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Economic effects of food supply chain re-localization on the Croatian economy

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Abstract

Securing the availability of healthy food at affordable prices is of fundamental public interest. The formerly prevailing paradigm of the absolute superiority of free trade in the global food market is changing in favour of re-localization after vulnerabilities were exposed by the war in Ukraine, the COVID-19 pandemic and the recent disorder in the global food market. Re-localization of food production could also have a positive impact on the environment, public health and sustainable local development. This paper analyses the trends and current conditions in the Croatian food market regarding the potential economic benefits of re-localization of food production. The purpose of the paper is to estimate the economic benefits of food re-localization in Croatia. The method of input–output analysis is applied to test hypotheses. Direct, indirect and induced effects of re-localization of food production are estimated and the results compared with other countries. The results confirm previous findings that re-localization of food production could stimulate the domestic economy. The multipliers estimated for Croatian agricultural and food production do not deviate significantly from the results published for other economies. Output multipliers related to the Croatian food sector are slightly lower than those estimated for new European Union members, while multipliers for the Croatian agriculture sector are in line with those estimated for the same group of countries. It is found that expenditures on domestic food products induce significantly larger economic effects in Croatia than expenditures on imported food. Import substitution and re-localization would also positively affect public finances. Re-localizing 10% of imports of agri-food products could increase the Croatian GDP by 0.32%. The employment effects would be even larger since labour intensity in the food and agriculture sectors is high.

Keywords: Food supply chain, Re-localization, Input–output analysis

Introduction

The availability and security of healthy food products at affordable prices is a vital factor in ensuring economic development of nations. In recent decades, the prevailing economic policy of foreign trade liberalization resulted in regions specializing in food production in accordance with their natural resources, and the development of global food markets. Productivity growth and strong international competition resulted in the long-term trend of decreasing relative food prices, which positively affected living standards in many economies. However, exogenous shocks related to political instabilities and the COVID-19 pandemic significantly affected global food supply chains, resulting in the growth of global food prices and even shortages of some important agricultural products (Apostolopoulos et al 2021). Increases in food prices induce serious concern, especially in underdeveloped economies and low-income households where expenditures for food can be a significant burden. Food insecurity has caused a wide range of negative social, economic and environmental impacts, which appear to have reached a critical threshold. Contrary to the formerly prevailing paradigm of the absolute superiority of free trade in the global food market, the vulnerabilities revealed by political turmoil, the war in Ukraine and disorder in the global food market have led to a new wave of economic thought advocating protectionism in the food product market. In addition to strategic factors in favour of national self-sufficiency for certain agricultural and food products, many economists and politicians claim that re-localization of food production could have positive impacts on the environment, public health and sustainable local development.

The potential social benefits of food production re-localization are provoking growing public interest, especially in more developed economies. The US Department of Agriculture has launched new initiatives to support access to more localized markets and shorter supply chains (McFadden et al. 2016). Similarly, many EU regions have recognized the promotion of local food as an important part of their development strategies (European Committee of the Regions 2020). The European Committee of the Regions (2017) adopted the opinion 'Towards a sustainable EU food policy that creates jobs and growth in Europe's Regions and Cities', which stressed the requirement for a comprehensive EU food policy. The goal of those initiatives is to create a sustainable food system that can provide safe, nutritious and healthy food products for present and future generations by adopting environmentally friendly production methods and which is robust and resilient to price shocks and other crises (SAPEA 2020).

The aim of this paper is to analyse the trends and current conditions in the Croatian food market regarding the origin of food products and to estimate the potential economic benefits of re-localization and increased self-sufficiency of food production. The institutional framework regulating and monitoring quality and health standards of food products in Croatia is still underdeveloped. The inadequate living standards resulted in a growing share of less expensive food products of lower quality on the Croatian market. Although Croatia has abundant natural resources for agriculture and a long history of producing high-quality food products (Božić et al. 2022), in recent years, food imports have crowded out some domestic producers (fi-compass 2020). This limits the potential for regional development with intensifying depopulation trends. The hypothesis of this paper is that promotion of the re-localization of food production could induce significant economic benefits and could spur transformation towards a sustainable food system as defined above. The approach considered in this study analyses the effects of the re-localisation strategy from the point of view of the Croatia assuming unchanged position of the other economies regarding international trade protection. To estimate the direct, indirect and induced effects of re-localization of food production, an input–output (IO) model is applied. The analysis is limited to Croatia, but the empirical findings and policy implications are also relevant to other small economies, especially those with prospects for future EU membership.

The remainder of the paper is organized as follows. After the introduction, section "Domestic production and imports of agri-food products in Croatia" presents trends in domestic production and imports of agri-food products in Croatia. Section "Literature review" presents a review of the recent literature on the economic effects of food re-localization in the IO framework. Research methodology and main data sources are outlined in section "Methodology". In section "Results", the results of the analysis of the final demand effects for agri-food products on the Croatian economy are presented. Finally, in section "Conclusions and recommendations", policy implications are discussed and suggestions for further research are provided.

Domestic production and imports of agri-food products in Croatia

The agri-food industry is one of the most important economic sectors in Croatia regarding its share of gross value added (GVA) and employment. In the 2010–2021 period, this industry's share of the Croatian GVA fell from 7.4 to 5.7%. Economic activity in agriculture recorded an average annual negative growth rate of 1.6% over this period. The real GVA of the food industry was growing until 2019, but a sharp decrease was recorded in 2020, which returned the real GVA to the 2010 level. The importance of the agri-food sector is even more pronounced in terms of employment, with the agri-food sector accounting for approximately 8% of total Croatian jobs (https://podaci.dzs.hr/en/statistics/labor-market/).[1] Despite the negative trends in agri-food production, the volume of international trade has increased substantially, especially after Croatia joined the EU in 2013. The volume of exports increased at an annual growth rate of 9.0%, while real imports grew at an average annual rate of 6% (Table 1). Over the entire analysed period, the agri-food sector recorded a negative trade balance. Although in nominal terms the negative trade balance almost doubled, the coverage ratio improved slightly. The strong growth in exports of agri-food products, despite the reduction in domestic production, is an indicator of a rising share of re-exported agri-food products due to Croatia's favourable geographical position and developed transport infrastructure.

The factors behind the trends in Croatian agri-food industry are complex. But this study is limited to the impact of structural changes in the final demand and technology captured by the IO model. Unfortunately, the official Croatian IO tables do not provide data in real terms to enable the direct comparison of results for 2010 and 2018. Thus, original IO data on the supply and use of agri-food products in current prices are presented in Table 2.[2] The IO data for the Croatian economy reveal that the total use of agri-food products in Croatia increased by 31.5% by value in the 2010–2018 period (Table 2).

Trends in demand for agricultural products and manufactured food significantly diverge. While demand for manufactured food increased by 60%, demand for raw agricultural products in the same period decreased by 16.5%. Domestic production in agriculture significantly decreased in the analysed period, which, to some degree, could be explained by full-trade liberalization after joining the EU. Stronger competition and

[1] Number of jobs in agriculture varies depending on the data source. Official social security schemes indicate 31 thousand of insured persons in agriculture, but labour force survey indicates 100 thousand employed persons in the same sector. Food industry employed 44 thousand of persons in 2022. Total number of employed persons in Croatia were 1.7 million in 2022 according to LFS.

[2] As explained in Sect. "Literature review", the empirical results in Sect. "Results" were based on IO data in real terms estimated using the approach proposed by Llop (2017).

