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Food Self-Sufficiency of the SEE Countries; Is the Region Prepared for a Future Crisis?

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Abstract: Although the concept of self-sufficiency has been accepted both in developed and developing countries, alternated with periods of its rejections, the food crisis from 2007/08 and COVID-19 pandemic returned focus to the availability of countries to be self-sufficient in food production. Considering the concerns over ensuring food security in many countries, the main objective of this paper is to estimate the ability to fulfill the feed demand of the population in the eight countries of South-East Europe (SEE), which is in crisis conditions, such as pandemic especially important. In that context, the food self-sufficiency ratio (SSR) is calculated for total food production, as well as for different food groups. The next step in the methodological framework was to estimate the influence of different factors on the self-sufficiency ratio, as it depends on natural, financial, economic, and political factors. The results show that the SEE region expresses a high level of SSR in food, so it shows that the region is quite ready to respond to the challenges posed by the crisis. However, as the SEE region is a group of very different countries, regional cooperation should be strengthened as food production is considered.

Keywords: food self-sufficiency; South-East Europe; COVID-19

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1. Introduction

The South-East Europe (SEE) countries have been moving from a national food self-sufficiency policy to a trade-based approach for almost three decades. In that process, many developing countries become net food importers under the rules of liberal trade policies [1]. However, the food crisis in 2007/08 returned to focus interest in food self-sufficiency [2–4]. According to Tadasse et al. [5], during the food crisis in 2007/08, the nominal food prices of the most agri-food products increased more than 50%. After only three years, a new crisis occurred, and this time food prices increased even more, which brought the problem of food security to the forefront. In the course of the last 15 years, several countries declared self-sufficiency as a medium-term policy objective, among others, Senegal and the Philippines concerning rice [2], and Russia concerning many agricultural products [6].

The COVID-19 crisis finds the world food system unprepared for possible trading halts and other restrictions, posing one of the major challenges to food systems and food security [7]. Namely, income shocks and supply disruptions have affected food security and livelihoods, especially in cases where supply chains were not integrated well [8], like in Western Balkans, where food supply chains are characterized by a low level of integration [9]. Disruptions in food value chains were different along the chain, as well as across different chains and regions. Moreover, previous research [10] suggested critical responses of policymakers to prevent that global health crisis from becoming a global food crisis. From one side, the pandemic will, most probably, undermine the quality of nutrition [11] and leave lasting economic scars. On the other side, it may act as a catalyst for greater food self-sufficiency. In the case of the SEE region, governments responded with different measures, which, combined with external shocks, are expected to result in a notable contraction across the region. Most of the countries in the SEE region are not heavily integrated into global value chains as the production of agri-food products is mainly for national and intra-regional consumption, so that this sector could represent great potential in intensifying intra-regional trade [12]. Furthermore, the SEE country-case differences are noticeable in the national agricultural policies that bring additional complexity in analyzing some commonalities of the countries in responding to the crisis. Several countries are already members of the European Union (EU), and thus, have aligned agricultural policy with the Common Agricultural Policy (CAP) of the EU. Most of the actions taken by the governments in the crisis periods mainly consider coordinated action with other EU countries. On the other hand, all the candidate countries are still in the harmonization process, continuously switching between national political interests and the formal EU requirements [13]. This is also reflected in the unharmonized regional reaction to the crisis, as mentioned before.

Considering the voiced concerns over ensuring food security in many countries around the world and most likely long-term social and economic consequences for the agricultural sector caused by crisis conditions, the **main objective** of this paper is to estimate the SEE region's ability to fulfill feed demand of its population which is especially important in situations, such as global food and financial crisis or pandemic. Additionally, this paper studies the factors affecting the level of food self-sufficiency in SEE. Since there are a limited number of papers analyzing food self-sufficiency in the SEE region, this paper contributes to filling this literature gap. Moreover, experience with the previous crisis could be a valuable direction in a potential future food crisis.

The paper is organized as follows: A literature review is elaborated in the Section 2, while the methodology used in this paper is described in the Section 3. The Section 4 includes the presentation of results, while the discussion of results is in Section 5. Finally, the conclusion in Section 6 includes implications of the results and consideration of future expectations.

2. Literature Review

The food self-sufficiency concept is quite important because it directly impacts the country's capability to meet the nutritional needs of its population. A certain number of countries do not have an adequate level of food self-sufficiency because of very unfavorable natural resources (inadequate water availability, the lack of arable land, etc.). To meet these needs, the country imports the necessary quantities of food. However, in the case of extreme events that in some way restrict international trade, negative consequences for countries with a low level of self-sufficiency are created. Namely, extreme events, such as extreme droughts, happen occasionally, but their occurrence has many adverse impacts [14]. Considering that those events are very rare and cannot be predicted, most countries are not prepared to cope with them regardless of whether they are countries with a high or low level of food self-sufficiency. Likewise, the causes of extreme events and the measures that are taken to eliminate and prevent negative impacts that are changing with time and with different political and economic conditions [15]. In his paper Torero [16] is giving the review of policies that have been proposed as a result of the food crisis in 2007/08 and 2010/11. Namely, the author states that proposed policies to prevent future price spikes include physical reserves at different levels, improvement in information and coordination, emergency reserves, food aid, internationally coordinated public grain reserves, national and regional stocks, and trade facilitation.

There are numerous definitions of the food self-sufficiency concept. Food self-sufficiency is the ability to meet the consumption needs with own production instead of buying and importing [17]. Authors claim that food self-sufficiency represents the potential of the household, region, or country to meet the consumption needs from its own production. According to FAO [18], "The concept of food self-sufficiency is generally taken to mean the extent to which a country can satisfy its food needs from its own domestic production". Beltrane-Pena et al. [19] define food self-sufficiency as the capability of a country to satisfy the caloric needs of its own population from domicile production.

Clapp [20] claims that the main feature by which the concept of food self-sufficiency differs depends on whether the definition of the concept includes trade. The most extreme case of the food self-sufficiency concept implies the complete exclusion of the concept of trade. This means that "this definition refers to a state practicing complete autarky in its food sector". On the other hand, the same author claims that a more pragmatic understanding of food self-sufficiency includes the concept of trade.

