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The Revealed Comparative Advantage of Agri-Food Industries in Selected Countries in the Central and Eastern Europe: Gross-Versus Value-Added Trade Flows

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Abstract

The aim of the article is to interrogate comparative advantage of agrarian and food processing sectors in the context of the agri-food global value chains in particular countries in the Central and Eastern Europe using gross trade and value-added trade data from TiVA database. The Normalized revealed comparative advantage index (NRCA) was applied to analyze comparative (dis)advantage of agrarian and food processing sectors from 1995 to 2020. The article contributes twofold: First, NRCA pairs of indices calculated using gross trade and value-added trade data are mostly consistent. The analysis identifies for what areas and countries there is a discrepancy; second, it reveals comparative advantage of agrarian and food processing sectors in each country separately. It indicates different trajectories of development among countries in the Central and Eastern Europe. These results are complementary to the results of studies that evaluated comparative advantages on the product basis.

Keywords

Agrarian sector, food processing, fragmentation, global value chain, value-added.

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Introduction

World trade and production are increasingly structured around global value chains (GVCs). A global value chain identifies the full range of activities that firms undertake to bring a product or a service from its conception to its end use by final consumers and takes place in numerous locations in different countries (Gereffi, 2014) and accounts for a significant share of international trade over the past decades (Lim and Kim, 2022). The agriculture and food sectors are no exceptions and are increasingly integrated into global value chains (De Backer and Miroudot, 2013; Kowalski et al., 2015; Giovannetti and Marvasi, 2016; Greenville et al., 2017; OECD, 2020; Montalbano and Nenci, 2022, Lim, 2021; Lim and Kim, 2022), however due to factors such as the perishability of raw and intermediate processed products in the food supply chain, nature of products and processes in agri-food industries, these chains differ from those in other sectors (Trienekens, 2011). Despite the slowdown in economic globalization in the last decade, the countries across Europe still remain integrated into GVCs (Antràs, 2020; Constantinescu et al., 2015; Xing et al., 2022).

International trade is traditionally analyzed by using data on gross trade (gross trade is trade that crosses national borders and is registered by customhouses). The assumption is that gross trade flows provide sufficient information to analyze the structure of international trade. Such an assumption is correct as long as the international fragmentation of the production chain is limited (Brakman and Van Marrewijk, 2017). However, the fragmentation of the production process has become a significant characteristic of the world economy (Jones and Kierzkowski, 1990; Krugman et al., 1995; Feenstra, 1998; Hummels et al, 2001; Grossman and Helpman, 2002; Grossman and Rossi-Hansberg, 2008) and international trade flows no longer (or to a lesser extent than it used to be) reflect what a country is producing and exporting (Brakman and Van Marrewijk, 2017). Analyzing characteristics of international trade flows thus becomes more challenging. Traditional trade statistics measured in gross terms, which

include both intermediate inputs and final products, double count the value of intermediate goods that cross international borders more than once and do not explicitly account for foreign value-added in final product (OECD, 2020). Ceglowski (2017) and Fertö (2018) conclude that countries' and/or industries' export competitiveness looks different through the lens of domestic value-added than on the basis of conventional measures using gross exports.

Historically, the value and importance of the data on gross trade to assess and monitor the trade performance of countries, have been illustrated in various scenarios. The gross trade data are regularly used in various types of trade analyses, e.g., to interrogate the concept of revealed comparative advantage in the agriculture and food industries in the countries of the Central and Eastern Europe (e.g. Bojnec and Fertő, 2009; Smutka et al., 2012; Jámbor, 2013; Ignjatijević et al., 2014; Carraresi and Banterle, 2015; Smutka et al., 2016; Bojnec and Fertő, 2019; Matkovski et al. 2019; Pavlak and Smutka, 2022; Vondráček et al., 2022). The agri-food gross trade data in these studies is typically structured according to products (following the methodology of e.g., Harmonized System, HS; or Standard international trade classification, SITC). Nonetheless, new datasets have recently emerged and allow studying trade performance of countries using research strategies that include value-added types of data. Also, the GVC methodology indicates ongoing specialization along the value chains and thus the necessity to identify more clearly what fragment in the production chain is internationally competitive in a particular country. There are currently several such a dataset as e.g. OECD TiVA, UNCTAD Eora, and IDE-JETRO. This new data allow to determine a country's weak and strong sectors based on value-added. Additionally, the way in which the data is structured also allows assessing the performance of individual sectoral segments in the agri-food value chain, i.e. not only the agricultural sector, but also the food processing industry separately and the mutual interaction of the development trajectories and its performance.

Against this background, the paper aims to interrogate comparative advantage and competitiveness of agrarian and food processing sectors in selected countries in the Central and Eastern Europe using gross trade and value-added trade data.

This paper contributes to several literature strands. It contributes to the literature on agricultural trade. There is a long, well established agriculture and development literature on the Countries of the Central and Eastern Europe (Bojnec and Fertő, 2009; Smutka et al., 2012; Jámbor, 2013; Ignjatijević et al., 2014; Carraresi and Banterle, 2015; Smutka et al., 2018; Bojnec and Fertő, 2019; Matkovski et al. 2019; Pavlak and Smutka, 2022; Vondráček et al., 2022). However, the majority of the literature looks at the relationship between agri-food trade and development from an angle of traditional gross trade data. Our analysis contributes to this broad literature by linking globalized agri-food chains to international trade performance. The validity of traditional method (specifically NRCA) that is used to analyze trade performance of countries and regions was assessed. Second, we contribute to the literature on agriculture development by providing evidence that show change in the comparative advantage of particular segments (industries) in the agri-good chains in the countries of Central and Eastern Europe. By highlighting the different trajectories in reveled comparative of agriculture and food sectors using value-added RCA we support policy makers to ensure supportive policies for agri-food firms.

Theoretical background

Over the last couple of decades, critical economic changes have affected the competitive position of the agri-food sector in the EU including globalization, evolution in the patterns of demand for food safety and quality, the completion of a single European Market, introduction of the Euro in some EU Member States, integration into the global value chains, impacts of new trade agreements, and the financial crisis in 2008 and currently the COVID-19 and energy crisis (Harvey et al., 2017; Čechura et al., 2017; Fertö, 2018; Bojnec and Fertő, 2019; Mizik, 2021; Pawlak et al., 2021; Hamulczuk and Pawlak, 2022; Matkovski et al., 2022; Blažková et al., 2023). These changes affected countries in Central and Eastern Europe nonetheless it was even more complex for them as the ex-socialist countries already underwent the substantial changes since the transformation and liberalization in 1990's. and became member states of the EU.