Table 1 Volume of domestic production and international trade of the Croatian agri-food industry in the 2010–2021 period

Year	Agriculture		Food industry		International trade, SITC 0 + 1: Food, drinks and tobacco		Trade balance, in million EUR	Coverage ratio
	Real GVA, 2010 = 100	Share in GVA, in %	Real GVA, 2010 = 100	Share in GVA, in %	Real Import, 2010 = 100	Real Export, 2010 = 100		$\frac{Exports}{Imports} * 100$
2010	100.0	3.5	100.0	3.9	100.0	100.0	− 549.0	63.4
2011	96.6	3.4	103.1	4.1	106.0	101.1	− 663.6	60.7
2012	74.6	3.0	97.3	4.1	108.0	110.7	− 633.8	64.3
2013	79.0	3.2	94.6	4.1	115.1	109.2	− 831.7	56.4
2014	64.6	2.6	98.0	4.0	130.8	132.2	− 887.1	58.2
2015	67.1	2.7	97.0	3.8	145.3	158.0	− 879.0	62.5
2016	72.7	2.8	99.6	3.7	152.2	183.3	− 761.1	69.0
2017	70.0	2.7	102.1	3.6	164.0	191.3	− 933.4	65.7
2018	74.9	2.8	107.8	3.6	172.1	212.8	− 855.3	69.7
2019	78.5	2.7	109.9	3.5	187.9	216.6	− 1,161.4	63.5
2020	77.8	2.9	95.1	3.2	177.2	237.1	− 785.3	73.7
2021	83.7	2.7	99.1	3.0	201.3	259.2	− 948.6	72.8
Average annual change, in %	− 1.6		-0.1		6.6	9.0		

Source Eurostat database, https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_A64__custom_6290100/default/table?lang=en

Table 2 Total supply/use of agri-food products in Croatia based on the IO table, in millions of HRK*

	2010	2018	Index 2018/2010
Total supply/use of agri-food products	66,091	86,917	131.5
Agriculture	24,587	20,528	83.5
Manufactured food	41,504	66,390	160.0
Domestic production of agri-food products	54,198	64,148	118.4
Agriculture	21,489	15,929	74.1
Manufactured food	32,710	48,219	147.4
Imports of agri-food products	11,893	22,769	191.5
Agriculture	3098	4599	148.5
Manufactured food	8795	18,171	206.6
Share of imports in total supply/use	18.0	26.2	145.6
Agriculture	12.6	22.4	177.8
Manufactured food	21.2	27.4	129.2

Source Eurostat database, https://ec.europa.eu/eurostat/databrowser/view/naio_10_cp1700/default/table?lang=en

*Exchange rate (2010) HRK/EUR = 7.29, exchange rate (2018) HRK/EUR = 7.41

lower prices of imported agricultural products resulted in a decrease in domestic production. Imports of agricultural products almost doubled in the analysed period and reached a share of 22.4% of total demand in 2018. Higher import dependency is also evident for manufactured food products, for which the share of imports in the same period increased from 21.2 to 27.4% of total demand. The lower incomes of Croatian

Table 3 Origin of imported agri-food products used as intermediate inputs and final domestic expenditures in Croatia in 2014, in millions of EUR

	Intermediate inputs		Final expenditures		Total imports		Total agri-food	
	Agriculture	Food	Agriculture	Food	Agriculture	Food	Value	Structure, in %
EU	201.7	197.8	197.7	877.7	399.4	1075.5	1474.9	78.1
Germany	20.8	34.3	23.9	237.7	44.7	272.0	316.7	16.8
Italy	13.5	33.8	65.7	130.7	79.2	164.4	243.6	12.9
Hungary	68.6	33.7	9.1	90.4	77.7	124.1	201.8	10.7
Poland	9.0	5.2	4.7	94.0	13.8	99.2	113.0	6.0
Netherlands	17.1	8.9	20.8	66.0	37.9	74.9	112.8	6.0
Slovenia	7.8	17.9	17.2	35.4	25.0	53.3	78.3	4.1
Spain	0.3	3.2	22.6	37.7	22.9	40.9	63.8	3.4
Czech	15.2	12.4	1.1	27.0	16.2	39.4	55.7	2.9
France	10.5	13.0	1.8	20.4	12.3	33.4	45.7	2.4
Belgium	1.1	4.3	0.4	22.5	1.5	26.8	28.2	1.5
Other EU countries	37.9	31.1	30.4	116.0	68.3	147.1	215.4	11.4
Non-EU	53.2	121.5	63.8	174.9	117.0	296.4	413.4	21.9
Brazil	7.2	21.2	3.9	1.4	11.1	22.6	33.7	1.8
India	6.6	15.6	0.4	0.5	7.0	16.1	23.1	1.2
UK	0.3	2.5	0.3	13.5	0.6	16.0	16.6	0.9
Turkey	0.9	2.1	17.9	6.9	18.8	9.1	27.9	1.5
Rest of the world	35.7	68.8	31.0	131.2	66.7	200.0	266.6	14.1
Total imports	255.0	319.3	261.5	1052.6	516.4	1371.9	1888.3	100.0
Memo item Use of domestic products	1415.3	646.3	1455.3	3698.4	2870.5	4344.8	7215.3	

Source WIOD (2021) World Input–Output Database 2016 Release, 2000–2014 (https://www.rug.nl/ggdc/valuechain/wiod/?lang=en)

households compared with more developed EU countries affect consumers' preferences in favour of less expensive imported products.

Table 11 in Appendix presents trends in domestic production and imports of the most important agri-food products in terms of the final demand in the 2010–2020 period. The share of imports increased for most of the observed products. Poultry is the only product in the list for which domestic production has recorded significant growth and the share of imports has decreased. The lowest share of imports has been recorded in the maize supply. A moderate increase in the share of imports has been recorded for food products such as apples, wheat, eggs and potatoes. The worst trend regarding the competitiveness of domestic producers can be found in the supply of sugar, milk products and pig meat. In the supply of pig meat, the imported quantities are higher than the domestic production, while in the production of milk products and sugar, the import share is close to 50%.

Table 3 presents data on the origin of agri-food products imported to Croatia based on the World Input–Output Database (WIOD 2021; Timmer et al. 2015). Due to the complexity of producing world IO tables, the most recent available data are for 2014. Almost 80% of agri-food products imported to Croatia were produced in EU countries. Croatia's most important trading partners were Germany, Italy, Hungary, Poland and the Netherlands, which together delivered over 50% of imported agri-food products. It is interesting to note that the highest share by value of agricultural products used as intermediate inputs was imported from Hungary, while products from Germany, Italy and the Netherlands were predominantly delivered for final consumption. The imports from other non-EU economies accounted for less than 20% of the total value of imported agri-food products. Unfortunately, WIOD includes individual IO data for only 43 countries, with all other deliveries grouped together in the 'rest of the world' (ROW) sector. In the case of Croatia, imports of agri-food products from the economies not individually included in WIOD covered 14.1% of total imports. Other data sources indicate that, regarding geographical proximity, ROW includes a heterogeneous set of economies. Important agri-food trading partners include neighbouring economies (such as Bosnia and Herzegovina and Serbia) but also distant countries for specific products such as coffee, cocoa and citrus fruits.

In the early 2000s, the most important agri-food imports were pork, beef and sugar (Grgić et al. 2011). Kovačićek et al. (2018) concluded that meat, milk, dairy products, chocolate and bakery and confectionery products were mostly imported from Germany. The most important imports from Italy were fruit and nuts, while meat, fats and oils, milk and dairy products and sugar were imported from Hungary. According to the Ministry of Agriculture (2022), the most important agri-food products imported in 2021 were cigarettes, oil cakes and other solid residues from soybeans, and fresh or chilled meat from domestic pigs.

International comparison with old and new EU member states (NMS) reveals that import dependence in the agri-food sector in Croatia is close to the EU average (Table 4). The share of imports in the total supply of goods and services on the Croatian market is 26.2%, which is between the levels recorded for old (22.0%) and new (31.8%) EU members. In the production of agricultural products, the import shares recorded for NMS and Croatia are lower than in more developed old EU members. On the other hand, the share of imported manufactured food products is higher in NMS (35.9%), in comparison with the Croatia and the average of old EU members. Although the import dependence of the Croatian agri-food sector does not significantly diverge from the EU average, trends indicating deterioration of international competitiveness in the recent period could raise some concern.