It is very important to point out the connection between the concept of food security and between the concepts of food self-sufficiency. Those two concepts are different. Namely, according to FAO definition [21] "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". The food security concept includes four dimensions: Stability, availability, access, and use. According to Clapp [1,20], the concept of food security does not consider the origin of the food. Moreover, it does not consider the capability of the country to produce the food. On the other hand, the author claims that the food self-sufficiency concept refers to the availability pillar of the concept of food security. It considers the origin of the food or the capacity of the country to produce the food in sufficient quantities.

Regarding food self-sufficiency concept analysis in the SEE region, there is no research on this subject so far. Considering that food self-sufficiency represents the availability dimension of the food security concept, the literature review will consider the paper in which the SEE region food security concept was analyzed. Namely, Brankov and Lovre [22] analyzed the concept of food security in the countries of the former Yugoslavia. In the paper, authors used the FAO food security index. The research results indicated significant differences among the analyzed countries. Moreover, the authors pointed out that it is necessary to solve complex interrelationships between those countries to ensure food security. Papić Brankov and Milanović [23] analyzed food security in Serbia. Using a set of indicators, the authors concluded that the greatest negative impact on the food system had a low level of gross domestic product per capita and corruption in the analyzed period. The research of the food security in the former Yugoslavia countries, authored by Kovljenić and Raletić-Jotanović [24], discussed that the highest level of food security is in Slovenia, and the lowest in Bosnia and Herzegovina. The key factors were: Level of economic development, population growth, international trade, and investment in the agriculture.

Matkovski et al. [25] recently analyzed factors that determine food security and the level of food security in the Western Balkan region during EU integration in crisis conditions. The results indicated important differences in the levels of food security among these countries. The main indicators contributing to that are food supply variability, dependence on cereal import, and GDP per capita. Authors claim that the importance of these factors is even more pronounced in times of crisis. Considering ranking in the cluster of Western Balkan and EU countries in the same research [25], all countries all analyzed countries belong to the worst group, i.e., group of countries with lower levels of food security. As the research suggests, food insecurity is most pronounced in North Macedonia and Bosnia and Herzegovina. Focusing on the dimensions of food security, it is noticed that the use of food utilization is a problem in the whole Western Balkans. Food supply stability is problematic in Bosnia and Herzegovina, Albania, and Montenegro; while food availability should be improved, especially in North Macedonia, Serbia, Croatia, and Bosnia and Herzegovina.

Many papers focus on the impact of COVID-19 on agriculture and food security. However, previous research on the effects of the COVID-19 on food security and self-sufficiency lacks timely and reliable data and shortcomings of economic theories [7]. Despite this, the effects of a pandemic on food security are determined in different ways. For example, the impact of COVID-19 on agriculture and food security in one research is estimated through different consequences for poverty and food insecurity at the household level across countries and regions, and according to this research, almost 150 million people could be endangered by extreme poverty and food insecurity [26]. Because of that, some measures as early policy responses to COVID-19 have been established, and research shows a large diversity of measures [14]. Namely, according to this research, emerging economies applied to a greater extent trade and market interventions, information and coordination and food assistance measures, and more particular measures that were urgent and necessary. This research included SEE countries that are part of the EU, which are also the focus of our analysis. For example, Bulgaria focus attention on information and coordination measures and trade and products flow measures, Croatia on agricultural and food support, general support and food assistance and consumer measures, while Romania has implemented information and coordination measures, agricultural and food support, as well as food assistance and consumer support measures [14]. In the case of Western Balkan countries (the SEE countries that are in the process of EU integration, not member states), pandemic conditions can become a problem because of the lower level of food security, especially in countries with high food supply variability, dependence on cereal import, and lower GDP per capita [25]. Because of that, these countries introduced different supporting measures of the economy, but the uncertain duration of the pandemic is one of the crucial dilemmas for policymakers in creating these optimal mitigation measures. Some countries introduced measures primarily focused on the food market. For example, Montenegro had special support to the agricultural sector, while Serbia, at the beginning of the pandemic, had price control for some basic food and export bans of some agri-food products [27].

3. Materials and Methods

Our sample is made up of eight countries of the SEE region, three of them—EU member states—belong to the group of developed economies (Bulgaria, Croatia, and Romania), while five are economies in transition (Albania, Bosnia and Hercegovina, Montenegro, North Macedonia, and Serbia) [28]. Only one of the observed countries is classified as high-income–Croatia, while the rest belong to upper-middle-income countries. This paper analyses the eight SEE countries over a 13-year period (2006–2018). The research period was selected in accordance with the availability of data. The initial year of research is 2006 because then, in the final act of the demise of Yugoslavia, Montenegro achieved its independence from Serbia.

We calculate a key indicator of the concept of food self-sufficiency–food self-sufficiency ratio (SSR_{food})–using the following equitation:

$$SSR_{food} = P_{food}/D_{food} \times 100\%, \quad (1)$$

where SSR_{food} is the rate of food self-sufficiency, P_{food} is the total domestic food output, and D_{food} is the total supply.

Referring to the FAO calculation method [29] the total supply represents:

$$D_{food} = P_{food} - E_{food} + Z_{food} + I_{food}, \quad (2)$$

where E_{food}, Z_{food}, I_{food} are food exports, changes in stocks (decrease or increase), and imports, respectively. We used data of Food Balance from the Food and Agriculture Organization Statistical database (FAO) [30]; for P_{food} production quantity and for D_{food} domestic supply quantity.

SSR was estimated for different food groups (cereals excluding total beer, starchy roots, total oil crops, fruits excluding wine, total vegetables, total sugar crops, total meat, total pulses, treenuts, total eggs, milk excluding butter, fish, and total seafood) for each country and the whole SEE region. In addition, we calculate overall SSR for all observed food groups for each observed country and the SEE region.

Theoretically, the achievement of food self-sufficiency of a country depends on natural, financial, economic, and political factors [6]. Thus, in the next step, an analysis of the impact of different factors on SSR_{food}, such as GDP per capita, yield, population density, political stability, and trade openness, was conducted using a model:

$$SSR_{it} = \alpha + \beta_1 GDP_{it} + \beta_2 Y_{it} + \beta_3 PD_{it} + \beta_4 PS_{it} + \beta_5 TO_{it} + \beta_6 EU_{it} + \mu_i + \lambda_t + u_{it}, \quad (3)$$

where SSR_{it} represents SSR in the country i in the period t; GDP_{it} represents GDP per capita in the country i in the period t; Y_{it} represents yield of the selected item in the country i in the period t; PD_{it} represents population density in the country i in the period t; PS_{it} represents political stability in the country i in the period t; TO_{it} represents trade openness in the country i in the period t; EU_{it} represents a dummy variable which covers effects of membership in the EU on SSR level; μ_i and λ_t represent cross-section and period-specific effects (random or fixed), respectively; and u_{it} represents a random error of the model.