Competitiveness and the following selection process among firms are key components of the market economy regardless of the sector. The term itself has undergone significant changes however there is not a commonly accepted

definition (Mizik, 2021). The diversity of concepts and measures of competitiveness largely relates to the variety of policy analysis needs, perspectives and objectives of the research (Bojnec and Ferto, 2009). The term competitiveness is close to the term comparative advantage. Both terms refer to a firm's ability to produce goods and services and to succeed against competitors over time.

Michael Porter (Porter, 1990) studied firm competitiveness and sources of comparative advantage. Porter's Five Forces Model analyses determinants of national competitive advantage and the model specifies four broad attributes of nation that individually and as a system constitute the diamond of national comparative advantage. These attributes are factor conditions, demand conditions and firm strategy, structure and rivalry, and related and supporting industries. The model describes the prominent role of supplier industries and other related industries as well as demand conditions on the international competitive position of the industry (the model also suggests that related and supporting industries are not the only factor playing a role). Following the logic of the model, it suggests possible linkages between performance of the agrarian industry and performance of the food processing industry in the globalized business environment. The competitive food industry can enhance the competitive position of the agrarian sector because the food processing industry is able to use the raw material produced by domestic farmers and then market processed food products at domestic food markets (competing against imports) or to successfully export processed food products and market it abroad. This potential synergy also applies other way round. The ability of the agricultural sector to supply quality and cheap raw materials to the food industry is a one of the prerequisite for the food industry to be able to show high performance against its foreign competitors and thus maintain or enhance its position on the market. Contrary to Porter's model, the GVC models indicate the fragmentation of the production process and the dispersion of production as a fundamental characteristic of current world production and trade (Gereffi and Fernandez-Stark, 2011). Countries tend to specialize in specific segments of the value chain or specific business functions and tasks. There they build its comparative advantage. GVC emphasize how export competitiveness relies on sourcing of efficient inputs (not necessarily locally produced) as well as access to final producers or consumers abroad.

As suggested by theories of global value chains the possible explanation behind the discrepancies between results using gross trade and value-added trade data can be the process of the international fragmentation of production. In the case of seaside countries, the reason for discrepancies could be existence of the Rotterdam-Antwerp effect. It describes potential distortions in trade statistics occurring as a result of misreporting of commodities passing through major world ports on their way to their final destination (Lemmers and Wong, 2019).

Materials and methods

Data used in the analyses were extracted from The Trade in Value-added (TiVA) database (TiVA, 2023). TiVa is a collection of measures that can provide insights into global production networks and supply chains beyond what is possible with conventional trade statistics. The TiVA database contains a selection of principal indicators that track the origins of value-added in exports, imports and final demand for the years 1995-2020. Indicators are available for 45 industries within a hierarchy based on ISIC Rev. 4. The indicators are derived from the 2018 version of OECD's Inter-Country Input-Output Database (Martins Guilhoto et al., 2022).

The first step was to assess the comparative advantage using gross trade and value-added value-added data. The most widely used indicator of comparative advantage in empirical trade analysis is based on the concept of revealed comparative advantage (RCA) index, which was developed by Balassa (Balassa, 1965), with its variants. The theoretical foundation and empirical distribution characteristics of the Balassa index have been extensively debated and criticized in the literature (Bowen, 1983; Vollrath, 1991; Hinloopen and Van Marrewijk, 2001; De Benedictis and Tamberi, 2004). Because of the shortcomings of the Balassa index, other indices have also been proposed (i.e. Bowen, 1983; Vollrath, 1991; Lafay, 1992; Dalum et al., 1998; Proudman and Redding, 2000; Hoen and Oosterhaven, 2006; Yu et al., 2009; Leromain and Orefice, 2014). At this point, it is worth emphasizing that none of the suggested alternatives seem to be without problems. Nonetheless, Yu et al. (2009) adopted an alternative measure to assess the dynamics of comparative advantage, utilizing the normalized revealed comparative advantage index (NRCA) to improve certain aspects of the original one. The advantage is that the NRCA allows comparison over space and trends over time.

The NRCA is defined as follows:

$$NRCA_{ij} = \frac{E_{ij}}{E} - \frac{E_i}{E} \times \frac{E_j}{E} \quad (1)$$

where E denotes total world trade, E_{ij} describes country i's actual export of commodity j in the world market, E_i is country i's export of all commodities and E_j denotes export of commodity j by all countries. The NRCA index ranges from -0.25 to 0.25 and the comparative neutral point is zero. The sum (and the mean value) of scores is constant and equals to zero and a sum of positive scores equals the sum of negative scores. If NRCA is higher (lower) that 0, a country has a comparative advantage (disadvantage) in product i. The higher the value, the stronger the comparative advantage and vice versa. The scores can be rescaled by multiplying with 10,000 without affecting the results (Sanidas and Sin, 2010). Due to these desirable properties, the NRCA index was used in this study. The TiVA database provided information about the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia, Bulgaria, Croatia and Romania. The TiVA is based on underlying input-output tables that are organized at the industry level (not products) according to NACE code. The two agri-food value chain related industries used in this study are (i) agriculture, hunting, forestry and fishing and (ii) food, beverages and tobacco. Following Fertő (2018), we use the TiVA measures for gross exports and the domestic value-add in foreign final demand to calculate NRCA scores. Even if these databases overcome some of the problems of traditional gross trade data, resorting to the traditional data while value-added data are available, implies that value-based data is probably still far from satisfactory. For more detail see Sturgeon (2013) and the challenges of economic globalization for statistical measurement.

To identify and compare the differences between the calculation of NRCA scores based on gross flows versus value-added flows we are following Brakman and Van Marrewijk (2017) and we use four possible sector classifications. First, a sector may reveal to have a comparative advantage for both gross trade NRCA and value-added NRCA (strong-strong). Second, a sector may reveal to have a comparative disadvantage for both gross trade NRCA and value-added NRCA (weak-weak). Third, a sector may reveal to have comparative disadvantage for gross trade and simultaneously a comparative advantage for value-added trade (weak-strong). Apparently the strength and importance of these sectors for a particular country are underestimated when using gross trade flows. Fourth, a sector may reveal to have a comparative advantage for gross trade and simultaneously a comparative disadvantage for value-added trade (strong-weak). Apparently the strength and importance of these sectors for a particular country are underestimated when using gross trade flows.

In the next step, pairs of scores of NRCA were analyzed regarding its consistency. Ballance et al. (1987) suggest empirical tests to examine the extent to which various NRCA scores are consistent as a cardinal measure (the extent to which a country has a comparative advantage or comparative disadvantage in a sector) and dichotomous measure (similarity in suggesting whether the sector have comparative advantage or comparative disadvantage), and ordinal measure (consistent in ranking sectors by NRCA).

In the third step, we suggest analytical tool to interrogate mutual interaction between the revealed comparative advantage of the agrarian and food processing sectors. For a particular country, we use NRCA scores for agrarian industries and NRCA scores for food processing industries together in the Cartesian coordinate system (Table 1).

