Intra-industry Trade in Croatia: Trends and Determinants

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Abstract

This paper investigates trends and determinants in intra-industry trade in Croatia. Intra-industry trade refers to a two-way trade of differentiated products. The level of intra-industry trade between Croatia and EU, CEE, and countries worldwide is calculated using the Grubel-Lloyd index under HS-2 and HS-4 product groups. Dynamic changes in intra-industry trade are shown by calculating marginal intra-industry trade indices. In addition to this, bilateral weighted adjusted intra-industry trade indices for Croatia and 24 most important trading partner countries are calculated in the period from 2001 to 2017. A panel-econometric analysis investigates the determinants of intra-industry trade in Croatia using a random effects model due to time-invariant characteristics of some determinants. The results of the analysis show that gross domestic product, common border, EU membership, and the distance between Croatia and trading partner countries have significant influence on the level of intra-industry trade in Croatia.

Keywords: intra-industry trade, Grubel-Lloyd index, Croatia, panel analysis

JEL classification: F14, F15

1 Introduction

Classical theories of international trade have observed patterns of trade in different products. This is the so-called inter-industry trade, which can be explained with the help of the theory of comparative advantages. New trade theories such as the Linder theory explain patterns of trade in similar but differentiated products that the classical theories of Smith, Ricardo, and the neoclassical Heckscher-Ohlin theory of international trade could not explain. Linder coined the consumer preference theory based on similarity in preferences for developed countries. However, the Linder theory could not explain the two-way trade in homogenous differentiated products of the same product group.

The concept of intra-industry trade was introduced in the 1960s. The theoretical and empirical interest in intra-industry trade has grown until today. Intra-industry trade is defined as the simultaneous export and import of similar but slightly differentiated goods. It is based on imperfect competition (Krugman, 1979) and economies of scale under increasing returns. Intra-industry trade is divided into two categories, that is, horizontal intra-industry trade and vertical intra-industry trade. Horizontal intra-industry trade is trade in differentiated products of the same quality, while vertical intra-industry trade is trade in differentiated products of different quality. The dynamics of intra-industry trade is represented through marginal intra-industry trade. Early measures of intra-industry trade are attributed to Balassa (1966) and Grubel and Lloyd (1971). The Grubel-Lloyd index is the most widely used measure for calculation of intra-industry trade shares in total trade. Various factors influence the determination of intra-industry trade, such as gross domestic product of trading countries, the difference between the level of development between trading countries, trade intensity, common border and language, membership in regional economic integrations, etc.

Early research on intra-industry trade in Croatia was presented in the paper written by Škuflić and Vlahinić-Dizdarević (2004), who investigated how much of the Croatian foreign trade is of an intra-industry type. Derado (2007) compared Croatian intra-industry trade with transition countries. The analysis showed that a small part of Croatian trade is of an intra-industry type, unlike the new member countries of the EU.

Buturac and Rajh (2006) studied vertical specialization and intra-industry trade in Croatia. The K-means cluster analysis indicated that three clusters of product groups exist in Croatia. High-quality exports are present in industries including tobacco products, pharmaceutical and medicinal products, and textile and fish products.

Buturac (2008) explored comparative advantages and export competitiveness of the Croatian manufacturing industry. He found a modest growth of export competitiveness of the engineering sector, a stagnation of the chemical industry, oscillations of the shipbuilding industry, and a decline of the textile and clothing industry.

Botrić (2012) examined intra-industry trade between the European Union and Western Balkan countries. Marginal intra-industry trade was measured to identify products with strong domestic performance. Trade with EU countries was quite low, as was the share of intra-industry trade.

Botrić (2013) also investigated the determinants of intra-industry trade between Western Balkan countries and EU-15 countries using bilateral trade data as well as data on horizontal and vertical components of intra-industry trade. The most important intra-industry trade determinants identified in Croatia were relative income level, distance, relative factor endowments, and relative trading costs.

Botrić and Broz (2016) investigated trade patterns for Croatia, Bosnia and Herzegovina, and Serbia with the eurozone in the time of economic crisis on the 2-digit level of NACE classification. Most industries in the observed countries recorded a low share of intra-industry trade, with labor-intensive industries having the highest degree of intra-industry trade. The research investigated whether the level of intra-industry trade in Croatia had changed since the EU accession and what the trends were in intra-industry trade since the year 2001. The analysis of the EU accession process is related to intra-industry trade and the smooth adjustment hypothesis. If the share of intra-industry trade is higher, the integration adjustment costs should be lower. Thus, it is very important to analyze trends and determinants of intra-industry trade in Croatia in light of the Croatian EU accession.

In our paper, the analysis, in a certain way, continues on Botrić (2013) by identifying and measuring the determinants of intra-industry trade in Croatia in the period from 2001 to 2017. Therefore, the focus is on the detailed analysis of Croatia's trade patterns with certain groups of countries and individual countries worldwide, which has not been done in previous investigations. Using the Grubel-Lloyd index, average and weighted intra-industry trade indices are calculated for trade with the world, EU countries, and CEE countries using the HS-2 and HS-4 product classification. The dynamics of intra-industry trade in Croatia is observed by calculating indices of marginal intra-industry trade. Bilateral trade between Croatia and its most important trade partner countries is analyzed by calculating weighted intra-industry trade indices, giving higher ponders to the most significant product groups. Factors that most influence the determination of intra-industry trade in Croatia are examined using an econometric panel regression analysis. The random effects model is preferred due to the time-invariant characteristics of the data.

The paper is structured in five chapters. After the Introduction, the Literature Review presents theoretical explanations of the existence of intra-industry trade, further divided into horizontal, vertical, and marginal intra-industry trade.

Special attention is dedicated to econometrical studies related to identifying the determinants of intra-industry trade. The Data and Methodology section is presented in chapter three, while the results of measuring intra-industry trade in Croatia and the econometric analysis of the determinants of intra-industry trade are shown in chapter four. The final chapter presents the conclusion, limitations of the study, and guidelines for further investigations.

2 Literature Review

Research on the importance of intra-industry trade can be divided into measurement and theoretical explanations of intra-industry trade, its horizontal and vertical components, and the dynamics presented by marginal intra-industry trade. On the other hand, there are econometrical studies employed to examine the determinants of intra-industry trade.

Bhattacharyya (2002) found a relationship between the level of economic development and dominating vertical intra-industry trade, with manufactured goods being a category with a relatively high intra-industry trade. Dynamic change in trade patterns determines economic adjustment and specialization.

Erlat and Erlat (2003) considered Turkey's trade worldwide in the period from 1969 to 1999. They found that there was an increase in intra-industry trade after the mid 1980s, but the pattern of Turkey's international trade is predominantly inter-industrial. Special attention is devoted to marginal intra-industry trade, a dynamic measure of intra-industry trends.

Erlat and Erlat (2003) and Fontagné, Freudenberg, and Gaulier (2005) disentangle between horizontal and vertical intra-industry trade. The authors show that an increase in intra-industry trade at the world level is due to a two-way trade of vertically differentiated products.

According to Cernosa (2007), former CEFTA countries (Czech Republic, Hungary, Poland, Slovenia, and Slovakia) show specialization in the production of vertically differentiated products of lower quality. The expansion of trade flows characterized by high marginal intra-industry trade is associated with faster productivity growth (Kaitila, 2008). The highest marginal intra-industry trade indices are found in sectors of differentiated goods and science and scale-intensive sectors. The lowest marginal intra-industry trade (MIIT) indices are found in resource and labor-intensive sectors.

Kucuksakarya (2014) investigates marginal intra-industry trade between Turkey and Israel from 1990 to 2012 at a SITC 3-digit level. He used Brülhart's A, B, and C indices. The free trade area membership variable (FTA) had little impact on the structure of marginal intra-industry trade.

The problem with the Grubel-Lloyd index is the aggregation level of data (Lindqvist, 2006). Highly disaggregated data are often included in a different subgroup and not treated as from the same industry and vice versa for aggregated data. There is also a problem of using bilateral versus multilateral data and the effect of unadjusted trade imbalances. Widodo (2009) modified the Grubel-Lloyd index by considering intra- and inter-regional trade in East Asia. Intra-industry trade has a greater increase in intra-regional trade than in inter-regional trade.

Leitao (2011) analyzed country-specific determinants of intra-industry trade for the United States. Relative factor endowments have a positive impact on horizontal intra-industry trade and overall intra-industry trade, but a negative impact on the vertical component of intra-industry trade. Furthermore, the foreign direct investments (FDI) variable has a positive impact, while geographical distance has a negative impact on intra-industry trade. European Union countries increase imports from Eastern European countries, while China remains a low product price exporter of low-skilled labor-intensive products (Ito & Okubo, 2012).

According to Henao-Rodríguez, Lis-Gutiérrez, Viloria, and Laverde (2016), indices that are mostly used for calculation of intra-industry trade are the Grubel-Lloyd, Greenaway and Milner, and Fontagné and Freudenberg indices.

The following paragraphs present and elaborate on research focusing on determinants of intra-industry trade.