The selection of appropriate panel model among the pooled Ordinary Least Square (OLS), Fixed-effect (FE), and Random-effect (RE) was based on the following tests: Joint significance of differing group means, Breusch-Pagan, and Hausman test statistic.

The expected influence of the explanatory variable on the dependent variable is defined in Table 1. Namely, it is expected to find a negative relationship between GDP per capita and SSR, because usually with economic growth, a country increases the ability to purchase food from abroad [31]. It is well known that yield increment increases food self-sufficiency [32,33], so the relationship between yield and SSR is expected to be positive. Population density could have a direct impact on supply and demand for agricultural goods [34,35]. Thereby, it is expected that population density negatively influences self-sufficiency in the constructed model. In general, political stability makes it possible to improve the population's economic and physical access to food [36], and contrary political instability slows down public investment in agricultural production and infrastructure [37]. Countries plagued by corruption and poor governance have little chance to achieve self-sufficiency [38]. In general, self-sufficiency and political stability are interdependent issues [39]. Thereby we can expect a positive influence of political stability on countries' self-sufficiency. Moreover, it is expected that trade openness positively affects food self-sufficiency. Openness to trade creates the opportunity for foreign investments in the development of domestic production [40,41]. Market autarky results in uncertainty and distortions that can cause lower production and higher food prices, and lower food security (and self-sufficiency) in the long-term [1].

Table 1. Explanatory variables.

Variable	Description	Source	Expected Relationship
GDP	GDP per capita in 2015 USD prices	FAO	Negative
Y	Yield in tons per hectare or kilograms per animal	FAO	Positive
PD	Population density (hectare of arable land per capita)	FAO/MONSTAT	Negative
PS	Index of political stability, and absence of violence/terrorism	FAO	Positive
TO	Trade openness	World Bank	Positive
EU	Membership in the EU	European Commission	Negative

Source: The authors' composition.

This research includes data obtained from several sources: FAO [30], World Bank database (WB) [42], Statistical Office of Montenegro (MONSTAT) [43], and European

Commission (EC) [44] (Table 1). For data of population density, an exception applies in the case of Montenegro, in which it is not possible to obtain exact data from FAO. Thus, data of arable land necessary for calculating population density in this country was used from MONSTAT.

4. Results

All observed countries easily meet their dietary needs with a very low hunger level-less than 5% (Table 2) [30]. Per capita, food supply available for human consumption during the reference period in terms of caloric value is above the global average calorific intake of 2653 kcal/person/day [45], since SEE countries tend to fall within the range of 2800–3500 kcal/person/day (Table 2). However, it should be noted that the only country in our sample with a noticeable increase in the prevalence of undernourishment in the total population in Serbia.

Table 2. Level of hunger and food availability per capita in the SEE countries.

	Albania		**Bosnia and Herzegovina**		**Bulgaria**		**Croatia**		**North Macedonia**		**Montenegro**		**Romania**		**Serbia**	
	2004–2006	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**	**2004–2006**	**2017–2019**
Prevalence of undernourishment in the total population in %	8.9	3.6	<2.5	<2.5	4.9	3.0	<2.5	<2.5	5.0	3.1	<2.5	<2.5	<2.5	<2.5	<2.5	4.6
Prevalence of severe food insecurity in the total population in %	10.0	10.0	1.5	1.5	1.9	1.9	0.6	0.9	3.6	3.2	2.1	2.2	5.6	3.4	1.7	2.0
Prevalence of moderate or severe food insecurity in the total population in %	38.8	37.1	9.6	9.2	14.9	12.5	6.5	10.0	15.1	14.4	12.6	12.9	19.3	14.5	11.4	12.4
Food supply (kcal/capita/day)	2855	3360	3016	3307	2759	2854	3070	3074	2827	3072	3276	3500	3430	3581	2750	2828

Source: FAO, 2020 [46] and FAO, 2021 [30].

Out of eight countries in our sample, there were four countries (Bulgaria, Croatia, Romania, and Serbia) that showed overall SSR_{food} above 100%, while four countries (Albania, Bosnia and Herzegovina, North Macedonia, and Montenegro) showed an SSR_{food} below the line of 100% (Figure 1).

Figure 1. Average self-sufficiency rates of food in SEE countries in period 2006–2018. Source: The authors' illustration.

However, as FAO recommends, applying the SSR concept to the overall food situation of a country should be very careful because it can mask the actual dependence on imports of certain foods [47]. The complexity of this issue is especially evident in crisis situations. For example, during the first wave of COVID, there was a great demand for flour. Romania announced export restrictions on wheat to non-EU countries. Serbia also imposed an export ban on wheat flour [48]. These measures, if they lasted, could jeopardize the food security of neighboring countries, such as Bosnia and Herzegovina, Montenegro, North Macedonia, and Albania. Because of that, we analyzed SSR levels for different groups of agri-food products (Figure 2). For example, Serbia is self-sufficient in cereals, oil crops, fruit, vegetables, sugar, and milk, but is highly dependent on fish import (produces only 15% of its fish requirements). Besides, Serbia is not self-sufficient in pulses and treenuts, while SSRs of starchy, meat, and eggs are near 100%. Similarly, although it showed the highest SSR in our sample, Bulgaria is not self-sufficient in starchy, fruit, vegetables, sugar, meat, pulses, treenuts, and fish. A high SSR score is obtained, due to the production of cereals and oil crops in abundance. The general assessment is much more applicable in the case of Montenegro because the country relies on the import of all food groups.