Based on the NRCA pair-scores for agrarian and food processing industries, the pair-score will belong to one of these four quadrants depending

Value added RCA or gross trade RCA of food processing industry	NRCA > 0	**B: disadvantage - advantage**	**A: advantage- advantage**
		weak agrarian sector and strong food processing sector	strong agrarian sector and strong food processing sector
	0 < NRCA	**D: disadvantage - disadvantage**	**C: advantage - disadvantage**
		weak agrarian sector and weak food processing sector	strong agrarian sector and weak food processing sector
		NRCA < 0	**0 < NRCA**
		Value added RCA or gross trade RCA of agrarian sector	

Source: authors own proposition

Table 1: Classification of the interaction between RCA of agrarian and food processing sector.

on NRCA and if it reveals comparative advantage or disadvantage. The meaning of each quadrant is following:

- Quadrant A (advantage- advantage): both agrarian sector and food processing industry reveal comparative advantage,
- Quadrant B (disadvantage - advantage): agrarian sector reveals comparative disadvantage, however the food processing industry reveals comparative advantage,
- Quadrant C (advantage - disadvantage): agrarian sector reveals comparative advantage, however the food processing industry reveals comparative disadvantage,
- Quadrant D (disadvantage - disadvantage): both agrarian sector and food processing industry reveal comparative disadvantage.

The situation of synergies derived from Porter's model (Porter, 1990) is representative for the situation in quadrants A and D as the role of supplier industries (or demand) positively or negatively effects the international competitive position of the agrarian industry resp. food processing sector. On the other hand, quadrants B and C rather represent the situation of the fragmentation of production process when countries tent to specialize in specific segments of the global value chain. However, it is necessary to point out that this tool has limitations, because the model also suggests that related and supporting industries as well as demand conditions are not the only factor playing a role. Also, part of production and trade still takes the form of classic bilateral trade, and the production chain is therefore not as fragmented as in the case of other sectors (electronics, cars). The reason could be because the specifics of agricultural and food products and production processes play a role. Thus, the mutual and complex interaction of the comparative advantages of the agrarian sector and the food sector is not clear and should be subject to further empirical assessment. Although this is a simple analysis and comparison, the results of the shifts in the pair-scores of comparative advantages of the agrarian and food industries indicate complex development trajectories in selected countries in the central and eastern Europe.

Results and discussion

The NRCA scores for the agri-food industries in selected countries of Central and Eastern Europe were calculated using gross trade and value-added data in the period 1995 to 2020. Please also figures (figure A1) in appendix. Then the consistency of NRCA scores was tested.

Agrarian industries

The first important result is that most of the Central and Eastern European countries (on average between 1995 and 2020) reveal comparative advantage in agriculture according to both gross trade and value-added data. The gross trade data suggest that about half of the agrarian industries in CEES countries have enhanced their comparative advantage in agriculture and with about half of them the comparative advantage has deteriorated. Analysis of the value-added data suggest that the comparative advantage of the agrarian industry deteriorated in almost all (except of Latvia) Central and Eastern European countries.

More in detail, based on the calculations of NRCA scores using traditional gross trade data (Table 2), the scores of NRCA suggest (on average) that 7 out of the analyzed 11 agrarian sectors in particular countries in the Central and Eastern Europe revealed comparative advantage from 1995 to 2020. To the contrary, 4 out of the analyzed 11 sectors revealed comparative disadvantage. Agrarian sectors in Bulgaria (0.568), Romania (0.393), Hungary (0.335), Lithuania (0.234), Latvia (0.144), Croatia (0.079) and Estonia (0.054) revealed a positive NRCA score. Agrarian sectors in Poland (-0.622), Czech Republic (-0.391), Slovak Republic (-0.148) and Slovenia (-0.132) revealed a negative NRCA score. The scores of NRCA also indicate that the comparative advantage of agrarian sectors in Poland, Czech Republic, Hungary, and Slovak Republic have deteriorated. On the other hand, the comparative advantage has improved in Romania, Bulgaria, Hungary, Lithuania, Latvia and Slovenia (despite revealing comparative disadvantage), and despite a certain decline in comparative advantage the last years in Estonia and Croatia. These results suggest a geographic association with changes in the comparative advantages of agrarian industries. From a geographical point of view, the Baltic and the Balkan countries show an improvement in comparative advantage. The countries of the Visegrad group in the center of Europe show a deterioration of their comparative advantage in agrarian production.

According to the results of calculations of NRCA scores using value-added data (Table 2), the scores of NRCA indicate on average that 7 out of the analyzed 11 agrarian sectors in selected countries in the Central and Eastern European

Agrarian sectors									
	Gross trade approach (index)								
	1995	2000	2003	2005	2010	2015	2020	avg. 95-20	Δ (T2 – T1)
Czech Republic	0.106	-0.164	-0.425	-0.259	-0.540	-0.360	-0.582	-0.391	-0.412
Estonia	0.074	0.046	0.033	0.036	0.055	0.067	0.068	0.054	-0.029
Hungary	0.332	0.194	0.215	0.247	0.501	0.246	0.246	0.335	-0.150
Latvia	-0.003	0.028	0.033	0.110	0.261	0.215	0.296	0.144	0.240
Lithuania	0.132	0.107	0.142	0.099	0.278	0.271	0.277	0.234	0.087
Poland	-0.485	-0.520	-0.515	-0.238	-0.665	-0.337	-1.361	-0.622	-0.446
Slovak Republic	0.076	-0.127	-0.274	-0.112	-0.098	-0.161	-0.350	-0.148	-0.250
Slovenia	-0.191	-0.128	-0.221	-0.129	-0.105	-0.079	-0.103	-0.132	0.112
Bulgaria	0.304	0.099	0.187	0.249	0.681	0.915	1.028	0.568	0.677
Croatia	0.043	0.071	0.054	0.087	0.118	0.107	0.069	0.079	0.034
Romania	0.012	-0.036	-0.097	-0.096	0.671	0.920	0.905	0.393	0.963
	Value added approach (index)								
	1995	2000	2003	2005	2010	2015	2020	avg. 95-20	Δ (T2 – T1)
Czech Republic	0.153	-0.181	-0.539	-0.413	-1.035	-0.753	-0.942	-0.593	-0.767
Estonia	0.070	0.066	0.073	0.093	0.083	0.046	0.096	0.083	-0.026
Hungary	0.976	0.499	0.309	0.206	0.323	0.231	0.362	0.442	-0.582
Latvia	0.011	0.044	0.035	0.092	0.202	0.106	0.275	0.101	0.203
Lithuania	0.235	0.175	0.146	0.085	0.027	0.066	0.092	0.157	-0.222
Poland	0.297	-0.636	-0.836	-0.567	-0.885	-1.193	-1.675	-0.737	-1.088
Slovak Republic	-0.170	-0.221	-0.352	-0.300	-0.315	-0.254	-0.412	-0.242	-0.078
Slovenia	-0.043	-0.078	-0.214	-0.154	-0.255	-0.229	-0.239	-0.178	-0.113
Bulgaria	0.429	0.232	0.309	0.370	0.379	0.504	0.580	0.468	-0.033
Croatia	0.184	0.209	0.093	0.122	0.075	-0.034	0.027	0.099	-0.203
Romania	1.049	0.227	0.444	0.165	0.254	0.266	0.294	0.426	-0.471

