
GDP	Country	Iceland	Estonia	Latvia	Lithuania	Slovenia
	Value	0.0219%	0.0331%	0.0396%	0.0613%	0.0631%
PCAP	Country	Iceland	Estonia	Lithuania	Luxembourg	Latvia
	Value	0.0292%	0.0397%	0.0611%	0.0659%	0.0747%
LABF	Country	Iceland	Luxembourg	Estonia	Latvia	Slovenia
	Value	0.0060%	0.0082%	0.0203%	0.0302%	0.0305%
MMIN	Country	Belgium, Denmark, Estonia, Iceland, Italy, Latvia, Lithuania, Netherlands, Slovenia				
	Value	0.0%				
FOR	Country	Iceland	Luxembourg	Netherlands	Greece	Ireland
	Value	0.0001%	0.0076%	0.0233%	0.0267%	0.0464%
OCNG	Country	Belgium, Finland, Iceland, Latvia, Luxembourg, Portugal, Sweden, Switzerland				
	Value	0.0000%				
PAST	Country	Luxembourg	Iceland	Estonia	Slovak Republic	Latvia
	Value	0.0123%	0.0126%	0.0242%	0.0281%	0.0318%
CROP	Country	Iceland	Luxembourg	Slovenia	Estonia	Norway
	Value	0.0002%	0.0018%	0.0096%	0.0103%	0.0152%
FISH	Country	Luxembourg	Slovenia	Slovak Republic	Switzerland	Austria
	Value	0.0%	0.0009%	0.0016%	0.0018%	0.0019%
R&DR	Country	Mexico	Chile	Turkey	Latvia	Italy
	Value	0.1658	0.2923	0.7901	1.2619	1.3464

Source: authors' calculation.

Table A4. Grouping of products according to their intensive production factor

Variable	Group of products
PCAP	Aluminium and articles thereof; Articles of iron or steal; Beverages, spirits and vinegar; Copper and articles thereof; Essential oils, perfumes, cosmetics, toiletries; Iron and steel; Lead and articles thereof; Nickel and articles thereof; Other base metals, cermets, articles thereof; Rubber and articles thereof, Soaps, lubricants, waxes, candles, modelling pastes; Tanning, dyeing extracts, tannins, derivs, pigments etc.; Tin and articles thereof; Tobacco and manufactured tobacco substitutes; Zinc and articles thereof,
LABF	Arms and ammunition, parts and accessories thereof; Articles of apparel, accessories, knit or crochet; Articles of apparel, accessories, not knit or crochet; Articles of leather, animal gut, harness, travel goods; Bird skin, feathers, artificial flowers, human hair; Carpets and other textile floor coverings; Ceramic products; Cotton; Footwear, gaiters and the like, parts thereof; Furniture, lighting signs, prefabricated buildings; Glass and glassware; Headgear and parts thereof; Impregnated, coated or laminated textile fabric; Knitted or crocheted fabric; Manmade filaments; Manmade staple fibres; Manufactures of plaiting material, basketwork, etc.; Miscellaneous articles of base metal; Miscellaneous manufactured articles; Musical instruments, parts and accessories; Paper & paperboard, articles of pulp, paper and board; Pearls, precious stones, metals, coins, etc.; Printed books, newspapers, pictures etc.; Silk; Special woven or tufted fabric, lace, tapestry etc.; Stone, plaster, cement, asbestos, mica, etc. articles; Tools, implements, cutlery, etc. of base metal; Toys, games, sports requisites; Umbrellas, walking-sticks, seat-sticks, whips, etc.; Vegetable textile fibres nes, paper yarn, woven fabric; Wadding, felt, nonwovens, yarns, twine, cordage, etc.; Wool, animal hair, horsehair yarn and fabric thereof; Works of art, collectors pieces and antiques
MMIN	Fertilizers; Ores, slag and ash; Salt, sulphur, earth, stone, plaster, lime and cement
FOR	Cork and articles of cork; Live trees, plants, bulbs, roots, cut flowers etc.; Pulp of wood, fibrous cellulosic material, waste etc.; Wood and articles of wood, wood charcoal
OCNG	Mineral fuels, oils, distillation products, etc.
PAST	Dairy products, eggs, honey, edible animal product nes; Furskins and artificial fur, manufactures thereof; Live animals; Meat and edible meat offal; Products of animal origin, nes; Raw hides and skins (other than furskins) and leather; Residues, wastes of food industry, animal fodder;
CROP	Animal, vegetable fats and oils, cleavage products, etc.; Cereal, flour, starch, milk preparations and products; Cereals; Cocoa and cocoa preparations; Coffee, tea, mate and spices; Edible fruit, nuts, peel of citrus fruit, melons; Edible vegetables and certain roots and tubers; Lac, gums, resins, vegetable saps and extracts nes; Milling products, malt, starches, inulin, wheat gluten; Miscellaneous edible preparations; Oil seed, oleagic fruits, grain, seed, fruit, etc., nes; Sugars and sugar confectionery; Vegetable plaiting materials, vegetable products nes; Vegetable, fruit, nut, etc. food preparations
FISH	Fish, crustaceans, molluscs, aquatic invertebrates nes; Meat, fish and seafood food preparations nes
R&DR	Aircraft, spacecraft, and parts thereof; Albuminoids, modified starches, glues, enzymes; Boilers, machinery, nuclear reactors, etc.; Clocks and watches and parts thereof; Electrical, electronic equipment; Explosives, pyrotechnics, matches, pyrophorics, etc.; Inorganic chemicals, precious metal compound, isotopes; Miscellaneous chemical products; Optical, photo, technical, medical, etc. apparatus; Organic chemicals; Other made textile articles, sets, worn clothing etc.; Pharmaceutical products; Photographic or cinematographic goods; Plastics and articles thereof; Railway, tramway locomotives, rolling stock, equip.; Ships, boats and other floating structures; Vehicles other than railway, tramway