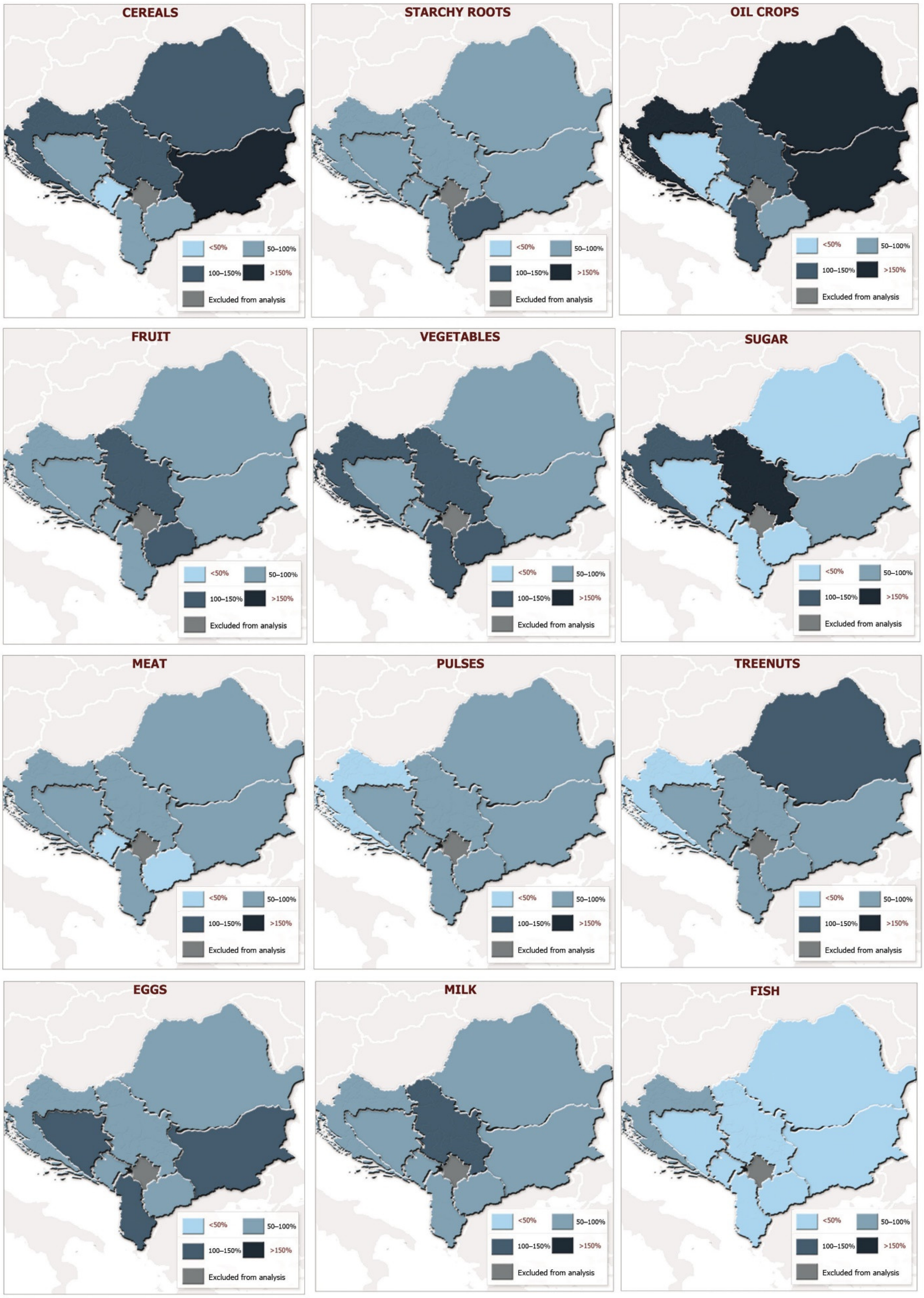

Figure 2. Average self-sufficiency rates of different types of food in SEE countries in period 2006–2018. Source: The authors' illustration.

In 2018, the SEE region was able to fulfill the demand of the population for cereals, starchy, oil, pulse, treenuts, and eggs; with a slight improvement, it can reach full self-sufficiency in starchy crops, vegetables, and milk; but it is highly dependent on fish import and moderate dependent on fruit, sugar, meat, pulses, and treenuts imports.

From an analysis of the impact of different factors on SSR, the sugar and fish food groups were excluded, due to the unavailability of data for yield variables for some countries. Moreover, due to the unavailability of the data, we used the yield of the beef meet as an expression of the total meat yield. Table A1 shows a summary statistic for our balanced panel data-mean, standard deviation, and measure of dispersion. The results show that there are significant differences among selected variables in SEE countries.

The selection of appropriate models among OLS, FE, and RE is made in Table 3. After providing all assumptions, an adequate model was performed.

Table 3. Panel diagnostic tests.

Dependent Variable	Joint Significance of Differing Group Means	Breusch-Pagan Test Statistic	Hausman Test Statistic
SSR_cereals	F(6, 91) = 20.4023 *p*-value= 0.0000	LM = 92.5969 prob(chi-square(1) > 92.5969) = 0.0000	H = 3.68522 prob(chi-square(5) > 3.68522) = 0.595565
SSR_starchyroots	F(6, 91) = 14.143 *p*-value=0.0000	LM = 13.3471 prob(chi-square(1) > 13.3471) = 0.00025882	H = 32.5038 prob(chi-square(5) > 32.5038) = 0.0000
SSR_oilcrops	F(6, 91) = 12.3303 *p*-value 0.0000	LM = 47.9459 prob(chi-square(1) > 47.9459) = 0.0000	H = 11.1894 prob(chi-square(5) > 11.1894) = 0.047751
SSR_fruit	F(6, 91) = 141.407 *p*-value =0.0000	LM = 365.704 prob(chi-square(1) > 365.704) = 0.0000	H = 2.2308 prob(chi-square(5) > 2.2308) = 0.816375
SSR_vegetables	F(6, 91) = 4.49306 *p*-value= 0.000497	LM = 1.08295 prob(chi-square(1) > 1.08295) = 0.298038	H = 18.9322 prob(chi-square(5) > 18.9322) = 0.00197887
SSR_meat	F(6, 91) = 245.107 *p*-value 0.0000	LM = 181.766 prob(chi-square(1) > 181.766) = 0.0000	H = 18.3627 prob(chi-square(5) > 18.3627) = 0.00252459
SSR_pulses	F(6, 91) = 13.7729 *p*-value=0.0000	LM = 5.47821 prob(chi-square(1) > 5.47821) = 0.019255	H = 29.622 prob(chi-square(5) > 29.622) = 0.0000
SSR_treenuts	F(6, 91) = 3.53037 *p*-value =0.00346552	LM = 0.404409 prob(chi-square(1) > 0.404409) = 0.524821	H = 19.803prob(chi-square(5) > 19.803) = 0.00136066
SSR_eggs	F(6, 91) = 18.0449 *p*-value 0.0000	LM = 62.5174 prob(chi-square(1) > 62.5174) = 0.0000	H = 5.24482 prob(chi-square(5) > 5.24482) = 0.386738
SSR_milk	F(6, 91) = 28.3636 *p*-value 0.0000	LM = 77.3517 prob(chi-square(1) > 77.3517) = 0.0000	H = 6.57094 prob(chi-square(5) > 6.57094) = 0.254554

Source: The authors' calculations.