Besides its economic effects, the production of agri-food products has significant environmental impacts. According to Bates et al. (2019), 30% of the environmental footprint of households is related to food consumption. Table 5 presents a comparison of the emissions of greenhouse gases (CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3, all expressed in CO_2 equivalent) in Croatia and its main trading partners.

In per capita terms, Croatia's greenhouse gas emissions, from both its food industry and its overall economy, are significantly lower than the corresponding emissions of its main trading partners. Germany and Italy recorded lower emissions in agriculture, but most imports from these economies are processed food products, for which the Croatian emissions are lower.

Table 4 International comparison of the share of imports in the total supply of agri-food products

	Reference period	Agriculture	Food industry	Agri-food sector
Old EU members				
Germany	2018	40.9	24.5	28.5
Greece	2015	12.6	23.2	19.5
Spain	2015	18.4	14.1	17.1
France	2018	15.1	19.5	18.3
Italy	2018	20.7	18.1	18.8
Austria	2017	33.3	29.1	29.9
Average old EU		23.5	21.4	22.0
NMS				
Czechia	2018	20.2	35.3	30.0
Estonia	2015	19.9	41.3	34.9
Cyprus	2018	21.9	42.0	36.5
Latvia	2015	22.3	43.9	36.3
Lithuania	2015	19.3	36.2	29.8
Hungary	2015	11.2	26.1	19.9
Malta	2015	54.2	52.9	53.1
Poland	2015	15.5	17.3	16.8
Romania	2015	14.4	16.5	17.8
Slovenia	2015	31.4	41.0	38.3
Slovakia	2015	25.0	42.4	36.7
Average NMS		23.2	35.9	31.8
Croatia	2018	22.4	27.4	26.2

Source Authors' calculations based on the Eurostat database, https://ec.europa.eu/eurostat/databrowser/view/naio_10_cp1700/default/table?lang=en

Table 5 Emissions of greenhouse gases (in CO2 equivalent) in Croatia and main trading partners, in kg per capita in 2021

	Agriculture, forestry and fishing [A]	Manufacture of food products; beverages and tobacco products [C10-C12]	Total—all NACE activities [TOTAL]
EU	1070	138	6412
Germany	735	141	7400
Italy	709	128	5274
Hungary	1027	109	5179
Poland	1502	158	9554
Netherlands	1603	248	8680
Slovenia	944	92	6008
Spain	1077	126	4791
Czech	887	155	9015
France	1235	134	4536
Belgium	1070	231	7149
Croatia	906	70	4437

Source https://ec.europa.eu/eurostat/databrowser/view/ENV_AC_AINAH_R2__custom_6443889/default/table?lang=en

Literature review

The concept of short food supply chains (SFSCs) is defined by Marsden et al. (2000). This definition does not include the specific distance or the number of distributors between the original producer and the final consumer, but the fact that the consumer is aware of the origin and potentially the production process applied. The important elements of the definition of local food are spatial proximity, the possibility of directly contacting the original producer through face-to-face or internet communication, and the product information including certification and legislation regarding its geographical origin (Marsden et al. 2000). The EU (EU Commission 2013) defines an SFSC as 'a supply chain involving a limited number of economic operators, committed to cooperation, local economic development and maintaining close geographical and social relations between food producers, processors and consumers'. The importance of orientation on local food has been recognized by EU institutions. Studies in the EU have examined the contribution of SFSCs to rural development and economic regeneration, generally finding evidence of positive employment effects on the local farming system and higher multipliers on local economies (Moya et al. 2009). Besides the positive effects of the orientation of local households to regional food products, synergies with the tourism sector are also found.

Direct food sales from farms to consumers bring several positive effects to local communities. Purchases of food from small local producers induce greater economic benefits than acquisition of the same goods from large supermarkets. The benefits of buying local goods are not limited to the income created for local agricultural producers but include other advantages, such as the possibility of directly monitoring the production process to ensure adherence to health, quality and environmental protection standards.

A systematic review of the economic effects of food re-localization has been carried out by Benedek et al. (2020). The empirical studies usually found positive effects of re-localization on the domestic economy. The economic effects of food re-localization usually include estimation of output, GVA and employment induced by spending on local food (Benedek et al. 2020). Besides the direct effects on monetary income or employment of local agricultural producers, studies often estimate GVA and employment multipliers. Multipliers are defined as the ratio of total effects along the value-added chain to direct GVA and employment of local producers (Benedek et al. 2020). The largest share of the research has examined economic effects of local food systems in various regions of the USA (Rossi et al. 2017; Miller et al. 2015; Pesch and Tuck 2019; Henneberry et al. 2009; Hughes et al. 2008; Hodges et al. 2014; Schmit et al. 2016), where the use of Impact Analysis for Planning (IMPLAN) based on IO model is common. Those studies usually found positive economic effects of re-localization. Studies using questionnaire and interviews usually found not only direct effects on revenues and employment of local producers but also several indirect economic benefits such as increase in profits or expansion of tax bases Bubinas (2011); Mundler and Laughrea (2016); Argent (2018) and Lobley et al. (2009). However, some papers based on the interviews (Gupta and Makov 2017) concluded that high share of imported inputs used by local producers limits positive effects. The econometric analysis is also applied in the agri-food re-localization estimation. Roberts et al. (2013) applied multivariate probit analysis based on the questionnaire, telephone-based and face-to-face survey data and concluded that diffusion of positive economic effects depends on the broader context and region. Brown et al. (2014) estimated IV regression model by using census of agriculture data and found no significant contribution of re-localization to the economic growth. Lambert et al. (2009) evaluated multinomial logit model based on the USDA agricultural resource management survey and secondary county data and concluded that distribution of positive effects differs in urban and rural areas.

Studies on the multiplicative effects of the agri-food sector on EU economies usually provide results for national territories. Based on an IO analysis, Bartóková (2019) analysed multipliers for the agriculture and food sectors of Slovakia, the Czech Republic, Hungary and Poland. In all these countries, simple output multipliers showed a decreasing trend in the 2000–2014 period. Simple output multipliers for the agriculture sector in 2014 ranged from 1.40 to 1.85 and for the food sector from 1.81 to 2.24. The highest simple output multipliers were recorded for the Polish, and the lowest for the Slovak agriculture and food sector. By analysing sectoral interdependencies for the Romanian, Hungarian and Slovak economies, Balla (2014) determined that in all three countries, agriculture sector is strongly forward interrelated with the food sector. Furthermore, a strong forward relationship between the food sector and the accommodation and food services sector was observed in Hungary and Slovakia, while in Romania this relationship was not significant. Heringa et al. (2013) based on IO model for multifunctional agriculture, which includes green care, tourism, recreation and education, farm sales and green services in the Netherlands concluded that the indirect effects were not significant.

Food production is a crucial element of the concept of bioeconomy, an economic model focussed on environmental protection and sustainable development. The bioeconomy is defined as an economy which comprises all economic activities related to the use of biological products and processes to produce food, feed, biological products and bioenergy (Ferreira et al. 2021). Loizou et al. (2019) estimated direct and indirect effects of bioeconomy sectors on the Polish economy. By replacing external inputs with local resources, farmers can obtain greater added value in food production, greater incentives for more sustainable methods and better quality of products, energy and transportation costs reduction, thus linking ecological and economic sustainability (Levidow and Psarikidou 2011).

Debate on the total effects of re-localization of food production on environmental sustainability is not fully conclusive. Re-localization can contribute to environmental protection because of the shorter distances of food transport. Process of re-localization should be coupled with improvements in the production methods, handling, storage, processing, packaging and distribution. Available empirical surveys strongly confirm the conclusion that SFSCs significantly contribute to social sustainability (Vittersø et al. 2019), but besides origin, other factors must be considered in designing policies aimed at improved EU food chain sustainability. The positive effects of re-localization include a reduction in CO2 emissions associated with transportation of food from the place of production to final consumers (Tudisca et al. 2015). Consumption of local food products could also be motivated by more environmentally sustainable methods of production (Augère-Granier 2016). Closer relations between producers and final consumers could result in more sustainable practices in the use of inputs such as pesticides, fertilizers, animal feed, water and energy.