Stone and Lee (1995) examined the determinants of intra-industry trade using longitudinal data for 68 countries from 1970 to 1987, distinguishing between manufacturing and nonmanufacturing countries and comparing static with dynamic estimates. The results were supportive for the intra-industry trade hypothesis, which appears to be dominated more by preference than by scale differentials.

Clark and Stanley (1999) identified country-specific and industry-level determinants of intra-industry trade between the United States and developing countries. Economic size and trade orientation influence it in a positive way, while distance exerts a negative effect.

Sharma (1999) presented patterns and determinants of intra-industry trade in Australian manufacturing since the late 1970s. There was a sharp rise in intra-industry trade starting with the mid 1980s associated with the outward-oriented policy. Intra-industry trade is positively related to product differentiation and scale economies.

Using econometric analysis, Ekanayake (2001) corroborated the predictions of the theoretical model in the case of Mexico. Mexican intra-industry trade is positively correlated with the average income levels, country size, trade intensity and orientation, common border and language, and participation in regional trade agreements (RTA), and negatively correlated with distance and trade imbalances.

Kandogan (2003) analyzed intra-industry trade of transition countries using trade data between 22 transition countries with 28 developed and developing countries from 1992 to 1999. While inter-industry trade is explained by the Heckscher-

Ohlin theory, intra-industry trade is explained by the increasing returns trade theory.

Li, Moshirian, and Sim (2003) studied the determinants of intra-industry trade in insurance services for the United States. The empirical analysis showed that foreign direct investment in insurance services is a significant contributor to the volume of trade.

Chidoko, Zivanomoyo, and Sunde (2006) established the determinants of intra-industry trade between Zimbabwe and its trading partners in the Southern African Development Community using modified gravity equation with the intra-industry trade index as the dependent variable. Explanatory variables in the model were per capita income, trade intensity, distance, exchange rate, and gross domestic product.

Caetano and Galego (2007) described the dynamics of trade among Central and Eastern European countries. There was an evident increase in the share of vertical intra-industry trade. Using panel data framework, the most significant determinants of intra-industry trade were the country's size and foreign direct investment. There is a rapid increase in intra-industry trade between EU-15 and Central, Eastern, and South-Eastern European countries. The importance of intra-industry trade is in achieving real convergence to the European Union (Dautović, Orszaghova, & Schudel, 2014).

Trivić and Klimczak (2015) investigated the determinants of intra-regional trade in the Western Balkans. The variables representing the ease of direct communication and the similarity of religious structures had the strongest influence on trade flows.

Łapińska (2016) investigated the determinants of intra-industry trade between Poland and the European Union in the period from 2002 to 2011 applying an econometric panel model. Factors that had a positive impact on intra-industry trade flows were the size of a partner country measured by gross domestic product, membership in the European Union, and the similarity of language. On the other hand, factors that had a negative impact on intra-industry trade flows were trade imbalances, geographical distance, and larger differences in the size of trading partners.

Sledziewska and Czarny (2016) analyzed the determinants of intra-industry trade of the new EU member states using panel data analysis focusing on the period since the Eastern-EU enlargement (2004–2013). Economic integration played a significant and positive role in the intra-industry trade growth: the deeper the regional trade integration, the more positive effect it had.

Aggarwal and Chakraborty (2017) examined India's bilateral intra-industry trade determinants for 25 major trading partners in the period from 2001 to 2015 using panel data framework. It seems that vertical intra-industry trade dominated horizontal intra-industry trade. Contrary to expectations, the preferential trade dummy was found to be non-significant.

Beck (2018) investigated the robustness of 48 potential determinants of bilateral intra-industry trade for a panel of 26 European countries from 1999 to 2011. Five determinants were robust, namely GDP, trade openness, EU membership, corruption, and difference in factor abundance. It was shown that cultural similarity and transportation costs have no impact on intra-industry trade patterns.

3 Data and Methodology

In this paper, the focus will be on the Grubel-Lloyd index, or intra-industry trade index (*IITI*). The Grubel-Lloyd intra-industry trade index was developed by Herbert Grubel and Peter Lloyd in 1971 (Grubel & Lloyd, 1971). It measures the intra-industry trade of a particular product. It is calculated by using the following equation:

$$IITI = 1 - \frac{|X - M|}{X + M}, \quad (1)$$

where *IITI* is the intra-industry trade index, *X* is the value of export from country *i* to country *j*, and *M* is the value of import from country *j* to country *i*. The intra-industry trade index is equal to one only if the export and import values are equal. In that case, the trade is considered to be intra-industry trade. On the other hand, the larger the difference between the export and import values is, the smaller *IITI* will be (but not lower than 0). The lower the intra-industry trade index is, the more it points to inter-industry trade.

We decided the value of *IITI* would be observed for Croatia and its main trade partners. Accordingly, following equation 1, the role of country *i* is taken by Croatia, whereas the role of country *j* is taken by Croatia's main trade partners, observed separately, one-by-one. To help us select Croatia's main trade partners, we used the values of trade between Croatia and other countries. In addition, we considered whether Croatia has had a tradition of trade with the country or not. Consequently, we selected the 24 most important trade partners with which Croatia has traded actively at least since 2001. The selected countries are: Austria, Belgium, Bosnia and Herzegovina, Bulgaria, China, Czech Republic, France, Germany, Hungary, Italy, Luxembourg, Netherlands, North Macedonia, Poland, Republic of Korea, Romania, Russian Federation, Slovakia, Slovenia, Spain, Switzerland, Turkey, United Kingdom, and United States of America.

The data for exports and imports are collected from the Trade Map database (International Trade Centre, 2019). The export and import data are collected at the 2-digit product level (HS-2) and at the 4-digit product level (HS-4). Because of this, it is possible to calculate two *IITI*s between Croatia and its main trade partners (one at the HS-2 level and the other at the HS-4 level). In addition to *IITI*, the marginal intra-industry trade index (*MIITI*) is observed as well. *MIITI* shows to what extent the change in trade flows is of intra-industry or inter-industry type. As the intra-industry trade index, the marginal intra-industry trade index can take a value from the closed interval from zero to one. If its value is 1, then marginal trade is completely intra-industrial, and vice versa.

The marginal intra-industry trade index is equal to:

$$MIITI = 1 - \frac{|\Delta X - \Delta M|}{|\Delta X| + |\Delta M|}, \quad (2)$$

where *MIITI* is the marginal intra-industry trade index, ΔX is the first-order difference value of export from country *i* to country *j*, and ΔM is the first-order difference value of import from country *j* to country *i*. However, because the first-order differences of export and import values in two consecutive periods are observed here, it is less likely that the marginal values will be obtained with *MIITI* than with *IITI*. Because export and import values from two periods are taken into account, *MIITI* is considered to be a more dynamic indicator than *IITI* (Brülhart, 1993). Brülhart (1993) suggested transposition of the Grubel-Lloyd index to marginal intra-industry trade indicating sectoral performance. *MIITI* values here are observed at the HS-2 and HS-4 levels as well.

Despite the advantages of the *IITI* and *MIITI* indicators, these indicators do not take into account the total trade value between two countries. Therefore, the main variable studied here is the weighted *IITI*, which is calculated as follows:

$$WIITI_j = IITI_j \cdot \frac{X_j + M_j}{X + M}, \quad (3)$$

where $WIITI_j$ is the weighted intra-industry trade index for the *j*-th product group, $IITI_j$ is the intra-industry trade index for the *j*-th product group, X_j is the export value of the *j*-th product group from country *i* to country *j*, *M* is the import value of the *j*-th product group from country *j* to country *i*, *X* is the total value of export from country *i* to country *j*, and *M* is the total value of import from country *j* to country *i*. The use of *WIITI* provides more reliable results. All mentioned trade indicators (*IITI*, *MIITI*, *WIITI*) are first analyzed by using descriptive statistics methods. In the analysis, Croatia and its main trade partners are observed in the period from 2001 to 2017. Due to a large number of countries and periods included, the analysis is based on average values of the observed trade indicators. However, in order to get some sense of the overall

Croatian trade position, the Croatian trade with the world, the European Union (EU-28) member states, and the Central and Eastern European (CEE) countries are inspected first. Afterwards, panel analysis is conducted by using data for Croatia and 24 other countries that are Croatia's most important trade partners in the period from 2001 to 2017. In this panel analysis, the main role as the dependent variable is taken by the *WIITI* variable. The role of the independent variable is taken by six additional variables. All independent variables are carefully chosen according to the conducted literature review and authors' expertise. In the literature section, they have been previously identified as the determinants of intra-industry trade.