For the analyses of SSR_cereals and SSR_fruit, we performed RE panel models. No cross-sectional dependence, serial correlation, and collinearity were confirmed by the Pasaran CD test, Wooldridge test, and Belsley-Kuh-Welsch test. We control for heteroskedasticity by observing any significant differences between conventional standard errors and robust standard errors. Thus, we confirmed that our results were based on homoscedasticity. It was found that recommended FE models for SSR_starchyroots, SSR_vegetables, SSR_pulses, and SSR_meat suffer from heteroskedasticity and autocorrelation, so we performed the Weighted Least Squares method (WLS) as the most appropriate to have efficient estimators. SSR_treenuts and SSR_oilcrops were analyzed initially by pooled OLS and FE model, respectively, but recommended models suffer from serious heteroskedasticity, but not autocorrelation, so we applied heteroskedasticity-corrected model. Panel diagnostic tests for SSR_milk and

SSR_eggs showed that the RE model is adequate, but autocorrelation is detected, so these models are estimated using WLS.

Based on the results of the panel analysis (Table 4, Tables A2–A11), the influence of **GDP per capita** on SSR_starchy is significant and positive, while its effect on SSR_oilcrops, SSR_pulses, and SSR_eggs is significant and negative, as expected. Despite the statistically significant results of the impact of GDP on the dependent variable, it is necessary to note that the impact is really small and that other factors have a greater impact on SSR. As expected, SSR increases in **yield** significantly in the case of SSR_cereals, SSR_fruit, SSR_meat, SSR_treenuts, and SSR_eggs. Contrary to our expectation, SSR_starchyroots, SSR_meat, SSR_treenuts, and SSR_milk significantly increase by increasing **population density**, and it could be explained that these types of production are relatively more intensive. The expected sign was obtained for SSR_oilcrops and SSR_vegetables. Interestingly, **trade openness** had the expected effect on SSR_cereals, but the opposite effect was predicted on SSR_starchyroots, SSR_fruit, SSR_meat, and SSR_milk. These opposite results are probably the consequence of the small economies as SEE countries are, where the extensive type of production is dominant, so the export of cereals is more present. According to estimated results, **political stability** had a negative and significant influence on SSR_cereals, SSR_starchyroots, SSR_eggs, and SSR_milk. The expected sign we obtained only in the case of SSR_oilcrops. Although estimated models showed a negative influence of political stability, it is important to highlight that SEE countries have relatively good political stability, and these results should be interpreted very carefully. Dummy variable, **membership in EU**, showed the negative effect only in the case of SSR_starchyroots. The membership in the EU enhanced these countries' SSR_oilcrops, SSR_vegetables, SSR_meat, and SSR_eggs.

Table 4. Model estimation of SSR for the SEE countries.

Variable	SSR_ cereals	SSR_ starchyroots	SSR_ oilcrops	SSR_ fruit	SSR_ vegetables	SSR_ meat	SSR_ pulses	SSR_ treenuts	SSR_ eggs	SSR_ milk
Const	−144.843 *	81.7702 ***	184.034 ***	74.2249 ***	139.699 ***	99.5100 ***	93.7567 ***	47.1884 **	108.933 ***	93.5911 ***
GDP	0.0026	0.00129376 **	−0.0149997 ***	−0.0010	0.00219857	−0.00170376	−0.0038 **	−0.0016	−0.00276955 *	
Y	18.8088 ***	0.203891	3.47374	2.0007 ***	−0.0152871	0.1364 ***	5.2229	4.5877 **	0.992642 *	−0.0001
PD	269.645	15.9565 *	−105.195 *	49.2464	−190.198 ***	35.1521 *	−2.6082	144.319 ***	−3.71317	35.9759 ***
PS	−18.3052 **	−8.45339 ***	17.7711 *	3.2010	−7.06949	2.30170	−0.6054	1.6654	−6.9202 **	−15.2959 ***
TO	0.5109 **	−0.0292573	−0.229614	−0.1417 *	0.0122405	−0.7047 ***	−0.0288	−0.0200	−0.0551	−0.1627 ***
EU	51.6783	−10.2562 ***	188.563 ***	−10.0437	12.7060 **	16.7313 **	−4.3501	−5.9680	15.3074 ***	2.6514
Periods included	13									
Cross-sections	8									
Total panel obs.	104									

*, ** and *** level of significance 10%, 5% and 1%, respectively. Source: The authors' calculations.

5. Discussion

The analysis of food self-sufficiency levels in the SEE region showed significant differences among observed countries. The countries differ greatly in their agricultural production capacities ranging from fully food import-dependent countries to the world's important exporters. However, they are similar in nutritional achievement in terms of calorific intake.

Five indicators are very important for food self-sufficiency in SEE: GDP per capita, yield, population density, trade openness, and political stability. The different effect of GDP per capita on SSR and the positive effect of yields on SSR obtained in our work is in line with previous research [31–33]. The analysis showed that negative correlation between population density and SSR [34,35], a positive correlation between trade openness and SSR [40,41], political stability, and SSR [6,36,37] from the previous research could not be applied to all countries and all food groups. Moreover, membership in the EU does not mean rejection of the concept of food self-sufficiency.

Forced by the projected climate changes, it is likely to expect a decline in yields [49], the decline in food self-sufficiency [50], and further transmission of pathogens [51], including COVID-19 [52]. Such a supply-side disorder associated with new infections would lead to an increase in the number of hungry and poor.