Note: T1 - average of 1995-2000; T2 - average of 2015-2020
Source: own calculations, data from TiVA

Table 2: RCAs indices for selected countries in Central and Eastern Europe using gross and value added approach, selected years.

countries revealed comparative advantage from 1995 to 2020. On the other hand, 4 out of the analyzed 11 sectors revealed comparative disadvantage. Agrarian sectors in Bulgaria (0.468), Hungary (0.442), Romania (0.426), Lithuania (0.157), Latvia (0.101), Croatia (0.099) and Estonia (0.083) revealed positive NRCA scores. The agrarian sectors in Poland (-0.737), Czech Republic (-0.593), Slovak Re-public (-0.242) and Slovenia (-0.178) revealed a negative NRCA score. The NRCA scores show discrepancies compared to the approach based on gross trade data. The calculation based on value-added data suggests that the comparative advantage of agrarian sectors deteriorated in Poland, Czech Republic, Hungary, Slovak Republic, and Slovenia. Croatia, Lithuania and Estonia. In the case of Bulgaria and Romania the NRCA scores fluctuates, but revealed a decline in the first decade followed by a rise of NRCA scores in the second half of the period under investigation. The only country revealing an improvement of its agrarian industry comparative advantage is Latvia. In the case of calculations using added value data, it is not possible to identify such distinct geographical connections as in the case of calculations using gross trade data.

The Brakman and Van Marrewijk (2017) classification gives the following results. In the case of Estonia, Hungary, Lithuania and Bulgaria and for most of the years Latvia, scores of NRCA revealed comparative advantage for both gross trade NRCA scores and value-added NRCA scores calculations (strong-strong). In the case of Poland, Czech Republic, Slovak Republic and Slovenia, the sector revealed to have a comparative disadvantage for both gross trade NRCA scores and value-added NRCA scores (weak-weak). Romania and Croatia revealed mixed results. Romania reveals a comparative

advantage for both gross trade NRCA scores and value-added NRCA scores calculation in most of the years, but in the years 2000-2006 (before the accession into the EU) revealed comparative disadvantage for gross trade and simultaneously a comparative advantage for value-added trade (weak-strong). Croatia also revealed a comparative advantage for both gross trade NRCA scores and value-added NRCA scores in most of the years, but in the years 2015-2019 (after the accession into the EU) revealed comparative advantage for gross trade and simultaneously a comparative disadvantage for value-added trade (strong-weak).

In the next step, NRCA scores pairs value-added were analyzed regarding their cardinal, dichotomous and ordinal consistency (using gross trade data and value-added data to calculate scores).

The consistency test of the indices as cardinal measures (the extent to which a country has a comparative advantage/comparative disadvantage in an industry) of comparative advantage was based on the correlation coefficient between paired indices in each of the 26 years (Table 3). Only 2 countries (Czech Republic and Latvia) show a high levels of correlation (≥ 0.75). Estonia, Poland, Slovak Republic and Bulgaria show moderate levels of correlation (≈ 0.5). The rest of the countries shows low levels of correlation (Hungary and Lithuania) or even show negative coefficient of correlations (Slovenia, Croatia and Romania). This suggests that the use of traditional gross trade and value-added data leads to consistent assessment in the case of Czech Republic and Latvia and partially Estonia, Poland, Slovak Republic and Bulgaria. When assessing revealed comparative advantage of agrarian sector in Hungary, Lithuania, Slovenia, Croatia and Romania we can expect inconsistencies in analysis as the gross trade data reflect what a country is producing and exporting to a lesser extent.

The test of indices as a dichotomous measure was based on assessment of the share of years in which both of the paired indices suggest comparative advantage or comparative disadvantage (Table 3). In the case of the Czech Republic, Estonia, Hungary, Lithuania, Slovenia and Bulgaria this test indicates perfect match between 1995 and 2020. Also, other countries as Latvia, Poland, Slovak Republic and Croatia are highly consistent with all shares higher than 70%. This suggest that application of NRCA indices calculated using gross trade or value-added data are consistent as dichotomous measures.

The consistency test of the indices as ordinal measures (consistent in cross-country ranking of industry by NRCA) was based on the rank correlation coefficient for each pairing of gross and value-added data (Table 4). On average,

	cardinal measure		dichotomous measure	
	No. of obs.	score	No. of obs.	score
Czech Republic	26	0.922	26	1.000
Estonia	26	0.449	26	1.000
Hungary	26	0.273	26	1.000
Latvia	26	0.910	26	0.885
Lithuania	26	0.219	26	1.000
Poland	26	0.597	26	0.923
Slovak Republic	26	0.571	26	0.923
Slovenia	26	-0.454	26	1.000
Bulgaria	26	0.545	26	1.000
Croatia	26	-0.292	26	0.808
Romania	26	-0.032	26	0.731

Source: own calculations, data from TiVA

Table 3: Tests of consistency – correlation coefficients of paired RCAs indices.

	ordinal measure						
	1995	**2000**	**2005**	**2010**	**2015**	**2020**	**avg. 95-20**
cross-country ranking	0.300	0.845	0.818	0.909	0.945	0.909	0.868

Source: own calculations, data from TiVA

Table 4: Tests of consistency – correlation coefficients of paired RCAs indices

the NRCA calculated using gross trade and value-added data shows high level of correlation (0.868) over the period.

Food processing industries

The gross trade data indicated about half of the countries revealed comparative advantage in food processing. On the other hand, the value-added data indicated that most of the analyzed Central and Eastern European countries revealed comparative advantage except of the Czech Republic, Slovak Republic and Slovenia. The gross trade data and value-added data indicated that the comparative advantage in food processing has deteriorated in most countries of Central and Eastern Europe. Therefore, the prevailing tendency is the weakening of food industries in the analyzed Central and Eastern European countries, but there are also exceptions to this tendency.