In this way, the following independent variables are included in the analysis: gross domestic product of Croatian trade partner *j* expressed in billions of USD (GDPj); the Linder variable (LINDER) defined as the absolute difference of gross domestic products per capita in Croatia and in its trade partner expressed in USD; the distance between the capital cities of Croatia and its trade partner expressed in kilometers (DISTANCE); the dummy variable which is equal to 1 if both Croatia and its trade partner are member states of the European Union (EU); the dummy variable which is equal to 1 if Croatia and its trade partner have a common (land or sea) border (COMMBORD); the dummy variable which is equal to 1 if the official language in the trade partner belongs to the group of Slavic languages (LANG). It is expected that GDP, the LINDER variable, COMMBORD, EU dummy, and LANG will be positively correlated with *IITI*. On the other hand, DISTANCE is expected to be negatively correlated with *IITI*. The data for all observed countries and for all observed years are successfully collected from different data sources and, consequently, the panel model used is balanced. Data for GDP and GDP per capita variable expressed in current USD are available from the World Bank database (World Bank, 2019a; World Bank, 2019b). Data for the distance between capital cities are available from the DistanceFromTo webpage (DistanceFromTo, 2019).

4 Results and Discussion

4.1 Descriptive Statistical Analysis of Observed Trade Indicators

In Table 1, the main descriptive statistics results regarding the *IITI* indicator are shown. The yearly average values have been calculated as an average of 24 *IITI* indicators calculated for each year by observing Croatia's trade with its 24 most important trade partners. The analysis was conducted separately for the HS-2 and HS-4 levels of product groups.

Table 1: *Basic Descriptive Statistics of* IITI *Average Values for the 24 Most Important Croatian Trade Partners According to the HS-2 and HS-4 Product Groups in the Period from 2001 to 2017*

Year	HS-2					HS-4				
	Average	*St. dev.*	*Median*	*Min.*	*Max.*	*Average*	*St. dev.*	*Median*	*Min.*	*Max.*
2001	0.1989	0.1009	0.1988	0.0320	0.4389	0.0821	0.0571	0.0710	0.0048	0.2608
2002	0.1952	0.0976	0.1777	0.0288	0.4238	0.0888	0.0562	0.0747	0.0064	0.2649
2003	0.1932	0.1028	0.1924	0.0191	0.4581	0.0901	0.0570	0.0799	0.0080	0.2578
2004	0.2126	0.1000	0.2084	0.0204	0.4860	0.0963	0.0574	0.0841	0.0102	0.2625
2005	0.2219	0.0971	0.2110	0.0413	0.4589	0.1002	0.0572	0.0854	0.0085	0.2612
2006	0.2222	0.1054	0.1993	0.0401	0.5181	0.1007	0.0575	0.0885	0.0110	0.2610
2007	0.2263	0.1073	0.2115	0.0253	0.4950	0.1067	0.0580	0.1049	0.0078	0.2760
2008	0.2168	0.1072	0.2010	0.0301	0.4793	0.1057	0.0590	0.0994	0.0072	0.2743
2009	0.2271	0.1065	0.2416	0.0320	0.4950	0.1082	0.0584	0.1038	0.0077	0.2601
2010	0.2353	0.1030	0.2484	0.0351	0.4842	0.1125	0.0580	0.1125	0.0113	0.2718
2011	0.2477	0.1038	0.2531	0.0431	0.5162	0.1194	0.0568	0.1170	0.0185	0.2812
2012	0.2499	0.1024	0.2662	0.0430	0.5092	0.1202	0.0547	0.1239	0.0159	0.2790
2013	0.2451	0.0986	0.2626	0.0744	0.4751	0.1104	0.0476	0.1016	0.0348	0.2336
2014	0.2567	0.1085	0.2610	0.0598	0.5252	0.1185	0.0557	0.1216	0.0314	0.2923
2015	0.2628	0.1035	0.2801	0.0849	0.5748	0.1302	0.0625	0.1295	0.0266	0.3388
2016	0.2738	0.1081	0.2846	0.0579	0.5733	0.1414	0.0649	0.1410	0.0340	0.3723
2017	0.2764	0.1128	0.2748	0.0591	0.5716	0.1432	0.0675	0.1401	0.0357	0.3716

Source: Authors' calculations.

According to the results from Table 1, it can be concluded that Croatia's trade with its most important trade partners is mostly of inter-industry character, but there appears to be a shift towards intra-industry trade. Namely, both used central tendency measures, average and median, show an increasing trend in the observed period. The conclusion is valid for both HS-2 and HS-4 levels of product groups.

Table 2: *Basic Descriptive Statistics of* MIITI *Average Values for the 24 Most Important Croatian Trade Partners According to the HS-2 and HS-4 Product Groups in the Period from 2002 to 2017*

Year	HS-2					HS-4				
	Average	*St. dev.*	*Median*	*Min.*	*Max.*	*Average*	*St. dev.*	*Median*	*Min.*	*Max.*
2002	0.2265	0.1038	0.2298	0.0397	0.4610	0.1129	0.0674	0.1046	0.0105	0.2993
2003	0.2361	0.1054	0.2361	0.0327	0.4801	0.1174	0.0650	0.1040	0.0156	0.2956
2004	0.2582	0.1039	0.2539	0.0435	0.4657	0.1291	0.0663	0.1207	0.0206	0.2964
2005	0.2723	0.1002	0.2627	0.0742	0.4834	0.1366	0.0678	0.1296	0.0219	0.3071
2006	0.2673	0.0939	0.2653	0.0773	0.4664	0.1362	0.0675	0.1288	0.0221	0.3067
2007	0.2593	0.1037	0.2628	0.0434	0.4752	0.1363	0.0666	0.1324	0.0274	0.3069
2008	0.2640	0.0969	0.2666	0.0861	0.4453	0.1415	0.0675	0.1387	0.0210	0.3125
2009	0.2469	0.0963	0.2511	0.0374	0.4553	0.1357	0.0640	0.1322	0.0158	0.3023
2010	0.2732	0.0976	0.2886	0.0628	0.4246	0.1476	0.0650	0.1491	0.0240	0.2935
2011	0.2786	0.0907	0.2973	0.0554	0.4438	0.1538	0.0657	0.1500	0.0377	0.3232
2012	0.2855	0.0835	0.2865	0.1197	0.4567	0.1554	0.0609	0.1512	0.0379	0.3129
2013	0.2544	0.0883	0.2582	0.0754	0.4405	0.1346	0.0556	0.1275	0.0356	0.2891
2014	0.2854	0.0991	0.3074	0.0776	0.4731	0.1546	0.0653	0.1416	0.0536	0.3493
2015	0.3007	0.0890	0.3082	0.1204	0.4786	0.1623	0.0647	0.1595	0.0482	0.3462
2016	0.3095	0.0934	0.3256	0.1200	0.4990	0.1729	0.0612	0.1728	0.0685	0.3562
2017	0.2982	0.0944	0.2826	0.0821	0.5071	0.1758	0.0640	0.1701	0.0744	0.3627

Source: Authors' calculations.

In Table 2, the descriptive statistics results related to the *MIITI* indicator are shown. Generally speaking, with the exception of a couple of years, an increasing trend of *MIITI* is present at the HS-2 and HS-4 product group levels, implying the strengthening of intra-industry trade.

Table 3: *Basic Descriptive Statistics of* WIITI *Average Values for the 24 Most Important Croatian Trade Partners According to the HS-2 and HS-4 Product Groups in the Period from 2001 to 2017*