Source: authors'.

Table A5. Results of the sign tests according to the groups of products, data for 2014

Code	Product	Sign matching		Share of matched signs
		Yes	No	
01	Live animals	15	18	45.45%
02	Meat and edible meat offal	19	14	57.58%
03	Fish, crustaceans, molluscs, aquatic invertebrates nes	23	10	69.70%
04	Dairy products, eggs, honey, edible animal product nes	15	18	45.45%
05	Products of animal origin, nes	23	10	69.70%
06	Live trees, plants, bulbs, roots, cut flowers etc	19	14	57.58%
07	Edible vegetables and certain roots and tubers	24	9	72.73%
08	Edible fruit, nuts, peel of citrus fruit, melons	26	7	78.79%
09	Coffee, tea, mate and spices	30	3	90.91%
10	Cereals	18	15	54.55%
11	Milling products, malt, starches, inulin, wheat gluten	17	16	51.52%
12	Oil seed, oleagic fruits, grain, seed, fruit, etc, nes	20	13	60.61%
13	Lac, gums, resins, vegetable saps and extracts nes	23	10	69.70%
14	Vegetable plaiting materials, vegetable products nes	28	5	84.85%
15	Animal,vegetable fats and oils, cleavage products, etc	24	9	72.73%
16	Meat, fish and seafood food preparations nes	23	10	69.70%
17	Sugars and sugar confectionery	23	10	69.70%
18	Cocoa and cocoa preparations	25	8	75.76%
19	Cereal, flour, starch, milk preparations and products	19	14	57.58%
20	Vegetable, fruit, nut, etc food preparations	22	11	66.67%
21	Miscellaneous edible preparations	20	13	60.61%
22	Beverages, spirits and vinegar	15	18	45.45%
23	Residues, wastes of food industry, animal fodder	22	11	66.67%
24	Tobacco and manufactured tobacco substitutes	12	21	36.36%
25	Salt, sulphur, earth, stone, plaster, lime and cement	18	15	54.55%
26	Ores, slag and ash	25	8	75.76%
27	Mineral fuels, oils, distillation products, etc	30	3	90.91%
28	Inorganic chemicals, precious metal compound, isotopes	11	22	33.33%
29	Organic chemicals	11	22	33.33%
30	Pharmaceutical products	15	18	45.45%
31	Fertilizers	22	11	66.67%
32	Tanning, dyeing extracts, tannins, derivs,pigments etc	21	12	63.64%
33	Essential oils, perfumes, cosmetics, toileteries	15	18	45.45%
34	Soaps, lubricants, waxes, candles, modelling pastes	16	17	48.48%
35	Albuminoids, modified starches, glues, enzymes	16	17	48.48%
36	Explosives, pyrotechnics, matches, pyrophorics, etc	11	22	33.33%
37	Photographic or cinematographic goods	9	24	27.27%
38	Miscellaneous chemical products	15	18	45.45%
39	Plastics and articles thereof	16	17	48.48%
40	Rubber and articles thereof	18	15	54.55%
41	Raw hides and skins (other than furskins) and leather	11	22	33.33%