More in detail, according to the results of calculations using gross trade data (Table 5), the scores of NRCA scores indicate on average that 6 out of analyzed 11 food processing industries in particular countries in the Central and Eastern European countries revealed comparative advantage from 1995 to 2020. Contrary 5 out of analyzed 11 industries revealed comparative disadvantage. On average, the positive NRCA scores revealed food industries in Poland (2.176), Lithuania (0.386), Croatia (0.386), Bulgaria (0.136), Latvia (0.134), and Estonia (0.057). The negative NRCA scores revealed food industries in the Czech Republic (-0.737), Romania (-0.538), Slovak Republic (-0.533), Slovenia (-0.317), and Hungary (-0.039). The scores of NRCA scores also indicate that comparative advantage of food processing industries deteriorated in the Czech Republic, Slovak Republic, Slovenia, Romania, and Croatia. The NRCA scores revealed mix result for Hungary, where the scores are oscillating around the comparative neutral point during the period under interrogation. In the case of Estonia, the comparative advantage deteriorated in the first decade of the period and then stagnated near the comparative neutral point. On the other hand, the comparative advantage improved in Latvia, Lithuania and significantly in Poland.

Food processing industries									
	Gross trade approach (index)								
	1995	2000	2003	2005	2010	2015	2020	avg. 95-20	Δ (T2 – T1)
Czech Republic	-0.242	-0.479	-0.817	-0.711	-0.838	-0.787	-0.925	-0.737	-0.793
Estonia	0.189	0.008	0.004	0.025	0.084	0.017	0.022	0.057	-0.143
Hungary	0.320	0.090	-0.175	-0.260	-0.131	-0.194	-0.114	-0.039	-0.537
Latvia	0.091	0.035	0.016	0.093	0.189	0.103	0.195	0.134	0.096
Lithuania	0.071	0.137	0.192	0.307	0.552	0.534	0.780	0.386	0.519
Poland	0.210	0.174	0.346	1.288	2.674	4.429	5.600	2.176	4.788
Slovak Republic	-0.310	-0.249	-0.464	-0.322	-0.611	-0.913	-0.846	-0.533	-0.488
Slovenia	-0.261	-0.186	-0.314	-0.341	-0.348	-0.346	-0.412	-0.317	-0.139
Bulgaria	-0.024	-0.049	-0.085	-0.054	0.312	0.309	0.365	0.136	0.365
Croatia	0.477	0.495	0.578	0.721	0.384	0.133	0.041	0.386	-0.433
Romania	-0.451	-0.294	-0.460	-0.526	-0.646	-0.620	-0.845	-0.538	-0.346
	Value added approach								
	1995	2000	2003	2005	2010	2015	2020	avg. 95-20	Δ (T2 – T1)
Czech Republic	-0.050	-0.133	-0.223	-0.119	-0.185	-0.266	-0.080	-0.186	-0.158
Estonia	0.096	0.015	0.007	0.001	0.033	0.007	0.005	0.025	-0.074
Hungary	0.188	0.148	0.035	-0.042	0.134	-0.032	-0.037	0.047	-0.214
Latvia	0.085	0.062	0.003	0.023	0.090	0.024	0.073	0.064	-0.020
Lithuania	0.104	0.135	0.182	0.235	0.309	0.317	0.453	0.257	0.213
Poland	0.817	0.448	0.427	0.999	1.946	2.187	2.849	1.369	1.712
Slovak Republic	-0.062	-0.068	-0.157	-0.039	-0.135	-0.274	-0.234	-0.125	-0.140
Slovenia	-0.021	-0.001	-0.052	-0.094	-0.110	-0.128	-0.149	-0.079	-0.129
Bulgaria	-0.011	-0.003	-0.010	0.022	0.137	0.197	0.117	0.100	0.135
Croatia	0.292	0.310	0.352	0.435	0.252	0.125	0.106	0.266	-0.165
Romania	0.012	0.093	0.185	0.085	-0.055	-0.146	-0.114	0.067	-0.161

Note: T1 - average of 1995-2000; T2 - average of 2015-2020
Source: own calculations, data from TiVA

Table 5: RCAs indices for selected countries in Central and Eastern Europe using gross and value added approach, selected years.

Also, the comparative advantage of food processing industry has improved and changed from comparative disadvantage to comparative advantage in Bulgaria.

According to results of calculations using value-added data (Table 5), the scores of NRCA scores indicated that 8 out of the analyzed 11 food processing industries revealed comparative advantage from 1995 to 2020. On the other hand, 3 out of analyzed 11 industries revealed comparative disadvantage. The positive NRCA scores revealed food industries in Poland (1.369), Croatia (0.266), Lithuania (0.257), Bulgaria (0.100), Romania (0.067), Latvia (0.064), Hungary (0.047), and Estonia (0.025). The negative NRCA score revealed food industries in the Czech Republic (-0.186), Slovak Republic (-0.125), and Slovenia (-0.079).

When comparing the changes in comparative advantage of food processing industries, the results show similarities as well as differences to the results based on the gross trade data. The scores of NRCA also indicate that comparative advantage of food processing industries deteriorate in Hungary, Slovenia, Slovak Republic, Czech Republic, Croatia and Romania. In the case of Estonia, the comparative advantage deteriorated in the first decade of the period under scrutiny and then stagnated near the comparative neutral point. The NRCA scores revealed mix result for Latvia. Scores are oscillating but keep the level of the comparative advantage in the period under scrutiny. On the other hand, the comparative advantage of food processing industry has changed from comparative disadvantage to comparative advantage in Bulgaria. The comparative advantage improved in Latvia, Lithuania and significantly in Poland.

This overview of revealed comparative advantages (calculated using gross and value-added trade data) indicates differences in the values of indicators. Following the Brakman and Van Marrewijk (2017) classification, in the case of the Poland, Croatia, Latvia, Lithuania, and partially Estonia, sectors revealed to have a comparative advantage for both gross trade NRCA scores and value-added NRCA scores (strong-strong). In the case of the Czech Republic, Slovakia and Slovenia sectors revealed to have a comparative disadvantage for both gross trade NRCA scores and value-added scores NRCA scores (weak-weak). In the case of Hungary and Bulgaria, the sectors revealed to have a comparative disadvantage for gross trade NRCA scores and simultaneously a comparative advantage for value-added trade NRCA scores (weak-strong) in some of the years under scrutiny. Apparently the strength and importance of these sectors for Hungary and Bulgaria were underestimated when using gross trade data. In the case of Romania, the sector revealed to have a comparative advantage for gross exports and simultaneously a comparative disadvantage for value-added trade (strong-weak). Apparently the strength and importance of these sectors for Romania was overestimated when using gross trade data. This could be caused by the Rotterdam-Antwerp effect.