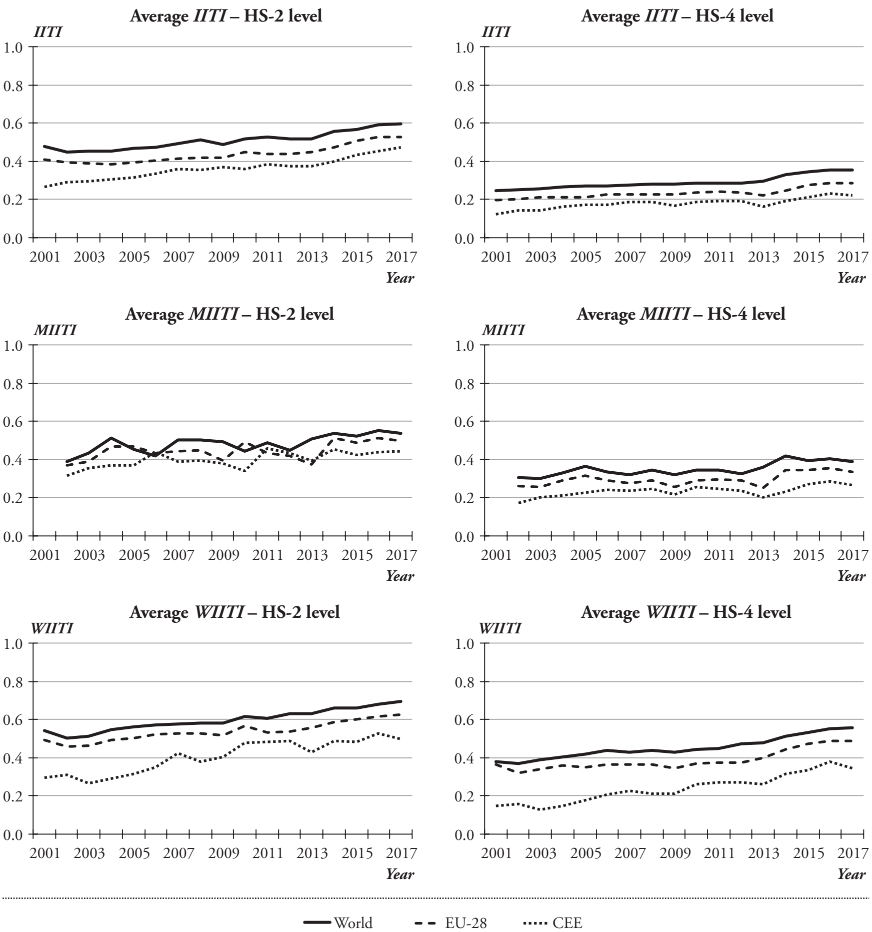
Year	HS-2					HS-4				
	Average	*St. dev.*	*Median*	*Min.*	*Max.*	*Average*	*St. dev.*	*Median*	*Min.*	*Max.*
2001	0.2518	0.1704	0.2030	0.0169	0.6587	0.1433	0.1464	0.1131	0.0023	0.5907
2002	0.2279	0.1488	0.2061	0.0163	0.5256	0.1181	0.1072	0.0876	0.0033	0.3803
2003	0.2366	0.1722	0.2137	0.0131	0.5942	0.1198	0.1146	0.0946	0.0060	0.4132
2004	0.2537	0.1582	0.2392	0.0129	0.6126	0.1321	0.1172	0.1098	0.0023	0.4523
2005	0.2821	0.1514	0.2798	0.0179	0.6038	0.1545	0.1135	0.1181	0.0037	0.4091
2006	0.2973	0.1523	0.2980	0.0145	0.6253	0.1560	0.1229	0.1480	0.0017	0.4183
2007	0.2970	0.1678	0.3069	0.0145	0.6328	0.1462	0.1117	0.1296	0.0027	0.3932
2008	0.2897	0.1617	0.3042	0.0128	0.6116	0.1386	0.1084	0.1253	0.0017	0.3638
2009	0.2966	0.1478	0.3139	0.0089	0.5694	0.1480	0.1053	0.1472	0.0022	0.3539
2010	0.3129	0.1605	0.3355	0.0074	0.5804	0.1549	0.1038	0.1526	0.0018	0.3560
2011	0.3101	0.1512	0.3091	0.0082	0.5752	0.1575	0.1002	0.1378	0.0016	0.3432
2012	0.3159	0.1575	0.3585	0.0204	0.6094	0.1639	0.1029	0.1556	0.0035	0.3757
2013	0.3506	0.1348	0.3562	0.0287	0.5711	0.1778	0.1009	0.1712	0.0032	0.3788
2014	0.3584	0.1400	0.3803	0.0102	0.6408	0.1982	0.1073	0.1921	0.0025	0.4648
2015	0.3544	0.1613	0.3956	0.0175	0.6922	0.1911	0.1232	0.1981	0.0023	0.5148
2016	0.3704	0.1706	0.4130	0.0210	0.6933	0.2059	0.1322	0.2079	0.0044	0.5186
2017	0.3611	0.1679	0.3845	0.0220	0.6439	0.2053	0.1284	0.2043	0.0052	0.4762

Source: Authors' calculations.

Finally, the basic descriptive statistics results regarding the *WIITI* indicator average values are shown in Table 3. As was the case for the *IITI* and *MIITI* indicators, an increasing trend at the HS-2 and HS-4 product group levels in the observed period is present here as well.

After showing the main descriptive statistics results of the observed trade indicators between Croatia and its 24 most important trade partners, the comparison of the average *IITI*, *MIITI*, and *WIITI* values between Croatia and the world, EU-28 member states, and CEE countries at HS-2 and HS-4 levels is shown. Therefore, in Figure 1 the average *IITI*, *MIITI*, and *WIITI* indicators observed at HS-2 and HS-4 levels are shown separately.

Figure 1: *Comparison of Average* IITI, MIITI*, and* WIITI *Values Between Croatia and the World, EU-28 Member States, and CEE Countries at the HS-2 and HS-4 Levels*



Source: Authors' calculations.

The point is that all values, with a few exceptions, are lower than 0.5, which indicates a larger inter-industry than intra-industry trade, which is in line with previous research in Croatia. Also, when using weights, higher values of the indicators were obtained. The values of all indicators, including HS-2 and

HS-4 product groups, are highest for *IITI* with the world, then for trade with EU-28, and lowest for trade with CEE countries. A steady and gradual increase can be noticed in the value of all indicators in the observed period from 2001 to 2017. The values of calculated indicators under HS-4 were lower than those under HS-2, as expected. The comparison of average *IITI*, *MIITI*, and *WIITI* values between Croatia and the observed 24 countries at HS-2 and HS-4 levels is presented in Figure A1 (in the Appendix). The joint conclusion is that the value of all indicators showed growth tendencies in the observed period, the values of weighted intra-industry trade indicators were higher than the values of intra-industry trade indicators and marginal intra-industry trade indicators, and the values under HS-2 were higher than those under HS-4. In addition, the values of intra-industry and marginal intra-industry trade indicators between Croatia and the world according to the HS-2 product codes in year 2017 are presented in Figures A2 and A3.

4.2 Panel Analysis of Weighted Intra-industry Trade Indices

In a panel dataset, the behavior of the same entities is observed across time. Here the role of entities is played by the 24 top import trade partners of Croatia. The data are observed on a yearly basis covering the period from 2001 to 2017. In the panel analysis, the main role, the role of the dependent variable, is played by the *WIITI* indicator. In the previously conducted analyses, the *WIITI* indicator was calculated by taking into account HS-2 and HS-4 levels of product groups. Therefore, overall two panel models are formed. However, in both models the same set of six independent variables (GDPj, LINDER, DISTANCE, EU, COMMBORD, LANG) are considered. First, the panel model with the *WIITI* indicator based on the HS-2 product group level is analyzed, and after that, the panel model in which the dependent variable is the *WIITI* indicator based on the HS-4 product group level.

In the panel analysis, some time-invariant variables are included. If the fixed effects panel model is used, those variables would be just included in the intercept and their individual impact would be unknown. Therefore, the main task is to estimate the random effects panel model. However, the appropriateness of the decision to use the random effects panel model over the fixed effects panel model and even the ordinary least squares (OLS) model is investigated by conducting different statistical tests. The results of Breusch-Pagan Lagrange multiplier (LM) tests (to choose between the random effects panel model and the OLS model), Hausman tests (to choose between the random effects panel model and the fixed effects panel model), and F tests (to choose between the fixed effects panel model and the OLS model) are shown in Table 4. The results of the statistical tests are provided by including all six independent variables (full model).

Table 4: *The Results of Breusch-Pagan Lagrange Multiplier (LM) Tests, Hausman Tests, and F Tests, Dependent Variable* WIITI*, Independent Variables GDPj, LINDER, DISTANCE, EU, COMMBORD, and LANG, n = the 24 Top Import Trade Partners of Croatia, and t = 17 Years (period from 2001 to 2017)*

HS product groups level	Test	Test statistics	P-value	Decision
HS-2	Breusch-Pagan LM	1,135.93	<0.0001	Reject H0
	Hausman*	0.818	0.6642	Do not reject H0
	F	59.67	<0.0001	Reject H0
HS-4	Breusch-Pagan LM	1,192.94	<0.0001	Reject H0
	Hausman*	0.461	0.7942	Do not reject H0
	F	63.86	<0.0001	Reject H0

Note: * Asymptotic assumptions of the Hausman test are not met. Therefore, the Sargan-Hansen test, asymptotically equivalent to the Hausman test, is conducted instead.

Source: Authors' calculations.

The results from Table 4 confirm that the random effects panel model should be used at both HS product group levels. If HS-2 product group level test results are observed, it can be concluded that the random effects panel model is preferred over the OLS model (Breusch-Pagan LM test) and over the fixed effects panel model (Hausman equivalent Sargan-Hansen test). According to the F test results, the fixed effects panel model is preferred over the OLS model. The same panel model relations are valid for the HS-4 product group level as well.

Table 5: *The Results of the Random Effects Panel Model, Dependent Variable* WIITI, *Independent Variables GDPj, LINDER, DISTANCE, EU, COMMBORD, and LANG, n = the 24 Top Import Trade Partners of Croatia, and t = 17 Years (period from 2001 to 2017), HS-2 Product Group Level*

Statistics	**Full random effect model**	**Reduced random effect model**
Intercept (baseline)	0.3057***	0.2981***
	(0.0344)	(0.0293)
GDPj	1.41E-05***	1.45E-05***
	(2.82E-06)	(7.20E-06)
LINDER	1.84E-07	-----
	(8.56E-07)	
DISTANCE	-3.62E-05***	-3.5E-05***
	(7.83E-06)	(7.20E-06)
EU	0.0827***	0.0833***
	(0.0175)	(0.0175)
COMMBORD	0.1569***	0.1517***
	(0.0513)	(0.0502)
LANG	-0.0279	-----
	(0.0459)	
Wald chi-square	76.30***	79.36***
DF	6	4
$\hat{\sigma}_v$	0.0732	0.0731
$\hat{\sigma}_u$	0.1034	0.0981
θ	0.8309	0.8222
Breusch-Pagan LM	1,135.93***	1,154.49***
N	408	408

Notes: Standard errors in parentheses. Statistical significance: * <0.10; ** <0.05; *** <0.01.
Source: Authors' calculations.