On the other hand, local suppliers can be less productive than agricultural producers who operate in more favourable environments, which could decrease efficiency and result in higher emissions of harmful particles (Stein and Santini 2022). The ecological footprint of agri-food production could be more closely related to the dietary choices of consumers than the origin of products. For example, increased consumption of seasonal food or reduced consumption of animal source foods could have positive environmental effects (Puigdueta et al. 2021). In addition to greenhouse gas emissions, the water footprint (WF) of the agri-food industry also has important ecological effects. Sturla et al. (2023) found that the largest sectoral component of the Italian WF is in agriculture (78.6% of the total WF). Čegar (2020) found significant multiplicative effects of water use in Croatia for agriculture and concluded that this sector plays a major role in the exploitation of national water resources.

The re-localization of the agri-food sector is also motivated by concerns regarding food quality and security. The need to strengthen food security is reflected both in developing and high-income economies as a result of rising food poverty, conflicts, climate variability, inequality and inadequate social security and welfare services (Arcuri et al. 2017, FAO 2020). Alternative food networks contribute to the development of more sustainable food systems, focussing on the drivers, initiatives and policies dealing with environmental and socio-economic harms (Cerrada-Serra et al. 2018). For the food chain to be sustainable, the economic, ecological and social dimensions must be integrated into a coherent system. The key component of this system is quality, which contributes to achieving economic growth and shaping any development strategy, especially those that strive to offer high-quality food (Mattas et al. 2022). European legislation recognizes the importance of food safety and quality, and each member state is expected to organize its own system in accordance with the general European system. Crucial elements in food quality legislation include the regulation of food hygiene and the use of pesticides, antibiotics, vitamins and similar items in food production (Pettoello-Mantovani and Olivieri 2022). Although legislation on food safety defines high standards, it allows additional regulatory intervention of Member States.

Methodology

The structure of IO tables that present the flow of intermediate and final products among industries and final consumers is widely described in the literature (see Miller and Blair 2009; ten Raa 2005; Mikulić 2018). Table 6 is a stylized IO table for an economy divided into economic sectors (industries producing homogeneous products). The columns of the IO table present the structure of the output of each economic sector: the intermediate costs of domestic and imported inputs and the GVA. Reading across the rows reveals the value of deliveries made by each industry to other economic sectors and final consumers. The data in IO table indicate that an expenditure of one sector is a revenue for another sector. The interindustry transactions in the IO table are marked as x_{ij}, indicating the value of goods or services delivered by sector i to be used as intermediary inputs in the production processes of sector j. The output of each sector can be separated into

Table 6 Simplified IO table with separated flows of domestic and imported products

		Producers			**Final uses**	**Total production**
		1...	...j...	...n	Y	x
Producers	1	x_{11}	$\ldots x_{1j}\ldots\ldots$	x_{1n}	Y_1^D	x_1
	...	...		...	...	...
	i	x_{i1}	$\ldots x_{ij}\ldots$	x_{in}	Y_i^D	x_i
	...	...	...	...	...	...
	n	x_{n1}	$\ldots x_{nj}\ldots$	x_{nn}	Y_n^D	x_n
Import	1	m_{11}	$\ldots m_{1j}\ldots\ldots$	m_{1n}	Y_1^M	M_1
	...	...		...	...	...
	i	m_{i1}	$\ldots m_{ij}\ldots$	m_{in}	Y_i^M	M_i
	...	...	...	...	...	...
	n	m_{n1}	$\ldots m_{nj}\ldots$	m_{nn}	Y_n^M	M_n
Net taxes on products		$tindx_1$	$tindx_j$	$tindx_n$	Y_{tind}	
GVA	v	$v_1\ldots$	v_j	$\ldots v_n$		v
Production/final uses	X	$x_1\ldots$	x_j	$\ldots x_n$	Y	

deliveries of intermediate products to other sectors (sum of x_{ij} for sector of interest i) and deliveries for final uses (Y_i^D=C_i^D +G_i^D+I_i^D+E_i^D, $i = 1, \ldots, n$). The final uses can be further separated (not presented in Table 6) into personal consumption (C), government consumption (G), investment (I) and exports (E). Superscript D denotes domestic origin of a product, while subscript $i = 1, \ldots, n$ stands for a particular sector of interest. The lower part of the IO table presents deliveries of imported goods and services. Expenditures of final consumers on domestic products increase domestic output and GVA, while expenditures on imported products cause outflow of funds to other countries.

Final consumption expenditures (Y) in the national accounts are usually valued at market purchaser prices, while IO tables use the concept of basic prices (prices received by a producer). Basic prices are defined as purchaser prices minus trade and transport margins and taxes on products. The transformation of expenditures for personal consumption from purchaser to basic prices can be expressed by the following formula:

$$Y^D = T^{DC}Y^{DK} \tag{1}$$

where Y^{DK} is a column vector with n rows, which represents the structure of final expenditures on domestic products valued at purchaser (retail) prices as usually available from standard statistical sources (in Croatian IO tables, $n = 64$, indicating 64 economic sectors). The transformation matrix T^{DC} is an $n \times n$ matrix. The diagonal entries represent the ratios of basic to purchaser prices for the output of each sector, that is, the shares of retail prices that go to the original producers. The rows for distributional sectors (trade and transport) represent the share of trade and transport margins in purchaser prices of each economic sector, while all other elements are zero. By this procedure, expenditures valued in retail prices are transferred to receipts of domestic producers, transportation and trade margins.

In the case of imported goods and services, the transformation matrix T^{UC} includes nonzero entries only in rows related to domestic distribution, where the share of domestic transport and trade services in the retail price of imported products is presented. In the case of imported products, Y^U includes only transport and trade margins of domestic distributors, which are included in the transfer of products from the foreign producer to the domestic final consumer. Zero entries on the diagonal of the transformation matrix indicate the absence of positive multiplicative effects on domestic producers because indirect and induced effects have been transferred abroad:

$$Y^U = T^{UC} Y^{UK} \tag{2}$$

This study is limited to final demand for sectors of interest: the agriculture and food manufacturing industries.

In the IO notation, the matrix A denotes a technical coefficient matrix whose elements $a_{ij} = \frac{x_{ij}}{x_j}, i, j = 1, \ldots, n$ represent the share of the intermediate inputs delivered by sector i required to produce a unit value of output in sector j. The elements of Leontief inverse matrix $L = (I - A)^{-1}$ represent the sum of direct and indirect outputs of sector i required per unit of output produced and delivered by sector j to the final user (Miller and Blair 2009). Indicators calculated from the matrix L, determining direct and indirect effects, are called type I multipliers. They are calculated as the ratio of the total (direct and indirect) effect to the initial effect. Indicators that include induced effects in addition to direct and indirect effects are type II multipliers. For the type II multipliers calculation, matrix $\overline{\mathrm{L}} = \left(\mathrm{I} - \overline{\mathrm{A}}\right)^{-1} = \begin{bmatrix} \overline{\mathrm{L}_{11}} & \overline{\mathrm{L}_{12}} \\ \mathrm{L}_{21} & \mathrm{L}_{22} \end{bmatrix}$ is used, where $\overline{\mathrm{A}}$ presents extended technical coefficient matrix A with an additional row representing the wage coefficients by sector and additional column representing the structure of personal consumption (Burrows and Botha 2013; McLennan 2006). When studying only the direct, indirect and induced effects of the original n sectors calculation, the matrix $\overline{\mathrm{L}_{11}}$ is used. Type II multipliers are calculated as the ratio of the total (direct, indirect and induced) effect to the initial effect. The total output induced by final consumption can therefore be estimated by the following equation:

$$x = \overline{\mathrm{L}_{11}} T^{DC} Y^{DK} \tag{3}$$

The total effects of final consumption on GVA can be calculated by the formula

$$VA = V\overline{\mathrm{L}_{11}} T^{DC} Y^{DK} \tag{4}$$

where V denotes a diagonal matrix whose elements are the shares of GVA in the output of each productive sector. The total effects on employment can be estimated according to

$$EM = E\overline{\mathrm{L}_{11}} T^{DC} Y^{DK} \tag{5}$$

where elements of the diagonal matrix E denote the ratio of the number of employees to the output of each productive sector.