In the next step NRCA scores were analyzed according to their cardinal, dichotomous and ordinal consistency (Table 6 and 7). Most countries (9 out of 11) show high levels

	cardinal measure		dichotomous measure	
	No. of obs.	score	No. of obs.	score
Czech Republic	26	0.841	26	1.000
Estonia	26	0.956	26	0.846
Hungary	26	0.798	26	0.769
Latvia	26	0.695	26	1.000
Lithuania	26	0.950	26	1.000
Poland	26	0.943	26	0.962
Slovak Republic	26	0.900	26	1.000
Slovenia	26	0.929	26	0.923
Bulgaria	26	0.870	26	0.808
Croatia	26	0.977	26	0.923
Romania	26	0.701	26	0.269

Source: own calculations, data from TiVA

Table 6: Tests of consistency – correlation coefficients of paired RCAs indices.

	ordinal measure						
	1995	2000	2005	2010	2015	2020	avg. 95-20
cross-country ranking	0.583	0.836	0.791	0.945	0.997	0.885	0.824

Source: own calculations, data from TiVA

Table 7: Tests of consistency – correlation coefficients of paired RCAs indices.

of correlation (≥ 0.75), and the correlation for all the observations was 0.946. In the case of Latvia (0.695) and Romania (0.701) the results show rather medium levels of correlation. This suggests that usage of NRCA indices and gross trade and value-added data are mostly consistent as cardinal measures (although there are exceptions).

The test of indices as a dichotomous measure was based on assessment of the share of years in which both of the paired indices suggest comparative advantage or comparative disadvantage. In the case of the Czech Republic, Slovakia, Latvia and Lithuania this test indicated perfect matches. Also, other countries like Estonia, Hungary, Poland, Slovenia, Bulgaria, and Croatia are highly consistent with all shares higher than 70%. Only Romania show high level of inconsistency (0.269). The consistency for all the observations was 0.864 which suggests that usage NRCA indices and gross trade and value-added approach are mostly consistent as dichotomous measures.

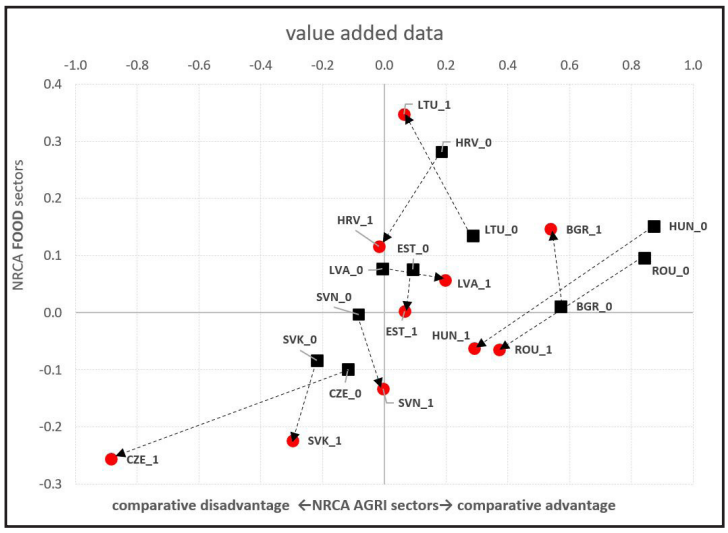
The consistency test of the indices as ordinal measures (consistent in cross-country ranking of industry by NRCA) was based on the rank correlation coefficient for each pairing of gross and value-added data. NRCA scores calculated using gross trade and value-added data show high correlations (0.934) over the period. Also, the consistency improved over the observed time period. Results show that the NRCA scores calculated using gross trade and value-added data are consistent in the cross-country ranking of industries.

Trajectories and mutual interaction between revealed comparative advantages

FFor a particular country, NRCA pair-scores for agrarian industries and food processing industries are presented in the Cartesian coordinate system. Both figures (Figure 1 and 2) compare the change in pair scores between the beginning of the period under scrutiny (average 1995-2000) and the end of the period (avg. 2015-2020).

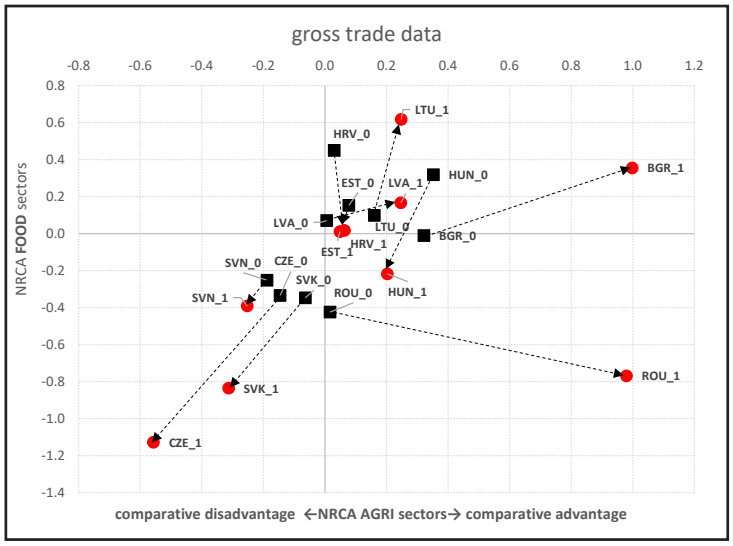
First interesting result is that pair scores indicate complex positioning and change in trajectory if we compare NRCA pair-scores of agrarian and food processing industries in specific countries of Central and Eastern Europe at the beginning and at the end of the period under scrutiny. Baltic countries show diverse trajectories when comparing each other. According to both gross trade data and value-added data, Estonia revealed comparative advantage in both agrarian and food processing industries at the beginning of the period. Gross trade as well as value-added trade data indicate a decline of the comparative advantage in both the agrarian and food processing industries (it shows dissimilarity when indicating how strong the decline is). At the end of the period, Estonia seems to have lost its comparative advantage in food processing and still (despite the decline) keeps its comparative advantage in agriculture. According to gross as well as value-added data, Lithuania revealed comparative advantage in both agrarian and food processing industries at the beginning of the period. The usage of trade or value-added trade show different tendency. The gross trade data suggest that the comparative advantage of both agrarian and food processing industries is getting stronger in Lithuania. The value-added data indicate that comparative advantage of food processing industry is getting stronger and the comparative advantage of the agrarian sector is deteriorating. Lithuania still maintains a comparative advantage in both industries, but at the end of the period, however, value-added data suggest a negative tendency in the development trajectory. According to both gross trade data and value-added trade data, Latvia revealed a comparative advantage for its food processing industry and a neutral position (close to comparative advantage neutral point) for its agrarian sector at the beginning of the period. The data suggest an improvement in the comparative advantage of the agrarian sector using both gross and value-added data. The gross trade seems to overrate the tendency in the comparative advantage of the food processing industry when compared to the value-added data. Latvia seems to maintain its comparative advantage in both industries by the end of the period.

In the case of Poland, both gross trade data and value-added data revealed a comparative disadvantage for the agrarian sector. Both types



Source: own calculations, data from TiVA

Figure 1: Classification of the interaction between RCA of agrarian and food processing sector (value added data).