Table 5 shows the results of the random effects panel models, where the dependent variable *WIITI* is defined by taking into account HS-2 product group levels. First, the full random effects panel model, where all six independent variables are included, is estimated. However, it turns out that variables LINDER and LANG are not statistically significant in the model. Therefore, an additional random effects panel model without these two independent variables is estimated as well. Still, both random effects panel models, according to the Wald chi-square test statistics, are statistically significant as a whole at the 0.01 level.

Briefly, the random effects panel model is defined as:

$$Y_{it} = \alpha + \beta \cdot X_{it} + (u_i + v_{it}), \tag{4}$$

where Y_{it} is the value of the dependent variable for the i-th unit in period t, α is the intercept, β is the coefficient, X_{it} is the value of the independent variable for the i-th unit in period t, u_i is random effect specific to the unit that is not included in the regression, and v_{it} is the error term. Consequently, here the coefficient values represent the average effect of an individual independent variable, holding other independent variables constant, on the value of the dependent variable *WIITI* when the independent variable changes across time and between the Croatian trade partners by one unit.

Obviously, the interpretations of the coefficients in the random effects panel model are somewhat cumbersome because they include the within-unit and between-unit effects. Because of this, only the signs and "after" absolute values of coefficients will be commented. If the full random effects panel model is observed, only for variables DISTANCE and LANG does a one-unit increase lead to an average decrease in the *WIITI* variable, whereas other independent variables have a positive impact on the dependent variable. However, the LANG variable turns out not to be statistically significant. In absolute terms, the highest impact on the *WIITI* variable is exerted by the COMMBORD (0.1569) and EU (0.0827) variables, which leads to the conclusion that Croatia's most important trade partners, neighboring countries and the EU member states, have a significant impact on the level of intra-industry trade flows. The values of coefficients in the full random effects panel and in the reduced random effects panel model are quite similar. Therefore, they lead to the same conclusions.

Table 6: *The Results of the Random Effects Panel Model, Dependent Variable* WIITI, *Independent Variables GDPj, LINDER, DISTANCE, EU, COMMBORD, and LANG, n = the 24 Top Import Trade Partners of Croatia, and t = 17 Years (period from 2001 to 2017), HS-4 Product Group Level*

Statistics	**Full random effect model**	**Reduced random effect model**
Intercept (baseline)	0.1640***	0.1439***
	(0.0349)	(0.0239)
GDPj	4.02E-06**	3.98E-06**
	(1.73E-06)	(1.84E-06)
LINDER	-2.73E-07	-----
	(3.83E-07)	
DISTANCE	-1.85E-05***	-1.63E-05***
	(6.87E-06)	(5.97E-06)
EU	0.0703***	0.0698***
	(0.0113)	(0.0116)
COMMBORD	0.1381***	0.1380***
	(0.0384)	(0.0366)
LANG	-0.0341	-----
	(0.0329)	
Wald chi-square	115.12***	97.32***
DF	6	4
$\hat{\sigma}_v$	0.0516	0.0516
$\hat{\sigma}_u$	0.0770	0.0738
θ	0.8395	0.8327
Breusch-Pagan LM	1,192.94***	1,219.45***
N	408	408

Notes: Standard errors in parentheses. Statistical significance: * <0.10; ** <0.05; *** <0.01.
Source: Authors' calculations.

The results of the random effects panel model are given in Table 6. However, unlike the results given in Table 5, here the dependent variable *WIITI* is defined by taking into account HS-4 product group levels. The results in Table 6 are very similar to those in Table 5 where the dependent variable *WIITI* was based on HS-2 product group levels. Here again the LINDER and LANG variables are not statistically significant. Because of this, the reduced random effects panel model without these two independent variables is developed as well, and the results are also shown in Table 6.

From the presented analysis, it can be concluded that the character of trade in Croatia is largely of inter-industry type. However, there is a trend showing a gradual but steady rise of intra-industry trade. The main determinants of intra-industry trade in Croatia are GDP of trade partner country, common border, and membership in the European Union. On the other hand, distance has a negative effect on the level of intra-industry trade, which is a highly expected result from the aspect of economic theory. The same can be said about the common border and EU membership variables, which have a positive and significant effect on intra-industry trade in Croatia. On the other hand, common Slavic language has not proven to be a feature that would improve the degree of intra-industry trade between Croatia and its trade partner countries.

The second important conclusion of the presented analysis is that the character of intra-industry trade in Croatia conforms to the gravity model of international trade contrary to the Linder hypothesis—which states that the majority of trade should occur between countries of similar income levels—because the GDP variable has a positive and significant effect on intra-industry trade, while the LINDER variable has a negative sign and is not significant in the analysis.

The results of the analysis can be generalized beyond the case of Croatia by using similar methodology to analyze trends and determinants of intra-industry trade in other countries worldwide. In order to get better results, the analysis could be conducted on a lower aggregation level by additionally dividing intra-industry trade into its horizontal and vertical components and separately evaluating them.

5 Conclusions

The goal of the paper was to investigate the trends and determinants of intra-industry trade in Croatia. The results of the analysis show that Croatia's trade with its most important trade partners is mostly of inter-industry character, but there appears to be a shift towards intra-industry trade. The conclusion is valid for both HS-2 and HS-4 levels of products groups.

The values of all indicators, including HS-2 and HS-4 product groups, are highest for trade with the world in comparison with trade with the EU-28 and CEE countries. Also, after using weights, the values of the indicators were higher than the values of ordinary *IITI* indicators. Panel regression analysis identified the main determinants of intra-industry trade in Croatia using data on bilateral trade between Croatia and its main trade partners. The fixed effects model was dismissed due to time-invariant characteristics of the data, so the random effects model was chosen as appropriate.

The main identified determinants of intra-industry trade in Croatia with a positive impact on *IITI* flows were trading country's GDP, the common border variable, and membership in EU. On the other hand, distance had a negative effect on *IITI*, while the LINDER variable and common Slavic language were not found to be significant.

The limitations of the research are related to the unavailability of data for the analysis of horizontal and vertical components of intra-industry trade. Further investigations should be carried out on a bilateral level by including a larger sample of countries and a detailed analysis of product groups with a larger share of intra-industry trade.