When IO tables for several time periods are available, structural decomposition analysis (SDA) is recommended to decompose changes in an economic indicator into its components (Dietzenbacher and Los 1998; Miller and Blair 2009; Rose and Casler 1996). For two time periods, $t = 0$ and $t = 1$, let $X^t = L^t Y^t$ be the output vector in year t. The matrix L^t is the Leontief inverse matrix in year t and Y^t is the final demand vector in year t. Then the change in outputs over the time period is

$$\Delta X = X^1 - X^0 = L^1Y^1 - L^0Y^0 \tag{6}$$

SDA enables the decomposition of the total change in outputs into changes in technical coefficients ($\Delta L = L^1 - L^0$) and changes in final demand ($\Delta Y = Y^1 - Y^0$). From a wide variety of possible decompositions (Rørmose 2010), Dietzenbacher and Los (1998) recommended using the average of the results obtained based on only year 1 values for L and only year 0 values for Y, and those based on only year 0 values for L and only year 1 values for Y. Following this approach, the decomposition of ΔX is

$$\Delta X = \frac{\Delta L(Y^0 + Y^1)}{2} + \frac{(L^0 + L^1)\Delta Y}{2} \tag{7}$$

where first term refers to technology change effect and the second to final demand change effect. Regarding data availability, the SDA model as presented by Eq. 7 is based on the following elements:

ΔX—the 64×1 vector of the change in sectoral output levels : $X^1 - X^0$
ΔL—the 64×64 matrix of the change in the Leontief inverse $\left(\mathrm{I} - \overline{\mathrm{A}}\right)^{-1}$: $\Delta L = L^1 - L^0$
ΔY the 64×1 vector of the change in final demand: $Y^1 - Y^0$.

The change in the final demand can be further decomposed on the final demand level, mix and distribution effects (Miller and Blair 2009; Dietzenbacher and Los 1998):

$$\Delta Y = \left(\frac{1}{2}\right)(\Delta f)(\boldsymbol{B}^0 d^0 + \boldsymbol{B}^1 d^1) + \left(\frac{1}{2}\right)[(f^0(\Delta B)\boldsymbol{d}^1 + f^1(\Delta \boldsymbol{B})\boldsymbol{d}^0] + \left(\frac{1}{2}\right)(f^0\boldsymbol{B}^0 + f^1\boldsymbol{B}^1)(\Delta \boldsymbol{d}) \tag{8}$$

where $\boldsymbol{B}$ is the 64×4 matrix of bridge coefficients, measuring the share of the final demand spent on products delivered from various sectors for each 4 individual components of final demand (personal consumption, government consumption, investments and exports); $\boldsymbol{d}$ is 4×1 vector with total final demand of different categories; f is the value of the total final demand (scalar).

Superscripts 0 or 1 indicate base (2010) or referent (2018) period, while Δ stands for the change in the value of elements in two different periods.

First term in Eq. 8 is used to capture the effects of the change in the volume of the final demand. The second term is focussed on the effects of the change in the product mix within final demand components, while the third term measures the effects of the change in the distribution of the final demand among components.

Official IO tables do not provide IO in constant prices to directly compare variables of interest, so the empirical results presented in section "Results" were based on a modelling approach that estimates the IO data in real terms as proposed by Llop (2017). To compare outputs in real terms, IO data should be expressed in terms of the prices of a reference year by the application of the double deflation method. Under the assumption of homogenous goods being produced by a given economic sector, the gross output, intermediate consumption and final demand should be deflated by the appropriate price index. The change in prices of products in each sector is based on the detailed breakdown of Croatian national accounts data, which are expressed in current prices and the prices of the previous year. The chain-linking technique is applied to combine annual price changes into cumulative price changes over the 2010–2018 period. The IO data for 2010 are converted to constant 2018 prices by the following procedure. The ratio of the current price to the base-year price level for sector i can be expressed as p_i. The matrix P is diagonal: it contains the elements p_i on the main diagonal, while the other elements are 0. The conversion to constant prices is based on the following formula:

$$X_r = A_r X_r + Y_r = (I - A_r)^{-1} Y_r \tag{9}$$

where $X_r = P^{-1}X$ is the vector of outputs expressed in constant prices, $Y_r = P^{-1}Y$ is the deflated final demand vector, and $A_r = P^{-1}AP$ is the matrix of IO coefficients in constant prices.

The main data sources in this research are the symmetric IO table for the Croatian economy for the year 2010, the first IO table for the Croatian economy available according to CPA rev. 1 classification and the symmetric IO table for the Croatian economy for the year 2018, the last published Croatian IO table. The IO tables were downloaded from Eurostat (2022). To estimate the effects of food re-localization, the food-related sectors in the IO tables were identified by the following codes:

- *CPA_A01* Products of agriculture, hunting and related services.
- *CPA_C10-12* Food, beverages and tobacco products.

For those two food-related sectors, the term *agri-food sector* is used in the remainder of the paper. The effects of the re-localization of food production were calculated by replacing the relevant entry of imported food (agri-food products) Y_1^M with domestic expenditure of the same value Y_1^D, while keeping the total value of expenditures on food products constant.

Results

In this section, results are presented on the effects of final demand for agri-food products on economic activity in Croatia as estimated by the IO model. The contribution of the Croatian agri-food sector in terms of GVA, GDP, employment and tax revenues is compared for 2010 and the most recent available data for 2018 as the reference year.

Economic effects of expenditures on agri-food products on the Croatian economy

As discussed in the methodology section, final expenditures stimulate an increase in economic activity to deliver demanded goods and services. The total retail price of both domestic and imported products includes value-added tax and other taxes on products. The market price, compared with the basic price of the product, additionally includes the costs of distribution from the producer to the final user, such as transportation and wholesale and retail margins. If consumers choose imported products, the effects on the Croatian economy are limited only to the collected taxes (value-added tax and excise duties for individual items) and activity in the

Table 7 Contribution of final expenditures on agri-food products to Croatian economic activity in 2010 and 2018, in millions of HRK

Effects		Agriculture			Manufactured food			Total agri-food	Relative effects, as % of Croatian total
		Domestic	Imports	Total	Domestic	Imports	Total		
Final uses, market prices	2010	11,729	1,674	13,403	44,957	11,367	56,324	69,727	15.4
	2018	9594	2,770	12,364	56,393	20,699	77,092	89,456	15.6
GVA	2010	9249	252	9501	26,770	1,520	28,291	37,792	13.5
	2018	6609	334	6943	32,047	2,810	34,857	41,800	13.2
GDP	2010	9167	254	9421	35,638	4,005	39,643	49,064	14.7
	2018	7503	490	7993	45,750	7,205	52,955	60,948	15.6
Net taxes and contributions	2010	3315	63	3378	15,685	2,855	18,539	21,917	19.9
	2018	1269	229	1498	19,616	5,017	24,633	26,131	19.8
Employment effects, in FTE jobs	2010	118,252	1737	119,988	195,248	10,531	205,779	325,768	19.5
	2018	49,986	1847	51,833	178,983	15,525	194,508	246,341	15.0

Source Authors' calculations

distribution value-added chain, which makes up only a small portion of the total retail price of the product. Positive economic effects related to the income of the producer of an imported product are transferred abroad and contribute to the economic activity in the country of origin. In contrast, if consumers choose domestic products, those expenditures activate multiplier effects in the entire domestic value-added chain.