Code	Product	Sign matching		Share of matched signs
		Yes	No	
42	Articles of leather, animal gut, harness, travel goods	29	4	87.88%
43	Furskins and artificial fur, manufactures thereof	14	19	42.42%
44	Wood and articles of wood, wood charcoal	27	6	81.82%
45	Cork and articles of cork	23	10	69.70%
46	Manufactures of plaiting material, basketwork, etc.	30	3	90.91%
47	Pulp of wood, fibrous cellulosic material, waste etc	21	12	63.64%
48	Paper & paperboard, articles of pulp, paper and board	23	10	69.70%
49	Printed books, newspapers, pictures etc	19	14	57.58%
50	Silk	31	2	93.94%
51	Wool, animal hair, horsehair yarn and fabric thereof	23	10	69.70%
52	Cotton	24	9	72.73%
53	Vegetable textile fibres nes, paper yarn, woven fabric	27	6	81.82%
54	Manmade filaments	24	9	72.73%
55	Manmade staple fibres	24	9	72.73%
56	Wadding, felt, nonwovens, yarns, twine, cordage, etc	15	18	45.45%
57	Carpets and other textile floor coverings	26	7	78.79%
58	Special woven or tufted fabric, lace, tapestry etc	20	13	60.61%
59	Impregnated, coated or laminated textile fabric	18	15	54.55%
60	Knitted or crocheted fabric	20	13	60.61%
61	Articles of apparel, accessories, knit or crochet	28	5	84.85%
62	Articles of apparel, accessories, not knit or crochet	28	5	84.85%
63	Other made textile articles, sets, worn clothing etc	5	28	15.15%
64	Footwear, gaiters and the like, parts thereof	28	5	84.85%
65	Headgear and parts thereof	26	7	78.79%
66	Umbrellas, walking-sticks, seat-sticks, whips, etc	30	3	90.91%
67	Bird skin, feathers, artificial flowers, human hair	32	1	96.97%
68	Stone, plaster, cement, asbestos, mica, etc articles	19	14	57.58%
69	Ceramic products	24	9	72.73%
70	Glass and glassware	19	14	57.58%
71	Pearls, precious stones, metals, coins, etc	13	20	39.39%
72	Iron and steel	17	16	51.52%
73	Articles of iron or steal	15	18	45.45%
74	Copper and articles thereof	15	18	45.45%
75	Nickel and articles thereof	13	20	39.39%
76	Aluminium and articles thereof	17	16	51.52%
78	Lead and articles thereof	14	19	42.42%
79	Zinc and articles thereof	15	18	45.45%
80	Tin and articles thereof	8	25	24.24%
81	Other base metals, cermets, articles thereof	13	20	39.39%
82	Tools, implements, cutlery, etc of base metal	22	11	66.67%
83	Miscellaneous articles of base metal	25	8	75.76%
84	Boilers, machinery, nuclear reactors, etc	17	16	51.52%
85	Electrical, electronic equipment	13	20	39.39%
86	Railway, tramway locomotives, rolling stock, equip.	16	17	48.48%

Code	Product	Sign matching		Share of matched signs
		Yes	No	
87	Vehicles other than railway, tramway	12	21	36.36%
88	Aircraft, spacecraft, and parts thereof	15	18	45.45%
89	Ships, boats and other floating structures	19	14	57.58%
90	Optical, photo, technical, medical, etc apparatus	20	13	60.61%
91	Clocks and watches and parts thereof	6	27	18.18%
92	Musical instruments, parts and accessories	29	4	87.88%
93	Arms and ammunition, parts and accessories thereof	16	17	48.48%
94	Furniture, lighting signs, prefabricated buildings	21	12	63.64%
95	Toys, games, sports requisites	29	4	87.88%
96	Miscellaneous manufactured articles	19	14	57.58%
97	Works of art, collectors pieces and antiques	17	16	51.52%
Total		1898	1270	59.91%

Source: authors' calculation.