Source: own calculations, data from TiVA

Figure 2: Classification of the interaction between RCA of agrarian and food processing sector (gross trade data).

of data indicate that the comparative advantage of the food industry is getting significantly stronger. (data for Poland are not in the Figure 1 and 2 because the axis scale does not allow to visualize the Polish data). On the other hand, despite the enhanced advantage in food processing, the comparative advantage of agrarian industry deteriorated in Poland. The Czech Republic and Slovak Republic revealed comparative disadvantage both in agrarian and food processing industries at the beginning of the period using gross data as well as value-added data. Both countries similarly show deterioration of the comparative advantage of agrarian and food processing industry. Hungary revealed comparative advantage in both agrarian and food processing industry at the beginning of the period using gross data as well as value-added data. There is deterioration of comparative advantage in both industries in Hungary. At the end of the period, Hungary almost lost its comparative advantage in food processing and could lose the comparative advantage of its agrarian industry if the trend continues.

In the case of Croatia, both gross trade data and value-added data revealed comparative

advantage of food processing industry and slight comparative advantage of agrarian sector at the beginning of the period. The trend shows deterioration of the comparative advantage of food processing industry, contrary to slight enhancement of the comparative advantage of agrarian sector. Croatia seems to face a risk of losing comparative advantage in food processing in upcoming years.

Slovenia revealed comparative disadvantage of both agrarian and food processing industry. Both gross and value-added data show further deterioration of the comparative advantage of food industry. In the case of the comparative advantage of agrarian sector, the gross data show slight improvement of comparative advantage. On the other hand, the value-added data indicate deterioration of the comparative advantage.

Both gross and value-added data indicate that the comparative advantage of food processing industry in Bulgarian has improved. Also, gross and value-added data are signaling mix results when used to analyze comparative advantage of agrarian sector in Bulgaria. The gross trade data indicates that comparative advantage of agrarian sector becomes stronger, the value-added data indicates opposite tendency. In the case of Romania, the calculations also show mix results. Both gross and value-added data indicate deterioration on comparative advantage of food processing industry, however revealing opposite levels of comparative advantage at the beginning of the period. The gross data indicate significant improvement of comparative advantage of agrarian industry. Value-added data show opposite tendency of deterioration of the comparative advantage of agrarian sector in Romania.

Conclusion

This article interrogates comparative advantage and competitiveness of agrarian and food processing sectors in the context of international fragmentation of production in selected countries in the Central and Eastern Europe using gross trade and value-added trade data. The international fragmentation of production could be a powerful source of increased efficiency and firm competitiveness. Despite the slowdown in economic globalization in the last decade, the countries across the Europe still remain integrated into GVCs. Analysis in this article delivers conclusion in two areas in the body of knowledge: 1) it assessed the consistency of NRCA scores calculated using gross and value-added trade data, 2) it assessed comparative advantage and competitiveness of agrarian and food processing sectors in particular Central and Eastern European countries (again using gross and value-added trade data).

The consistency test suggests that NRCA pairs of indices calculated for agrarian sectors using gross trade and value-added trade data suggests that are generally consistent as dichotomous and ordinal measures (excl. Romania). Test of NRCA pairs of indices as cardinal measures shows high discrepancies in all countries of scrutiny, except of the Czech Republic and Latvia. The analysis of NRCA scores for food processing industries suggests that these scores are generally consistent as cardinal, dichotomous and ordinal measures, except of Romania (as dichotomous measure). The possible explanation for such a discrepancy in the case of Romania could be also Rotterdam-Antwerp effect.

Ceglowski (2017) and Fertö (2018) concluded in theirs studies that countries' and/or industries' export competitiveness look different through the lens of domestic value-added exports than on the basis of conventional measures using gross exports. Fertö (2018) assessed specifically agri-food trade. Results of this analysis have found significant differences for NRCA pairs as cardinal measures in the case of agrarian sectors. On the other hand, results of this study generally do not support the conclusions of Ceglowski (2017) and Fertö (2018) because of the dichotomous and ordinal characteristics of agrarian industries and the cardinal, dichotomous and ordinal characteristics of food industries.

In the period under review (1995-2020), most of the analyzed Central and Eastern European countries (Estonia, Hungary, Latvia, Lithuania, Bulgaria, Croatia and Romania) revealed comparative advantage in agricultural production in both gross trade and value-added trade data. The Czech Republic, Poland, Slovenia, and Slovakia revealed comparative disadvantage in agrarian production. The gross trade data has indicated about half of the countries (Poland, Estonia, Latvia, Lithuania, Bulgaria and Croatia) reveal comparative advantage and the Czech Republic, Hungary, Slovakia, Slovenia, Romania revealed comparative disadvantage in food processing. However, using value-added data, the results suggest that only the Czech Republic, Slovak republic and Slovenia revealed comparative disadvantage.

Although the results of this analysis offer insight (identifying which sectors have or do not have a comparative advantage as a whole) on the state

of comparative advantage and competitiveness of the agricultural and food sectors of selected countries, it is necessary to point out that even if a country does not have a comparative advantage in the agricultural sector (or food processing), it may have a comparative advantage in specific sub-sectors of production, or with specific regions. In this sense, the results of this study should be used as complementary findings to the results of studies that evaluated the comparative advantages of individual sub-sectors using data structured according to the applied methodologies, e.g., the Harmonized System or Standard international trade classifications (e.g. Smutka et al., 2018; Bojnec and Fertő, 2019; Matkovski et al. 2019; Vondráček et al., 2022).