The total effects of final demand on domestic activity for the year 2010 and 2018 are calculated by the application of formula (3–5) in which the values of final expenditures (after transformation from retail market prices to the basic prices received by a producer) on agricultural and manufactured food products are multiplied by the Leontief inverse matrix (Table 7).

Expenditures on food products in Croatia made up a relatively high share of total final uses (15.4% in 2010 and 15.6% in 2018). The higher share than in more developed countries can be explained by the lower incomes of Croatian citizens but also the relatively high demand of foreign tourists. As can be seen from Table 7, the final demand for food products generates 61 billion HRK or 15.6% of Croatia's GDP and more than 246 thousand FTE jobs. The significant decrease in the number of FTE jobs (compared to 326 thousand jobs in 2010) is a result of increased productivity.

The share of net taxes and contributions related to the consumption of agri-food products is even higher (19.8% of total taxes collected in Croatia) than the share of GDP, because the sector 'Food, beverages and tobacco products' includes items subject to high taxation such as alcohol and tobacco products. Due to the increase in VAT rate and the harmonization of excise duties after joining the EU, the relative importance of agri-food products to the total public revenues increased. The total economic effects induced by consumption of manufactured food were significantly higher than the effects of demand for agricultural products. It is interesting to note that the effects of expenditures on imported products are significantly lower than the

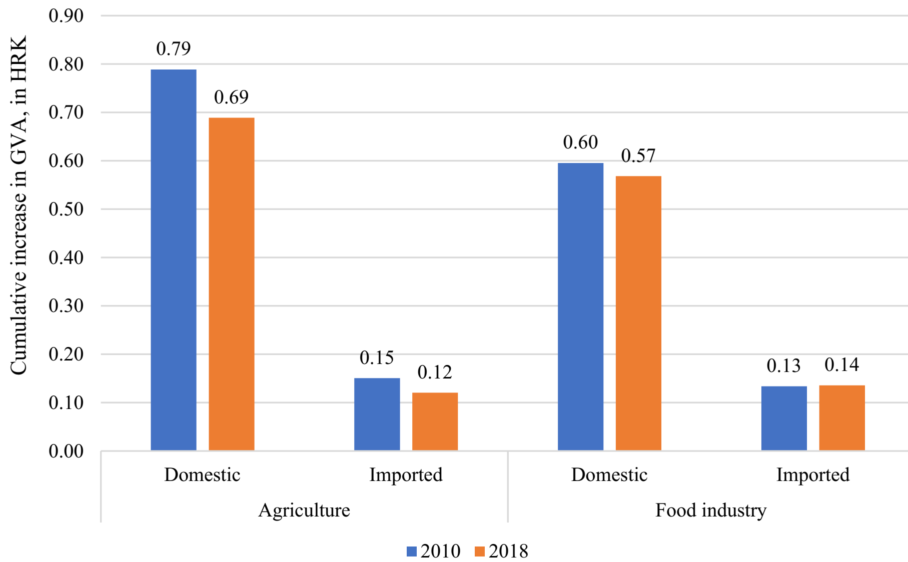

Fig. 1 GVA effects per 1 HRK expenditure on domestic and imported agricultural and manufactured food products. *Source* Authors' calculations

effects of expenditures on domestic products. Figure 1 illustrates the difference in relative effects of expenditures between domestic and imported goods.

Each 1 HRK of expenditure on domestic agricultural products stimulated 0.69 HRK GVA in the Croatian economy in 2018 along the supply chain. The same value of expenditures for imported products generated only 0.12 HRK GVA, mainly in distributive sectors such as trade and transport. The relative effects of expenditures on manufactured food indicate lower multiplicative effects in comparison with the agricultural sector. The lower relative effects in 2018 for both sectors are probably a consequence of higher requirements for imported intermediary inputs.

Mechanism of the expansion of the initial effects induced by demand for domestic and imported products

The IO model is convenient for comparing the total economic effects of demand regarding the origin of agri-food products. The overall economic effect of the change in final demand on the national economy includes direct effects (revenues received by an original producer), indirect effects (revenues of all production units included in the value-added chain) and induced effects related to the additional personal consumption financed by wages received by employees throughout the supply chain. Thus, the overall effects on economic activity are greater compared with the initial value of the expenditure. The type I and type II multipliers, described in the methodology part of the paper, are shown in Fig. 2 and are effective for output valued at the basic price received by an original producer. Because of the more complex production processes used in manufacturing industries, the multipliers in the food industry are higher than in agriculture. As can be seen, type II multipliers recorded a decrease in the analysed period for both sectors. It is interesting to note that type I multipliers (including direct and indirect effects) in the manufactured food products sector

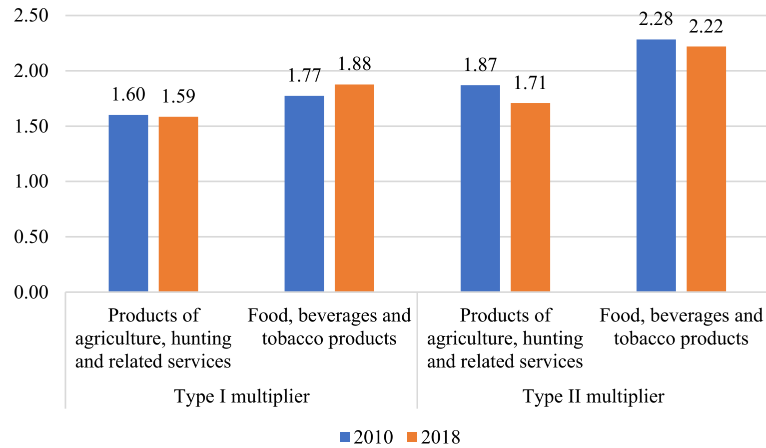

Fig. 2 Type I and type II output multipliers for the agriculture and food industries in 2010 and 2018. *Source* Authors' calculations

increased, which indicates higher integration with domestic producers of intermediate inputs. The decreasing type II multipliers indicate lower induced effects and are probably a result of the decreasing share of wages and salaries in the supply chain of the food manufacturing industry.

When consumers buy domestic manufactured food products, the government receives value-added tax and other obligatory taxes, distributive sectors receive trade and transport margins, and the remainder of the retail price goes to the domestic producer. The structure of the retail prices of goods sold to households for their personal consumption is presented by the first four rows of Table 8. The structure of the total market price paid for other components of final demand could deviate slightly from the structure of personal consumption because of differences in tax obligations (for example, exports are not subject to value-added tax) and differences in distribution channels. According to the IO data, out of 1,000 HRK of the retail price paid by the final consumer, only 556 HRK is distributed to the domestic food manufacturer, while an expenditure of the same value, because of lower taxes, results in revenues of 759 HRK received by an agricultural producer.