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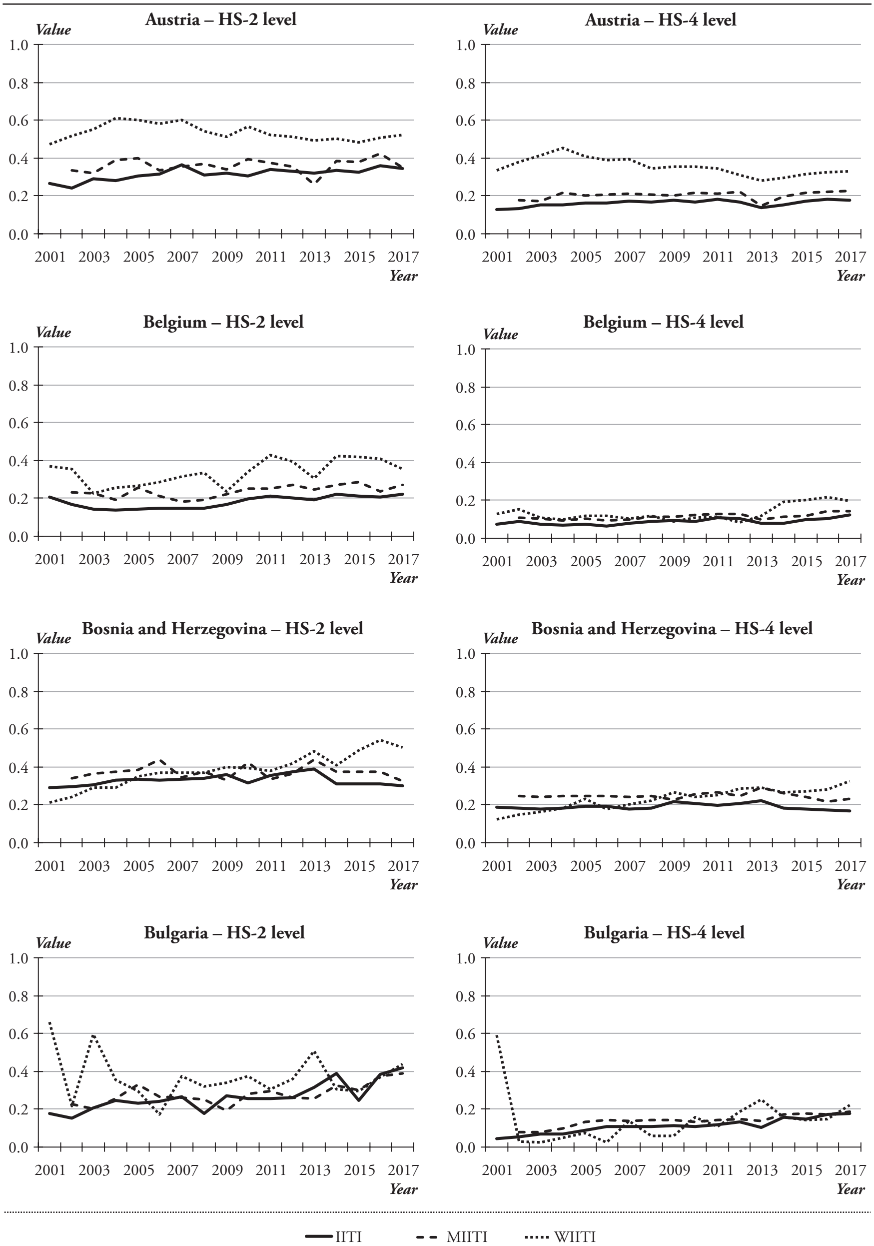
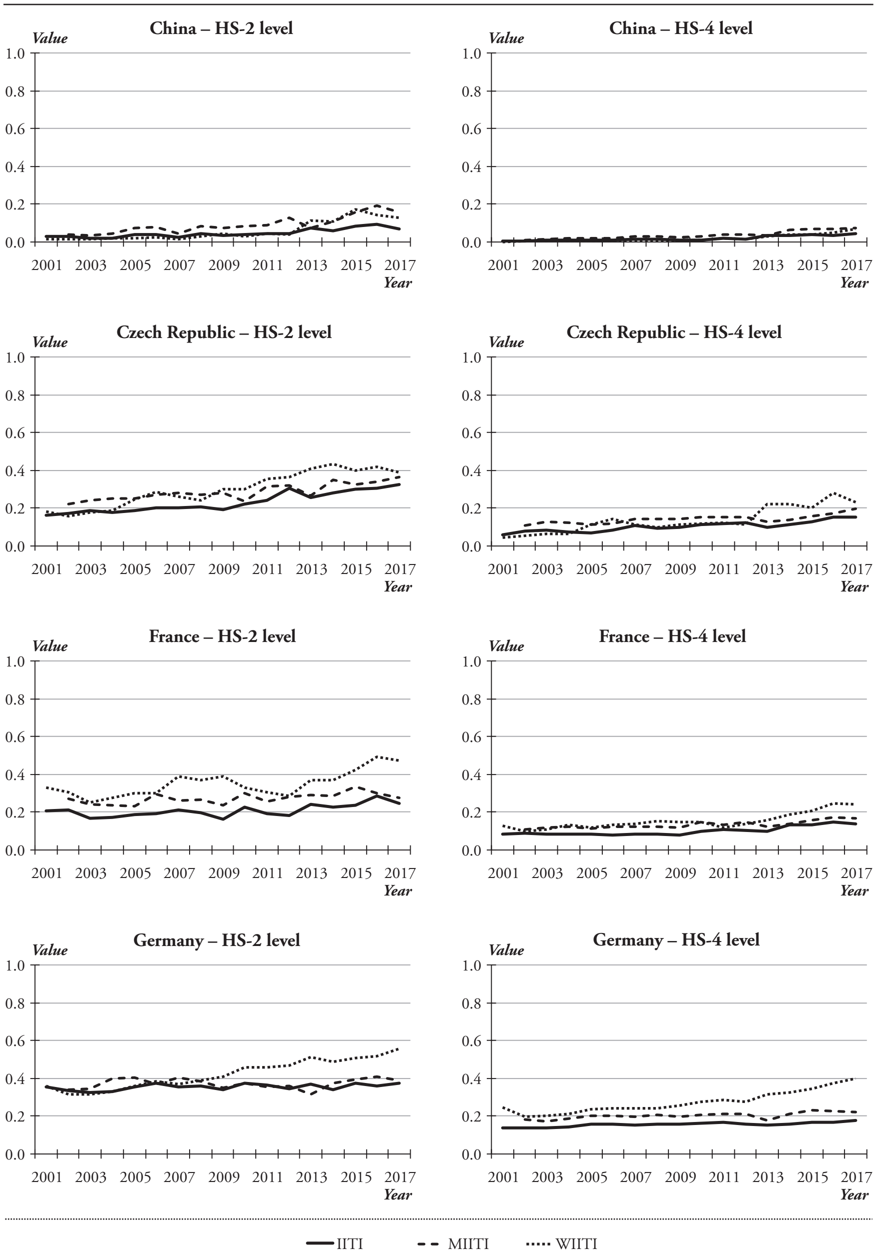
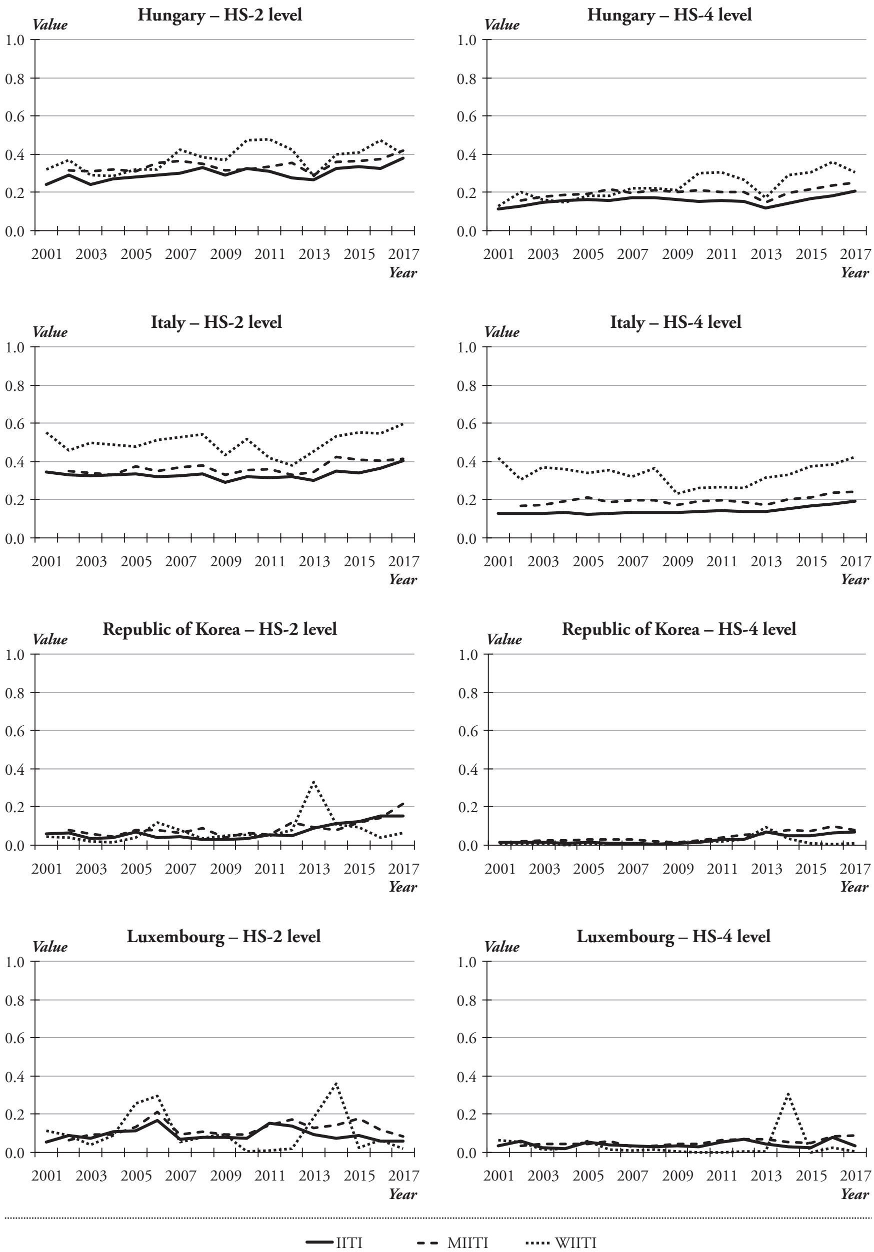
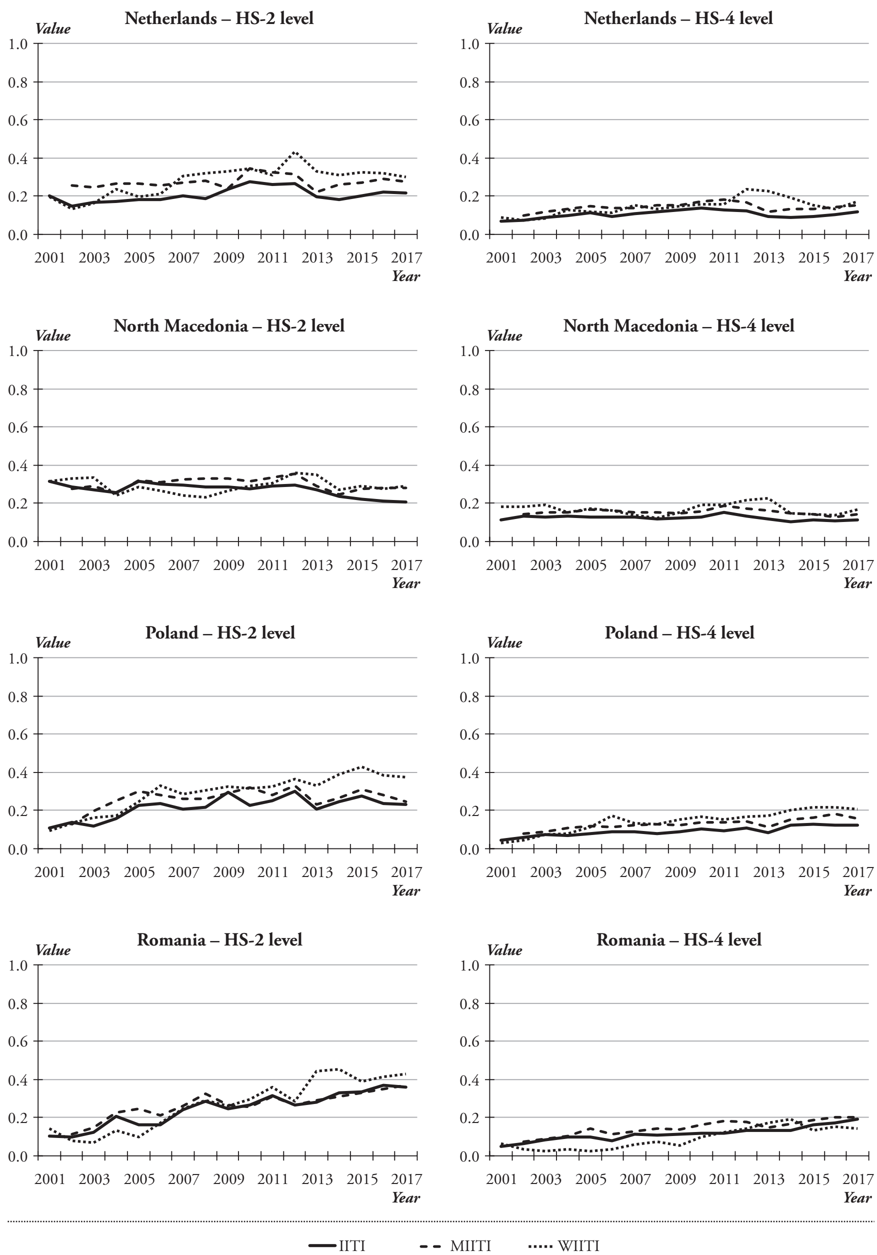
Appendix