Despite all regions will experience declining population growth in the coming decades [53], the projected level of urbanization [54] increases the likelihood of new pandemics [55]. This can put further pressure on peri-urban agriculture [56] and jeopardize food self-sufficiency.

As well as urbanization, trade openness increases the likelihood of infectious diseases [57]. To avoid a cross-country human disease pandemic, some nations may impose trade restrictions. In such a situation, domestic food production is quite justified from an economic and political point of view.

Also, there is a possibility that democratic decline throughout SEE caused by weak institutions [58] can undermine its political stability. These disturbances jointly may retain economic growth [59] and turbulence in the food self-sufficiency achievement. Further, autocratic regimes directly adversely impact health security, due to insufficient investments in public health [60].

Based on the above, preserving and improving food self-sufficiency is a complex issue. Most countries in our sample are traditional agricultural countries with favorable agri-environmental conditions and sufficient knowledge to sustain their own population even under challenging conditions, such as a pandemic.

In understanding the results of this research, it should be bear in mind that the sample includes countries in transition with a very turbulent history (e.g., NATO bombing and international sanction of Serbia). This country traditionally was greatly oversupplied in both food and agricultural products–the degree of its self-sufficiency was 122.24% in the 1970s [61], and due to adverse events on the international scene, it was forced to maintain as much self-sufficiency as possible. Similarly, the degree of self-sufficiency in North Macedonia at the end of the 1970s was 118.84% [61] although food insecurity is most pronounced in this country [25]. Considering these historical circumstances and the centrally-planned system of the economy that existed in these countries, it is obvious that the agricultural policy was conducted according to different principles than in the old EU member states that have had CAP for more than 60 years. Precisely because of this, food self-sufficiency has been achieved and maintained in different ways in the SEE countries in relation to the developed countries of the EU, where one of the goals of the CAP was to increase production to achieve self-sufficiency. Today, the three analyzed countries from our sample are EU members–Bulgaria, Romania, and Croatia, and all three, according to the results of our research, have an SSR greater than 100%. The remaining countries in our analysis are candidates for EU membership, except for Bosnia and Herzegovina, which is a potential candidate for EU membership. In the process of assessment to the EU, Serbia and Montenegro have made the most progress. Serbia achieves SSR greater than 100%, like EU member states in our sample, while all other analyzed countries have SSR between 50 and 100%. Albania and North Macedonia are next in terms of progress in accession, while Bosnia and Herzegovina are far behind these countries in the negotiation process. At the moment of adjustment in the EU, these countries must be able to implement the CAP, which is very challenging from two aspects: The EU’s accession requirements and pressures applied by various interest groups in each individual country. The current situation is such that SEE countries (that are not members of the EU) adopt agricultural policy directions compatible with the CAP, but in reality, implement an agricultural policy that is optimal from the point of view of the domestic perspective, so it is necessary to work on further policy harmonization in the future [13]. The importance of sustainability within the EU has already been highlighted, so additional challenges on this path of EU accession will be the growing importance of environmental protection measures [62]. Agri-environmental measures in SEE countries that are not EU member states are poorly implemented. For example, Serbia lags significantly behind the EU regarding agri-environment protection policy [63].

However, the presented data provide hope that the countries of the region are quite accustomed and ready for future food crises. The rationale for this claim can also be found in the relatively easy passage of the SEE food sector through the short-term disruptions in supply and demand during the pandemic. Unfortunately, at present, it is not possible to make a proper empirical assessment of the far-reaching social and economic consequences of the outbreak of COVID-19 in the region. Because of that, it would be the subject of our future research.

6. Conclusions

Results of our analyses showed that the SEE region expresses a high level of self-sufficiency in food. Accordingly, the region is quite ready to respond to the challenges posed by the crisis situations. Bearing in mind that the region is composed of very different countries from exporters to highly dependent importers, it is clear that regional cooperation needs to be strengthened, especially on the political level that would allow seamless flow of agri-food products between countries, especially in a crisis period, a concept similar to the EU initiative on green lanes [64].

In crisis and some specific situations question of self-sufficiency gains in importance. For example, in Russia, the food embargo on food trade induced increased domestic production and led to more food self-sufficiency. When SEE countries are concerned, results showed generally satisfactory levels of self-sufficiency in food, so crisis conditions, such as financial crisis or pandemic, did not make some big problems in the market of agri-food products. Some problems in crisis conditions on the food market are detected in the “peak” of the crisis (e.g., 2007/08), but with adequate measures, these problems did not influence big distortions on the food market. So, the SEE countries could easily face crisis conditions in terms of food self-sufficiency based on the previous crisis which we were focused on.

It should be mentioned that our results are confirmation of the Clapp theses [1] that food self-sufficiency policies should be seen in relative terms, not ‘black and white’ narrow-minded. Thus, the results of our analysis can be very useful for policymakers in defining proper measures to support the production, conservation, and distribution of domestic food. This is especially important in the crisis conditions, which warned us that global food production and trade flows do not guarantee the stability of food availability and access for an individual country.

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Appendix A

Table A1. Descriptive statistic for indicators of food security in Western Balkans and EU countries.

Variable	Average	Median	Standard Deviation	Minimum	Maximum
GDP per capita (2015 USD prices)	6364	5780	2620	2790	13,035
Population_density (hectare of arable land per capita)	0.3113	0.3031	0.09899	0.1905	0.4932
Political _stability (index)	0.05740	0.1000	0.4174	−0.8200	0.8200
Trade_ openness (exports plus imports as percent of GDP)	94.22	89.29	18.56	58.47	133.2
Cereals_yield (tons per hectare)	4.2	4.0	1.1	1.6	7.1
Starchyroots_yield (tons per hectare)	15.3	14.9	4.05	8.1	26.2
Oilcrops_yield (tons per hectare)	2.5	2.2	1.3	0.9	9.5
Fruit_yield (tons per hectare)	8.7	7.7	4.9	2.6	22.4
Vegetables_yield (tons per hectare)	15.8	14.7	7.3	5.4	36.3
Meat_yield (kilograms per animal)	166.0	161.0	37.9	92.9	243.0
Pulses_yield (tons per hectare)	1.8	1.8	0.6	0.6	3.4
Treenut_yield (tons per hectare)	1.8	1.5	1.3	0.2	4.9
Eggs_yield (kilograms per animal)	8.7	8.3	2.6	4.9	14.1
Milk_yield (kilograms per animal)	1,1	756.0	706.0	351.0	3.0
SSR_cereals (%)	101.0	84.7	65.5	4.79	308.0
SSR_starchyroots (%)	91.0	92.9	10.6	65.4	122.0
SSR_oilcrops (%)	118.0	99.1	83.5	0.0	337.0
SSR_fruit (%)	83.4	77.2	23.1	44.2	147.0
SSR_vegetables (%)	98.5	92.3	36.2	54.4	310.0
SSR_meat (%)	62.6	67.8	24.0	19.2	104.0
SSR_pulses (%)	77.5	77.4	34.2	18.2	302.0
SSR_treenuts (%)	82.8	79.3	33.6	25.0	267.0
SSR_eggs (%)	97.2	100.0	12.8	57.1	124.0
SSR_milk (%)	90.2	92.5	11.0	62.0	106.0