To produce a manufactured food product, the producer requires numerous intermediary inputs bought on the domestic or foreign markets, such as slaughter cattle, chemical products and energy. In the case of manufactured food, when the value of the intermediate inputs is subtracted from the revenues of the direct producer (556 HRK), it results in 216 HRK of direct GVA (GVA of the direct producer), while the labour requirements of the direct producer are estimated at 2 person-hours. The results of the IO model estimate that 668 HRK of output, or 316 HRK of GVA, are indirectly induced in the domestic supply chain of the meat industry, while the indirect labour requirements are estimated to add 3 person-hours. Part of the GVA is distributed to the employees in the form of wages and salaries, which increases the income of domestic households and consequently the value of total personal consumption. Additional personal consumption of various goods and services induces 396 HRK of output, 186 HRK of GVA and 2 person-hours of employment. If direct, indirect and induced effects are summed together, expenditures on domestic food products worth 1000 HRK in the group 'Food, beverages

Table 8 Economic effects of final demand on domestic and imported agri-food products based on the 2018 IO table

	Agricultural products	**Food, beverages and tobacco**
Personal consumption in HRK, retail market price	1000	1000
Effects of buying domestic products		
Net indirect taxes	74	257
Trade and transport margins	166	187
Revenues of domestic producers	759	556
Indirect revenues of suppliers of intermediary inputs	705	688
Induced revenues related to increase of wages	322	396
Total output	1787	1640
Direct GVA	354	216
Indirect GVA	316	316
Induced GVA	151	186
Total GVA	821	718
Direct labour requirements (person-hours)	6	2
Indirect labour requirements (person-hours)	3	3
Induced labour requirements (person-hours)	2	2
Total labour requirements (person-hours)	11	7
Direct taxes and social contributions	250	196
Indirect taxes	172	382
Total taxes and social contributions	422	578
GDP (GVA + net indirect taxes)	993	1099
Effects of buying imported products		
Total GVA	121	136
GDP	195	393
Labour requirements (person-hours)	1	1
Total taxes and social contributions	115	303
Effects of the import substitution		
Total GVA	701	582
GDP	798	706
Labour requirements (person-hours)	10	6
Total taxes and social contributions	307	275

Source Authors' calculations

and tobacco' induce 718 HRK GVA or 1099 HRK GDP (GVA plus net taxes on products). Expenditures on domestic goods positively affect public finances as 578 HRK of taxes and contributions are collected along the supply chain.

On the other hand, the total effects of expenditures on imported food products of the same value are limited to the supply chain of domestic distributors. Therefore, 1000 HRK spent on imported products induces only 136 HRK of GVA and 303 HRK in taxes and contributions. The total effects of import substitution represent the difference in effects for the purchase of a domestic product and an imported product. Import substitution by a domestic food product of 1000 HRK value will result in an increase in the Croatian GVA of 582 HRK, or 706 HRK in terms of GDP. The substitution also contributes to the stability of public finances, by inducing an additional 275 HRK of taxes and contributions. Import substitution of agricultural products has even greater economic effects than substitution of manufactured food products.

Table 9 Structural decomposition analysis—changes in agri-food output decomposed to technological and structural factors in period 2010–2018, millions of HRK in 2018 prices

	Agriculture	Food industry	Agri-food, total
Total change (A + B)	− 7943.1	15,056.8	7113.6
A. Technological change	− 5627.8	9483.3	3855.5
B. Structural change	− 2315.3	5573.5	3258.1
B1. Final demand volume effects	1407.0	2824.4	4231.4
B2. Products mix effects	− 3987.1	2182.0	− 1805.1
B3. Distribution effects	264.8	567.0	831.8
Structural effects by categories of final expenditures			
Personal consumption	− 2540.4	817.2	− 1723.2
Government consumption	617.8	89.4	707.2
Investments and change in inventories	− 1386.3	3500.5	2114.2
Exports	993.6	1166.4	2160.0
Total	− 2315.3	5573.5	3258.1

The mechanism of expansion of effects related to the change in the structure of domestic and imported products is effective in both directions. Thus, the process of growing import dependence in the 2010–2018 period decreased the potential for positive effects of increasing final demand by domestic households and tourists.

Structural decomposition analysis of changes in agri-food output in Croatia in period 2010–2018

The SDA method defined in section "Literature review" decomposes the change in gross output in all economic sectors into effects related to changes in technological coefficients and structural changes in final demand. Table 9 summarizes results in constant 2018 prices for agri-food sector only.

Table 9 reveals that production in the agriculture and food industries recorded divergent trends. The real economic activity in Croatian agriculture decreased, while a positive trend is found for the food industry. For both sectors, the effects of technological changes have been more pronounced than those of structural changes in final demand. In the case of agricultural production, the impact of technological change is the most pronounced in decreasing the requirements of domestic food industry for domestic agricultural inputs and intermediate intra-industry deliveries. In 2010, deliveries of intermediate inputs from agriculture to other domestic sectors were concentrated in the food industry (which covered 60% of all intermediate deliveries) and intra-sectoral deliveries (18% of intermediate deliveries). Direct requirements of the food industry for domestic agricultural inputs fell from 0.17 per unit of output in 2010 to only 0.10 in 2018, while the IO coefficient for intra-industry deliveries also fell from 0.15 to 0.10. Positive impacts of technological changes in food industry were the most pronounced for deliveries of food products used as intermediate inputs by hotels and restaurants (IO coefficient increased from 0.05 to 0.13) and intra-sectoral deliveries (IO coefficient increased from 0.02 to 0.06).

While effects of the growth in the volume of final demand of final consumers are positive for both sectors, the product mix effects are the most important source of negative structural change effects in the case of agriculture. It is probably a consequence of the shift in demand towards processed food products (where product mix effects are found to be positive) and increased share of imported agricultural products. Distribution effects are found to be positive for both sectors, but the intensity of those effects is less pronounced. Those results are consequence of the increased share of personal consumption and exports (where agri-food is important item) at the expense of government consumption and investments. Changes in the level and structure of the final demand indicate the importance of the increase in exports, which positively affected both the agriculture and food industries. While the effects of personal consumption on the food industry were positive, the output of domestic agricultural producers decreased because of the falling demand from Croatian households. It can be noticed that a significant share of the value of the output of the food industry in 2018 was not delivered to domestic units or exports but was recorded as an increase in inventories.

Effects of potential import substitution of food products

Recent global shocks have led to appeals for the redefinition of strategic goals and policy measures to recognize the importance of attaining a higher degree of self-sufficiency in agri-food production. Besides geopolitical security, increased self-sufficiency could contribute to policy goals such as environmental protection and sustainable development (Voznyak et al. 2022; Gu et al. 2022).

The scenario presented in this section analyses the effects of limited substitution of imported agri-food products, which can be achieved with measures that are not contrary to regulations on free international trade. Improvements in Croatian quality standards regulation could prevent imports of low-quality products at dumping prices. Measures harmonized at the EU level regarding taxation of imports according to their associated emissions could increase the competitiveness of domestic producers. Consumer protection regulations and raising awareness of the benefits of buying high-quality local products could speed up the process of food re-localization. In this scenario, it is assumed that 10% of imports of agri-food products can be replaced by domestic production. This assumption seems reasonable and achievable in the medium term. Croatia has favourable preconditions for development of agriculture and food production, such as a mild climate and availability of high-quality agricultural land. Slight increase in self-sufficiency would only bring it closer to comparable EU economies.

Table 10 presents the economic effects of potential import substitution of food products under the assumption that 10% of imports are substituted by domestic re-localized products. A modest import substitution could increase the Croatian GDP by 1.3 million HRK or 0.32%. Because of higher taxes on products (value-added tax and similar taxes), the effects of substitution on net taxes and social contributions are less pronounced than the effects on GVA, but the total government revenues could increase by 0.26%. The relative effects are most pronounced for the labour market (0.39) due to the high labour intensity in agriculture.

Estimating the overall ecological effects of potential import substitution would require the application of WIOD or similar global models, which can capture the changes in the ecological footprint related not only to direct emissions in the production and transport of agri-food products but also to indirect effects through intersectoral deliveries. Emissions of harmful particles in transport are expected to reduce as a consequence of re-localization, but this could be partially offset by cleaner production of some products in

Table 10 Economic effects of potential import substitution of 10% in final consumption of agri-food products, in millions of HRK

	Food	Agriculture	Total	Effects, as % of total Croatia
Value of import substitution	1657	222	1879	
Effects on output	2241	327	2568	
GDP effects	1103	167	1270	0.32
GVA effects	961	150	1111	0.35
Direct	393	81	474	
Indirect	327	45	371	
Induced	242	24	266	
Effects on taxes and social contributions	314.1	25.0	339.1	0.26
Employment effects, FTE jobs	5327	1136	6463	0.39

Source Authors' calculations

the countries of origin (for example, agriculture goods imported from Italy or Germany, where direct greenhouse gas emissions are lower).