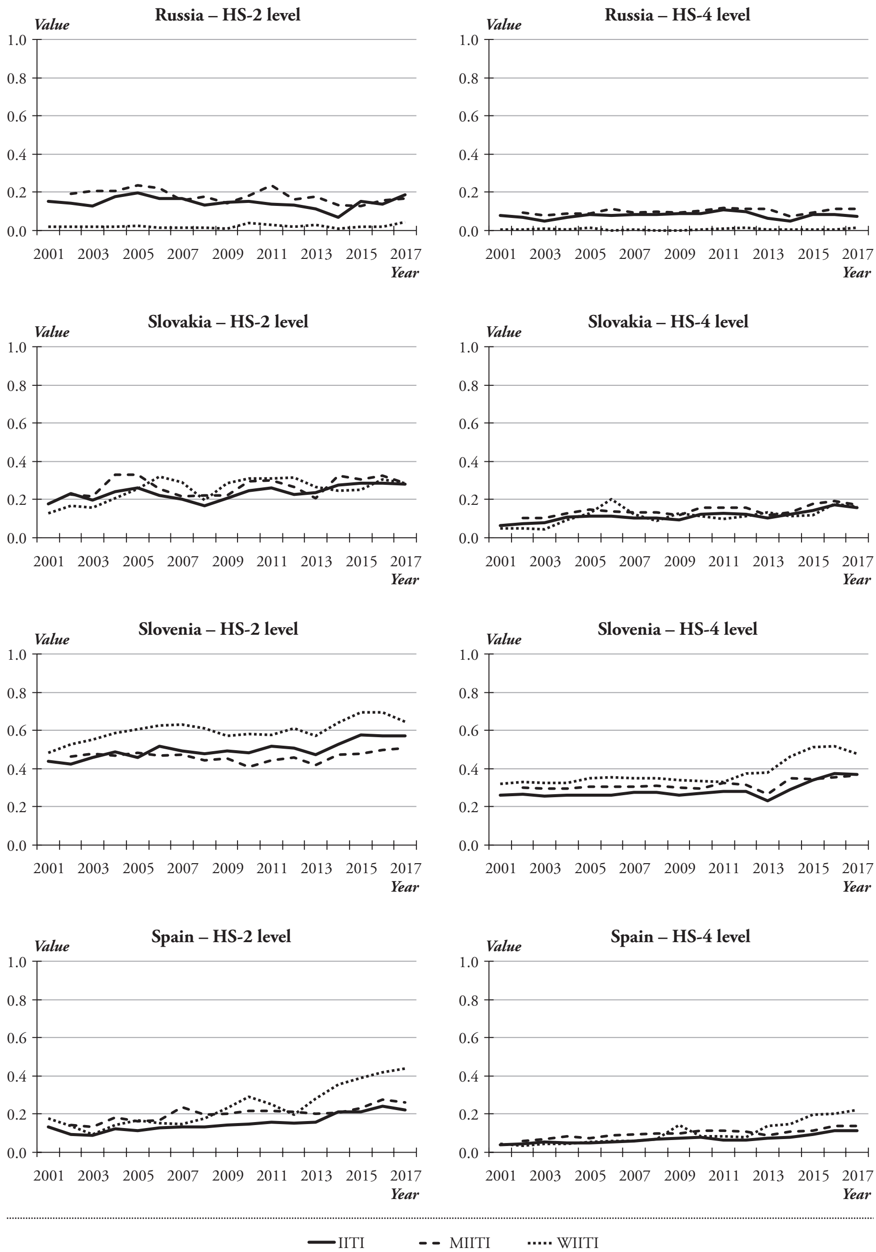
Figure A1: *Comparison of Average* IITI, MIITI, *and* WIITI *Values Between Croatia and the Observed 24 Countries at HS-2 and HS-4 Levels*