Source: The authors' calculations.

Table A2. Estimation of model SSR_cereals using RE.

	Coefficient	**Std. Error**	**z**	***p*-Value**	
const	−144.843	33.6873	−4.300	<0.0001	***
GDP	0.00261952	0.00436141	0.6006	0.5481	
Y	18.8088	3.39692	5.537	<0.0001	***
PD	269.645	90.1184	2.992	0.0028	***
PS	−18.3052	9.07728	−2.017	0.0437	**
TO	0.510923	0.215514	2.371	0.0178	**
EU	51.6783	37.3091	1.385	0.1660	
Mean dependent var	101.1531		S.D. dependent var	65.53334	
Sum squared resid	138617.6		S.E. of regression	37.60938	
Log-likelihood	−521.7139		Akaike criterion	1057.428	
Schwarz criterion	1075.939		Hannan-Quinn	1064.927	
rho	0.366242		Durbin-Watson	1.113405	
Time-series length:	13				
Cross-sectional units	9				
Total observations:	104				

** and *** level of significance 5% and 1%, respectively. Source: The authors' calculations.

Table A3. Estimation of model SSR_starchyroots using WLS.

	Coefficient	**Std. Error**	**t-Ratio**	***p*-Value**	
const	81.7702	7.84977	10.42	<0.0001	***
GDP	0.0012938	0.0005837	2.216	0.029	**
Y	0.203891	0.194412	1.049	0.2969	
PD	15.9565	9.07371	1.759	0.0818	*
PS	−8.45339	2.80496	−3.014	0.0033	***
TO	−0.0292573	0.0487961	−0.5996	0.5502	
EU	−10.2562	3.21875	−3.186	0.0019	***
Statistics based on the weighted data:					
Sum squared resid	91.14988		S.E. of regression	0.969376	
R-squared	0.329807		Adjusted R-squared	0.288352	
F(6, 97)	7.955745		*p*-value(F)	0.0000	
Log-likelihood	−140.7116		Akaike criterion	295.4231	
Schwarz criterion	313.9338		Hannan-Quinn	302.9223	
Statistics based on the original data:					
Mean dependent var	90.99774		S.D. dependent var	10.60705	
Sum squared resid	10,206.16		S.E. of regression	10.25759	
Time-series length:	13				
Cross-sectional units	9				
Total observations:	104				

*, ** and *** level of significance 10%, 5% and 1%, respectively. Source: The authors' calculations.

Table A4. Estimation of model SSR_oilcrops using Heteroskedasticity-corrected model.

	Coefficient	**Std. Error**	**t-Ratio**	***p*-Value**	
const	184.034	20.1515	9.132	<0.0001	***
GDP	−0.0149997	0.0034174	−4.389	<0.0001	***
Y	3.47374	3.32425	1.045	0.2986	
PD	−105.195	54.7837	−1.920	0.0578	*
PS	17.7711	10.0071	1.776	0.0789	*
TO	−0.229614	0.157188	−1.461	0.1473	
EU	188.563	18.3477	10.28	<0.0001	***
Statistics based on the weighted data:					
Sum squared resid	243.3173		S.E. of regression	1.583801	
R-squared	0.792799		Adjusted R-squared	0.779982	
F(6, 97)	61.85723		*p*-value(F)	0.0000	
Log-likelihood	−191.7683		Akaike criterion	397.5367	
Schwarz criterion	416.0474		Hannan-Quinn	405.0359	
Statistics based on the original data:					
Mean dependent var	118.1973		S.D. dependent var	83.50482	
Sum squared resid	289,631.4		S.E. of regression	54.64331	
Time-series length:	13				
Cross-sectional units	9				
Total observations:	104				

* and *** level of significance 10% and 1%, respectively. Source: The authors' calculations.

Table A5. Estimation of model SSR_fruit using RE model.

	Coefficient	**Std. Error**	**z**	***p*-Value**	
const	74.2249	20.3964	3.639	0.0003	***
GDP	−0.00105553	0.00149583	−0.7056	0.4804	
Y	2.00072	0.496732	4.028	<0.0001	***
PD	49.2464	37.0937	1.328	0.1843	
PS	3.20170	3.38027	0.9472	0.3436	
TO	−0.141663	0.0794075	−1.784	0.0744	*
EU	−10.0437	29.2599	−0.3433	0.7314	
Mean dependent var	83.38263		S.D. dependent var	23.07188	
Sum squared resid	64707.58		S.E. of regression	25.69594	
Log-likelihood	−482.0982		Akaike criterion	978.1965	
Schwarz criterion	996.7072		Hannan-Quinn	985.6957	
rho	0.006829		Durbin-Watson	1.671688	

* and *** level of significance 10% and 1%, respectively. Source: The authors' calculations.

Table A6. Estimation of model SSR_vegetables using WLS model.

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	139.699	12.1704	11.48	<0.0001	***
GDP	0.0021986	0.0013025	1.688	0.0946	*
Y	−0.0152871	0.310285	−0.04927	0.9608	
PD	−190.198	31.6474	−6.010	<0.0001	***
PS	−7.06949	5.14029	−1.375	0.1722	
TO	0.0122405	0.0694542	0.1762	0.8605	
EU	12.706	5.66565	2.243	0.0272	**
Statistics based on the weighted data:					
Sum squared resid	79.25072		S.E. of regression	0.90389	
R-squared	0.482755		Adjusted R-squared	0.45076	
F(6, 97)	15.08865		*p*-value(F)	0.0000	
Log-likelihood	−133.4373		Akaike criterion	280.8747	
Schwarz criterion	299.3854		Hannan-Quinn	288.3739	
Statistics based on the original data:					
Mean dependent var	98.49706		S.D. dependent var	36.19693	
Sum squared resid	124,761.9		S.E. of regression	35.8637	

*, ** and *** level of significance 10%, 5% and 1%, respectively. Source: The authors' calculations.