Conclusions and recommendations

It is widely accepted that free international trade is one of the key factors for economic development and the effective use of a nation's comparative advantages. Free trade is important for economies that technologically lag behind the most developed countries, since trade openness can stimulate the adoption of modern technologies and improve productivity. However, if the institutional framework for consumer protection and quality control is underdeveloped, liberalization can result in a high proportion of low-quality imported products in certain market segments. Besides food quality concerns, supporters of food re-localization highlight other potential benefits, such as reduced emissions associated with long-distance transport, better control of environmental protection in production processes and improved economic resilience to potential negative global shocks or supply shortages (Vittersø et al. 2019; McFadden et al. 2016).

Results presented in this article confirm the previous findings that re-localization of food production could stimulate domestic economic activity (Moya et al. 2009; Rossi et al. 2017; Pesch and Tuck 2019; Schmit et al. 2016). Increased production of agricultural and manufactured food products stimulates economic activity in many other domestic sectors that produce the intermediate goods and services required in their production processes. The multipliers estimated for Croatian agricultural and food production do not deviate significantly from the results presented for other economies. The output multipliers related to the Croatian food sector are slightly lower than the multipliers estimated for NMS countries (Bartóková 2019; Loizou et al. 2019). On the other hand, the multipliers calculated for the Croatian agriculture sector are in line with the findings of Bartóková (2019).

According to the results of the IO model for the Croatian economy, final expenditures on domestic food products valued 1000 HRK induce 718 HRK GVA or 1099 HRK GDP. In contrast, if final consumers buy imported food of the same value, it induces only 136 HRK of GVA or 393 HRK GDP. Import substitution also positively affects the stability of public finances: taxes and contributions collected along the supply chain are 275

HRK higher if, instead of imported food, domestic manufactured food is purchased. The estimated relative economic effects of import substitution for agricultural products are higher than for manufactured food products. Expenditures on domestic agricultural products valued 1,000 HRK induce 821 HRK GVA or 993 HRK GDP. If domestic agricultural products are purchased rather than imported, the taxes and contributions in the supply chain increase by 307 HRK. In addition to the relative effects of import substitution, the results present a scenario of moderate import substitution in the agriculture and food industries. If 10% of imports of final demand for agri-food products are replaced by domestic production, this could increase the Croatian GDP by 1.3 million HRK or 0.32%. Although import substitution of some inputs can reasonably be expected, substitution in some sectors could be impossible due to technological factors and availability of domestic resources.

The overall environmental effects of reallocation of expenditure towards domestic agri-food products would likely be positive. The greenhouse gas emissions of Croatia's food industry are significantly lower than those of its main trading partners. However, some proportion of positive effects could be offset because of lower emissions from agriculture in important trading partners such as Germany and Italy. By re-localizing agri-food imports, the ecological footprint of the economy changes, shifting pressures from other countries to the Croatian ecological system. This could negatively affect some ecosystems, which could be particularly important in the case of water, since according to Čegar (2020), Croatian agriculture uses a significant share of the national water resources. In future work, a more detailed estimate of total environmental effects is required, including calculation of direct and indirect greenhouse gas emissions and water footprint effects, spreading of indirect effects among countries and industries and accounting for the differing transport modes of various kinds of agri-food products.

Moderate import substitution in the use of agricultural and food products can be realized without introducing any additional restrictions on international trade. As an EU member, Croatia is obligated to apply the EU regulations on import restrictions and general quality standards of food products. Member states can define additional requirements for food quality standards. A set of measures to eliminate unfair competition from low-quality imported food products should be based on a detailed analysis of markets for specific products. The IO model for the Croatian economy provides information for relatively heterogeneous sectors such as the agri-food industry and is not able to identify specific products for which domestic production has been crowded out by unfair competition. Instead of trade restrictions, policy measures should be focussed on raising the awareness of Croatian consumers on the advantages of buying high-quality local products. More efficient allocation of funds for rural areas could speed up the process of technological transformation of the agricultural sector and consequently increase the stability and resilience of the economy to external shocks.

Despite the numerous analytical advantages of the IO model, the assumptions of fixed technical coefficients and availability of resources to increase output could be considered as significant limitations (Miller and Blair 2009). As technical progress over the time leads to changes in production technology, the assumption of fixed technical coefficients is acceptable only in the short term and if the structure of economic sectors changes slowly over time. The real output of Croatian agriculture has been decreasing and as a result of strong growth in imports. The volume of production in 2021 was 16% below the level recorded in 2010. Previous studies indicate that 38% of land area appropriate for agriculture is not used in agricultural production (Tomić et al. 2013) so the availability of natural resources is not a factor that should limit moderate import substitution in the agri-food sector.

Appendix

See Table 11.

Table 11 Domestic supply and imports of the most important food products in Croatia, in 1000 tonnes

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Apples											
Domestic production	107	113	45	128	97	102	45	57	93	68	64
Import	13	15	16	23	10	22	25	27	25	16	19
Import, % of supply	10.8%	11.7%	26.2%	15.2%	9.3%	17.7%	35.7%	32.1%	21.2%	19.0%	22.9%
Eggs											
Domestic production	43	42	35	37	34	33	40	39	29	33	37
Import	4	3	3	3	7	9	9	8	8	7	8
Import, % of supply	8.5%	6.7%	7.9%	7.5%	17.1%	21.4%	18.4%	17.0%	21.6%	17.5%	17.8%
Maize											
Domestic production	2068	1734	1298	1874	2047	1709	2154	1560	2147	2298	2431
Import	46	55	47	41	73	78	46	63	77	74	108
Import, % of supply	2.2%	3.1%	3.5%	2.1%	3.4%	4.4%	2.1%	3.9%	3.5%	3.1%	4.3%
Wheat											
Domestic production	681	782	1,000	999	649	759	969	688	744	803	868
Import	95	97	101	129	229	237	248	324	365	332	335
Import, % of supply	12.2%	11.0%	9.2%	11.4%	26.1%	23.8%	20.4%	32.0%	32.9%	29.3%	27.8%
Sugar											
Domestic production	247	263	154	201	335	130	250	275	275	150	151
Import	53	113	207	118	163	221	224	177	183	152	141
Import, % of supply	17.7%	30.1%	57.3%	37.0%	32.7%	63.0%	47.3%	39.2%	40.0%	50.3%	48.3%
Potatoes											
Domestic production	179	168	151	163	161	171	194	156	182	173	174
Import	41	36	40	43	38	51	56	50	65	59	57
Import, % of supply	18.6%	17.6%	20.9%	20.9%	19.1%	23.0%	22.4%	24.3%	26.3%	25.4%	24.7%
Pig meat											
Domestic production	121	120	127	107	96	94	98	105	114	121	110
Import	66	69	73	86	111	130	129	135	139	136	129
Import, % of supply	35.3%	36.5%	36.5%	44.6%	53.6%	58.0%	56.8%	56.3%	54.9%	52.9%	54.0%
Poultry											
Domestic production	29	28	34	29	60	65	66	66	64	68	70
Import	15	14	17	18	20	22	24	24	26	30	25
Import, % of supply	34.1%	33.3%	33.3%	38.3%	25.0%	25.3%	26.7%	26.7%	28.9%	30.6%	26.3%
Milk											
Domestic production	785	801	828	739	728	707	689	668	631	615	612
Import	176	198	213	288	272	389	449	480	510	462	421
Import, % of supply	18.3%	19.8%	20.5%	28.0%	27.2%	35.5%	39.5%	41.8%	44.7%	42.9%	40.8%

Source FAO Food Balances, https://www.fao.org/faostat/en/#data/FBS

Abbreviations

EU European Union
GVA Gross value added
IO Input–output
IMPLAN Impact Analysis for Planning
FTE Full-time equivalent
SFSC Short food supply chains

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DM and ŽL contributed to conceptualization; DM and DK contributed to formal analysis; DM and DK contributed to methodology. All authors contributed to resources, results validation and writing, review and editing. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used during the current study are available from the corresponding author on request.

Declarations

Competing interests
The authors declare no competing interests.

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