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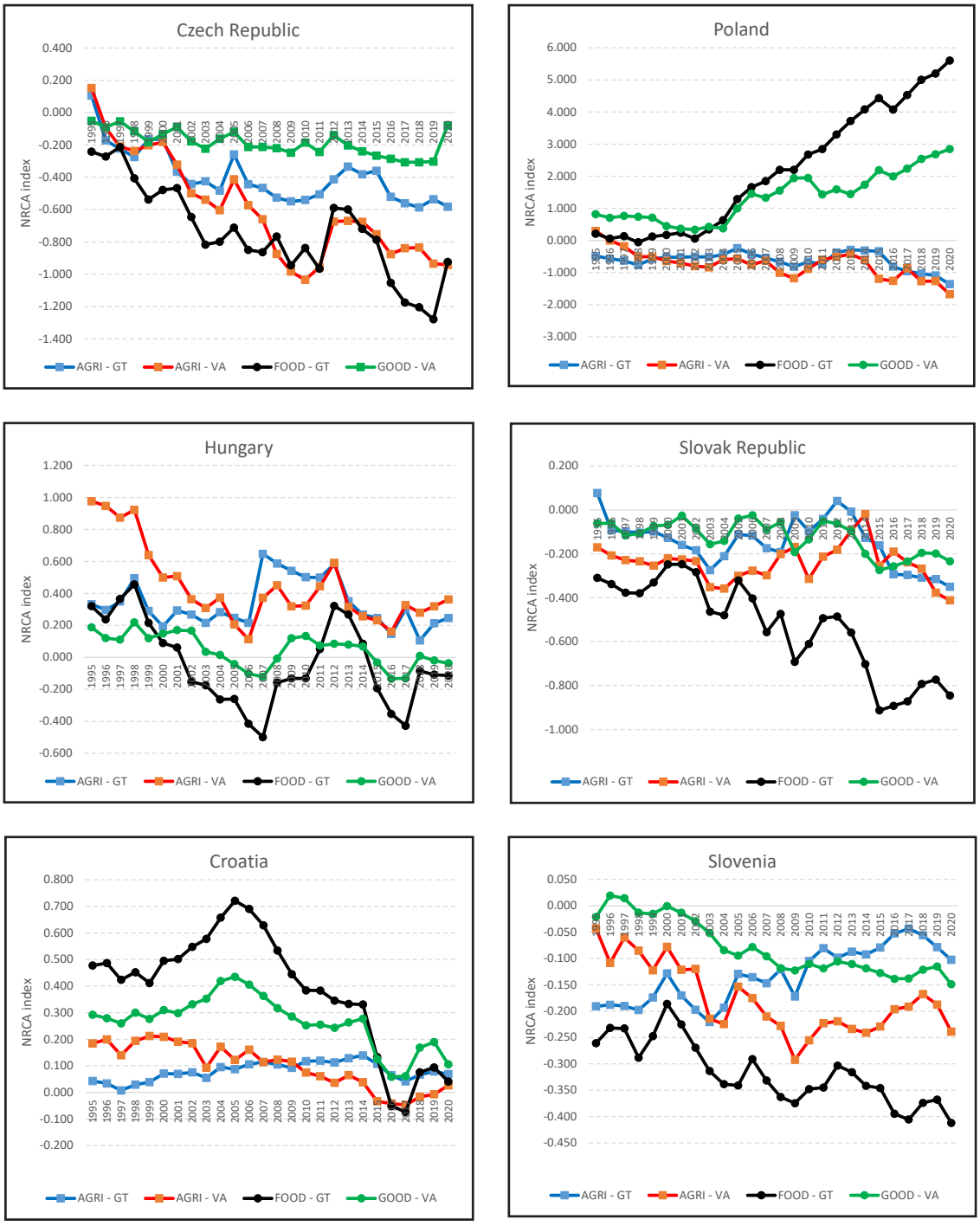
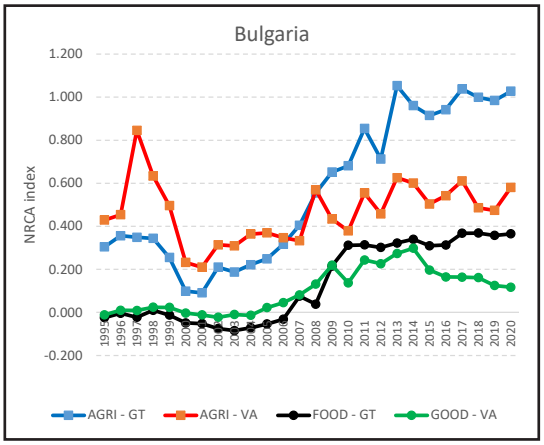
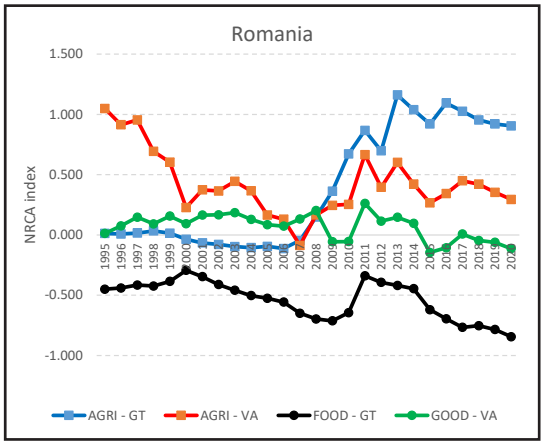
Appendix

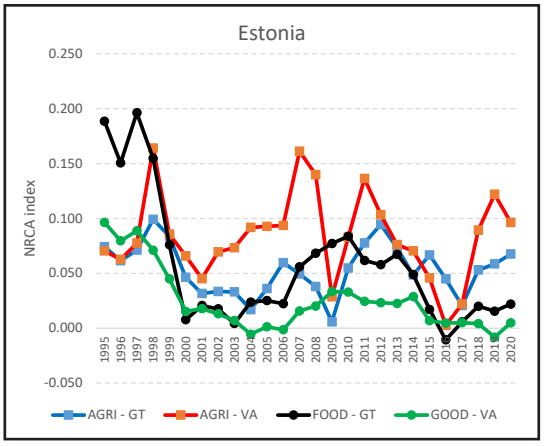


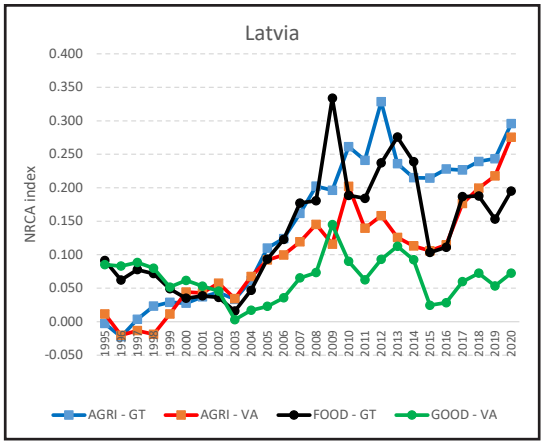
Source: own calculations, data from TiVA

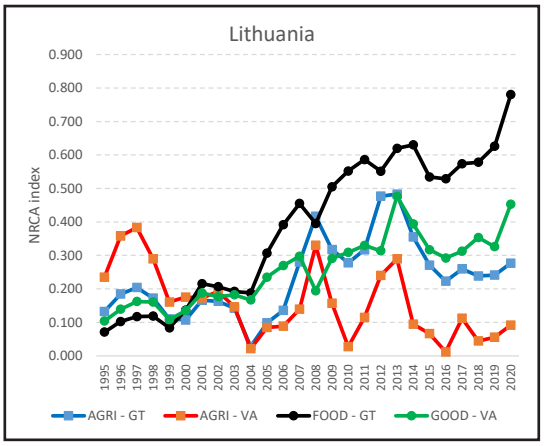
Figure A1: NRCA scores for agrarian and food processing sectors using gross trade and value-added trade data. (To be continued).











Source: own calculations, data from TiVA

Figure A1: NRCA scores for agrarian and food processing sectors using gross trade and value-added trade data. (Continuation).