Table A7. Estimation of model SSR_meat using WLS model.

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	99.51	9.76075	10.19	<0.0001	***
GDP	−0.00170376	0.0011654	−1.462	0.147	
Y	0.136412	0.0392644	3.474	0.0008	***
PD	35.1521	18.4229	1.908	0.0593	*
PS	2.3017	4.44216	0.5181	0.6055	
TO	−0.704772	0.0712279	−9.895	<0.0001	***
EU	16.7313	6.8294	2.45	0.0161	**
Statistics based on the weighted data:					
Sum squared resid	86.03608		S.E. of regression	0.941791	
R-squared	0.586966		Adjusted R-squared	0.561417	
F(6, 97)	22.97455		*p*-value(F)	0.0000	
Log-likelihood	−137.7092		Akaike criterion	289.4183	
Schwarz criterion	307.929		Hannan-Quinn	296.9175	
Statistics based on the original data:					
Mean dependent var	62.59653		S.D. dependent var	23.99961	
Sum squared resid	29,070.68		S.E. of regression	17.31178	

*, ** and *** level of significance 10%, 5% and 1%, respectively. Source: The authors' calculations.

Table A8. Estimation of model SSR_pulses using WLS model.

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	93.7567	11.859	7.906	<0.0001	***
GDP	−0.00388207	0.0017059	−2.276	0.0251	**
Y	5.22298	4.10463	1.272	0.2063	
PD	−2.60819	21.2699	−0.1226	0.9027	
PS	−0.605406	4.27039	−0.1418	0.8876	
TO	−0.0288006	0.0795712	−0.3619	0.7182	
EU	−4.35011	11.6696	−0.3728	0.7101	
Statistics based on the weighted data:					
Sum squared resid	61.16177		S.E. of regression	0.794062	
R-squared	0.491814		Adjusted R-squared	0.46038	
F(6, 97)	15.64583		*p*-value(F)	0.0000	
Log-likelihood	−119.9644		Akaike criterion	253.9289	
Schwarz criterion	272.4396		Hannan-Quinn	261.4281	
Statistics based on the original data:					
Mean dependent var	77.48189		S.D. dependent var	34.172	
Sum squared resid	119,520.7		S.E. of regression	35.10232	

** and *** level of significance 5% and 1%, respectively. Source: The authors' calculations.

Table A9. Estimation of model SSR_treenuts using Heteroskedasticity-corrected model.

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	47.1884	19.4735	2.423	0.0172	**
GDP	−0.00167608	0.0018224	−0.9197	0.36	
Y	4.58774	2.01867	2.273	0.0253	**
PD	144.319	26.1031	5.529	<0.0001	***
PS	1.66547	7.975	0.2088	0.835	
TO	−0.0200302	0.145813	−0.1374	0.891	
EU	−5.96805	12.8692	−0.4637	0.6439	
Statistics based on the weighted data:					
Sum squared resid	313.2098		S.E. of regression	1.796933	
R-squared	0.634301		Adjusted R-squared	0.61168	
F(6, 97)	28.04091		*p*-value(F)	0.0000	
Log-likelihood	−204.8987		Akaike criterion	423.7974	
Schwarz criterion	442.3081		Hannan-Quinn	431.2966	
Statistics based on the original data:					
Mean dependent var	82.76984		S.D. dependent var	33.56389	
Sum squared resid	96,218.98		S.E. of regression	31.49521	

** and *** level of significance 5% and 1%, respectively. Source: The authors' calculations.

Table A10. Estimation of model SSR_eggs using WLS model.

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	108.933	6.1672	17.66	<0.0001	***
GDP	−0.00276955	0.0005752	−4.815	<0.0001	***
PD	−3.71317	10.2242	−0.3632	0.7173	
PS	−6.92024	3.29512	−2.100	0.0383	**
TO	−0.0550982	0.0545307	−1.010	0.3148	
EU	15.3074	3.71985	4.115	<0.0001	***
Y	0.992642	0.527698	1.881	0.063	*
Statistics based on the weighted data:					
Sum squared resid	92.53628		S.E. of regression	0.97672	
R-squared	0.396652		Adjusted R-squared	0.359331	
F(6, 97)	10.62825		*p*-value(F)	0.0000	
Log-likelihood	−141.4965		Akaike criterion	296.993	
Schwarz criterion	315.5038		Hannan-Quinn	304.4923	
Statistics based on the original data:					
Mean dependent var	97.18661		S.D. dependent var	12.80922	
Sum squared resid	10,580.51		S.E. of regression	10.44402	

*, ** and *** level of significance 10%, 5% and 1%, respectively. Source: The authors' calculations.

Table A11. Estimation of model SSR_milk using WLS model (GDP variable used as a weight).

	Coefficient	Std. Error	t-Ratio	*p*-Value	
const	93.5911	6.26561	14.94	<0.0001	***
Y	−0.000139572	0.0014136	−0.09873	0.9216	
PD	35.9759	10.936	3.29	0.0014	***
PS	−15.2959	3.01438	−5.074	<0.0001	***
TO	−0.162694	0.0520695	−3.125	0.0023	***
EU	2.6514	2.50007	1.061	0.2915	
Statistics based on the weighted data:					
Sum squared resid	51755299		S.E. of regression	726.7154	
R-squared	0.423553		Adjusted R-squared	0.394143	
F(5, 98)	14.4014		*p*-value(F)	0.0000	
Log-likelihood	−829.6872		Akaike criterion	1671.374	
Schwarz criterion	1687.241		Hannan-Quinn	1677.802	
Statistics based on the original data:					
Mean dependent var	90.23006		S.D. dependent var	10.95745	
Sum squared resid	8356.375		S.E. of regression	9.234129	

*** level of significance 1%, respectively. Source: The authors' calculations.

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