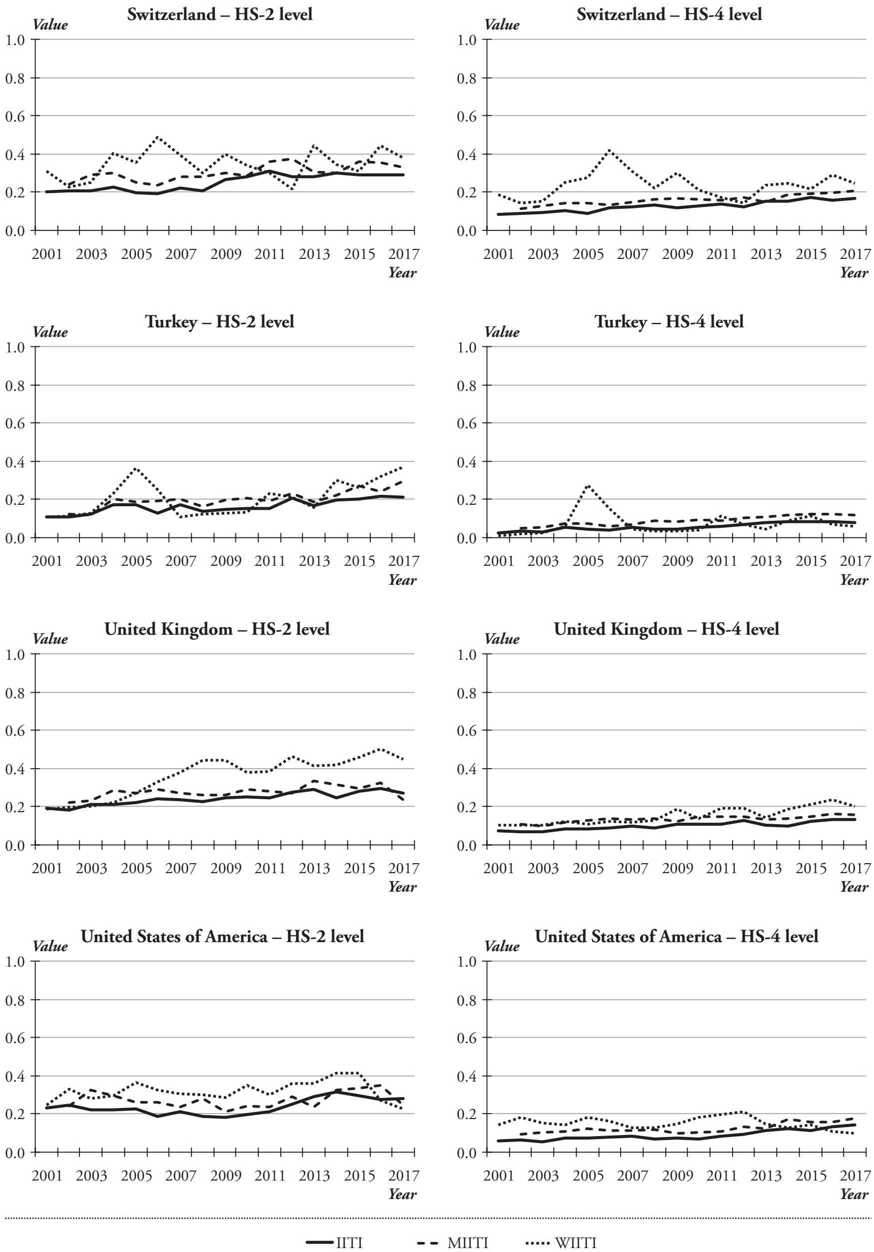



China – HS-2 level
China – HS-4 level
Czech Republic – HS-2 level
Czech Republic – HS-4 level
France – HS-2 level
France – HS-4 level
Germany – HS-2 level
Germany – HS-4 level
Value
1.0
0.8
0.6
0.4
0.2
0.0
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year
IITI
MIITI
WIITI


Hungary – HS-2 level
Hungary – HS-4 level
Italy – HS-2 level
Italy – HS-4 level
Republic of Korea – HS-2 level
Republic of Korea – HS-4 level
Luxembourg – HS-2 level
Luxembourg – HS-4 level
Value
Year
IITI
MIITI
WIITI

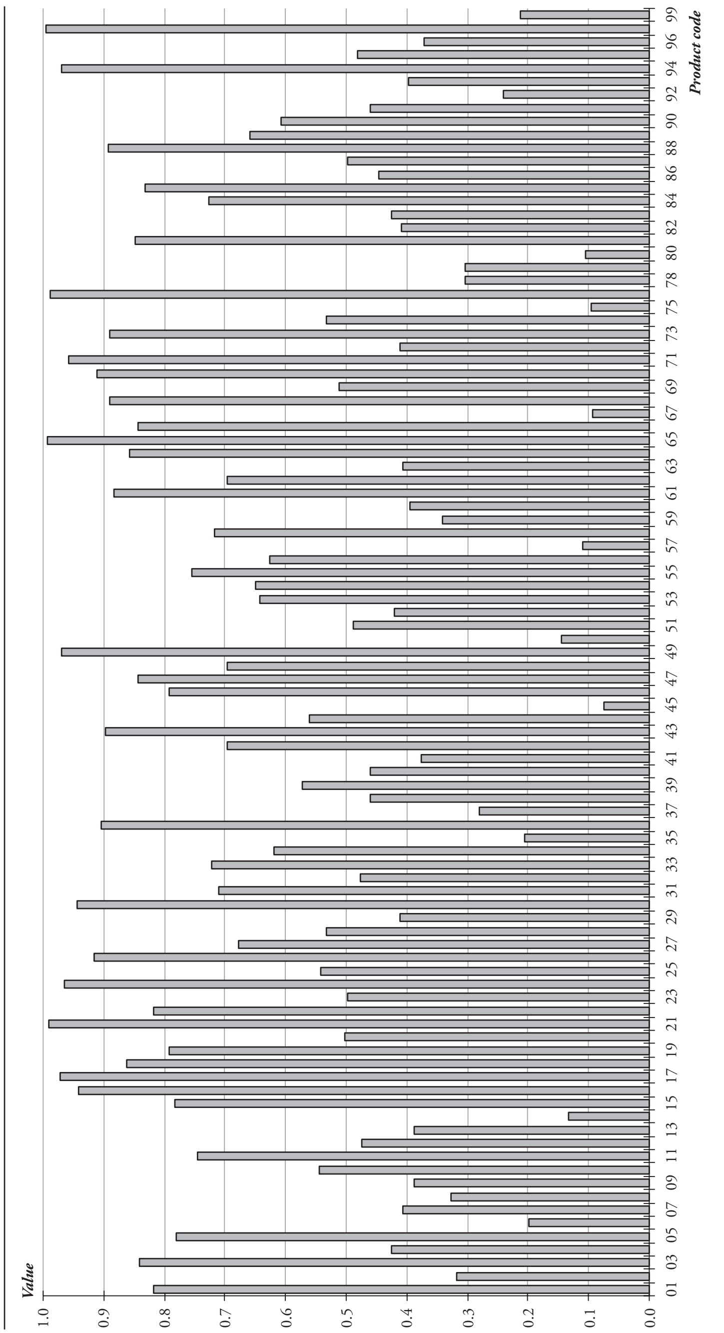

Netherlands – HS-2 level
Netherlands – HS-4 level
North Macedonia – HS-2 level
North Macedonia – HS-4 level
Poland – HS-2 level
Poland – HS-4 level
Romania – HS-2 level
Romania – HS-4 level
Value
1.0
0.8
0.6
0.4
0.2
0.0
2001
2003
2005
2007
2009
2011
2013
2015
2017
Year
IITI
MIITI
WIITI


Russia – HS-2 level
Russia – HS-4 level
Slovakia – HS-2 level
Slovakia – HS-4 level
Slovenia – HS-2 level
Slovenia – HS-4 level
Spain – HS-2 level
Spain – HS-4 level
Value
1.0
0.8
0.6
0.4
0.2
0.0
2001 2003 2005 2007 2009 2011 2013 2015 2017
Year
IITI
MIITI
WIITI



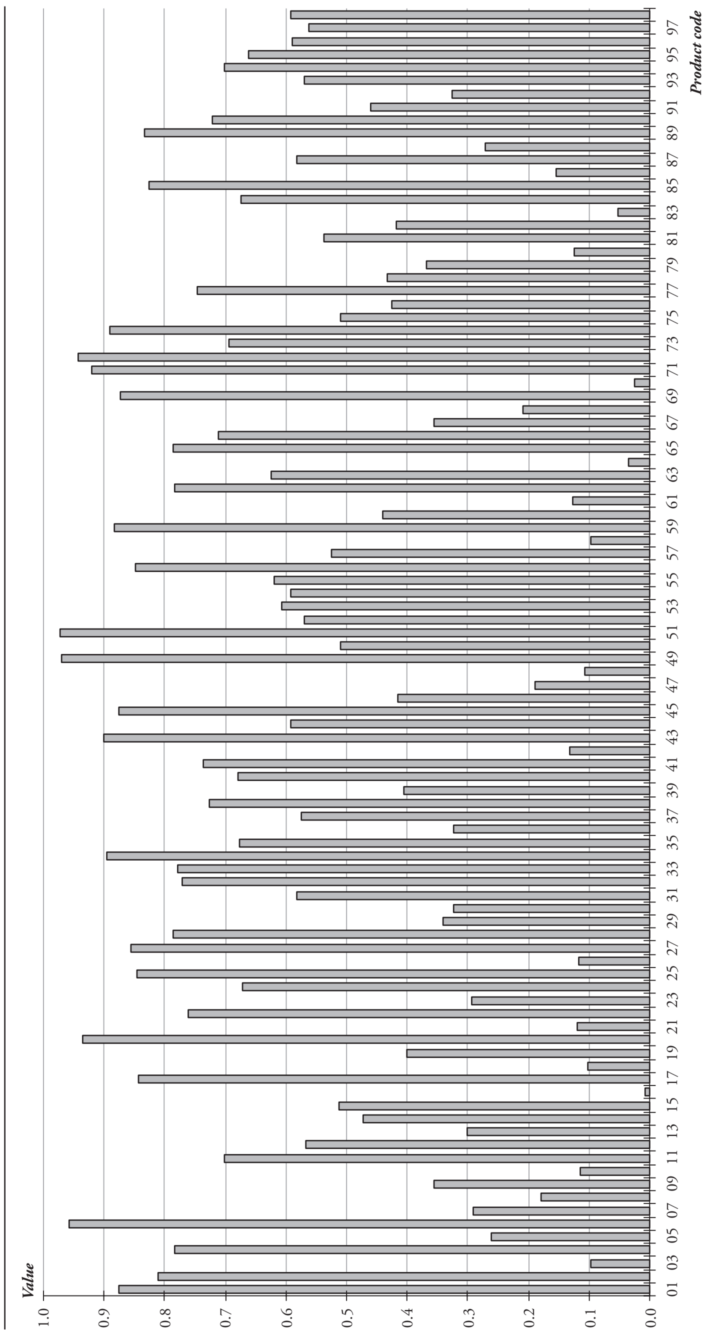
Source: Authors' calculations.

Figure A2: IITI *Values Between Croatia and the World According to the Product Code, HS-2 Level, in 2017*



Source: Authors' calculations.

Figure A3: MIITI *Values Between Croatia and the World According to the Product Code, HS-2 Level, in 2017*



Source: Authors' calculations.