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RESEARCH ARTICLE

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Mapping potential implications of temporary COVID-19 export bans for the food supply in importing countries using precrisis trade flows

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Abstract

Despite pleas from international organizations, governments and trade economists to refrain from imposing trade-distorting measures, over 20 countries have implemented bans on the export of agri-food products since the onset of the COVID-19 crisis. These export prohibitions might adversely impact food security and disrupt well-established global supply chains. We identify importing countries that could potentially be affected by the imposed export bans using a measure of their import dependency during the pre-pandemic period to illustrate our results on global trade maps. We find that many importers rely on just one country for a significant share of the overall domestic supply of a particular commodity. [EconLit Citations: F10, F13, Q17, Q18]

KEYWORDS

agri-food trade, COVID-19, export bans, food security, temporary trade measures

1 | INTRODUCTION

Government authorities worldwide responded swiftly to the COVID-19 pandemic and enacted temporary trade measures aiming at stabilizing domestic food prices and ensuring domestic food security. As of mid-June 2020, over 150 countries have put trade measures into force, mainly involving vital medical supplies, while according to the International Trade Center (ITC), 23 countries have banned exports of agri-food products (ITC, 2020). For instance, on March 31st, 2020, Belarus imposed restrictions on all exports of buckwheat, onions, and garlic, while at the beginning of April, Cambodia and Myanmar prohibited the export of rice. This tendency contradicts pleas from several international organizations, governments, and trade economists to let food move freely across borders without restrictions, insofar as compliance with existing food safety standards is ensured (FAO, IFAD, WFP, and the World Bank, 2020).[1] In this context, research on the impact of export restrictions imposed temporarily as a reaction to the COVID-19 pandemic on trade flows, food prices and food security, especially in affected importing countries, is of high policy relevance.

In this paper, we focus on the potential implications of temporary export bans on agri-food commodities during the COVID-19 pandemic for importing countries, based on pre-pandemic trade flows.[2] The impact of an export ban on an importing country is strongly determined by its import dependency (Deuss, 2017). Therefore, we calculate past import dependencies for trade partners of countries imposing temporary export bans on agri-food products during the pandemic. Based on the results, we then compile maps to illustrate potential disruptions of the importers' supply of the commodity under consideration. Our objective is to identify cases requiring further analysis with respect to the impacts of COVID-19-related temporary export bans on social welfare and food security. We do not conduct an impact analysis to derive precise implications for trade flows, prices and food security in the importing countries.

As of mid-June 2020, 23 countries have implemented 104 prohibitions on agri-food exports (ITC, 2020). While the number of newly adopted trade measures has decreased in the meantime (Joller & Kniahin, 2020), concerns remain as restrictions in place are not lifted promptly. In addition, previous research shows that, although export bans might be lifted after a few weeks, their effects can be long lasting (e.g., Deuss, 2017). While both temporary export and temporary import measures are designed to ensure domestic food security, a liberalization of imports implies higher trade flows and a convergence of domestic to world market prices in the respective country and gives exporters access to new markets. Moreover, an import ban can also aim at stabilizing domestic farm incomes (Larue & Ker, 1993). In contrast, export bans are intended to isolate the enacting country's markets from international price fluctuations, which gained prominence during the 2007/2008 and 2010/2011 food price crises (see e.g., Diao & Kennedy, 2016; Djuric et al., 2015; Tangermann, 2011b). At the same time, such measures can lead to severe issues in terms of rising world market prices as well as insufficient supply of affordable food for dependent trade partners (Martin & Anderson, 2012).[3] In particular, export restrictions can affect developing countries that rely heavily on imports from the country imposing the ban and where significant food price increases can have severe impacts on overall poverty (Anania, 2013; Deuss, 2017; Ivanic & Martin, 2008; Sharma, 2011). These adverse effects of export restrictions have led to an intensive debate on how to curb such measures (Tangermann, 2011b). Note that while both restrictive measures related to imports and export subsidies have been strictly regulated through the eighth round of multilateral trade negotiations (Uruguay Round) this does not apply to export restrictions (Tangermann, 2011b).

Our analysis contributes to a better understanding of the potential disruptions that temporary export bans on agri-food products may provoke in importing countries during times of a global pandemic by considering the affected countries' dependency on imports. In doing so, we identify which countries are likely most severely affected using trade flow data from the pre-pandemic period. We assume that pre-COVID-19 import dependency is strongly related to dependency during and after the pandemic. The results can therefore be of interest for further research involving impact analyses of temporary export prohibitions (e.g., Kerr, 2020) as they help identify

[1]Food export restrictions were also among the measures discussed at the G20 Extraordinary Agriculture Ministers Meeting on April 21st, 2020, and at a special meeting of the WTO's regular Committee on Agriculture on June 18th, held to review the measures introduced by governments since the COVID-19 outbreak.

[2]Note that in our analysis we include all importing countries regardless of their domestic production quantities w.r.t. a specific commodity or the degree of re-exporting.

[3]Research has also shown that domestic agricultural policies do not necessarily destabilize world prices if effective combinations of multiple measures are used (Zwart & Blandford, 1989). Moreover, several studies have shown that the extent of adverse effects depends on the combination of the trade restrictions applied and the size of the country applying them (e.g., Larue & Ker, 1993; Zwart & Blandford, 1989).

relevant cases with respect to potential effects on social welfare and food security and can aid the development policies aimed at increasing food self-sufficiency.

The rest of this paper is organized as follows. The next section, Section 2, gives an overview of the related literature. In Section 3, we introduce the methodological framework and present the data. The empirical results are presented and discussed in Section 4. Finally, in Section 5, we present some conclusions and the implications for further research that can be derived from our findings.

2 | LITERATURE BACKGROUND

Short-term export bans on agri-food products gained prominence during the 2007/2008 and 2010/2011 food price crises as a potential measure to stabilize prices of staple foods and promote domestic food security (Martin & Anderson, 2012; Porteous, 2017; Sharma, 2011). However, export restrictions on agricultural commodities have also been identified as a major driver of these crises as they increased world market price volatility (Liefert et al., 2012; Martin & Anderson, 2012; Sharma, 2011). For example, Martin and Anderson (2012) find that trade restrictions contributed substantially to the 2007/2008 price increases with the limitations resulting in 45% and 30% of the increase in world market prices for rice and wheat, respectively. Accordingly, Tangermann (2011a) indicates that export restrictions in reaction to crop shortfalls were a major cause of the 2010/2011 price spikes on grain markets (Tangermann, 2011a).

Similar consequences may be anticipated for bans imposed during the COVID-19 pandemic (Barichello, 2020; Glauber et al., 2020). Nevertheless, we expect that the effects of temporary export bans on agri-food products during the 2020 COVID-19 pandemic will differ in several ways from those experienced during the 2007/2008 and 2010/2011 food price crises. Key differences in the underlying context include the fact that production levels of major staples are above the average of the past 5 years, oil prices are low, and global stock levels of major grains in relation to consumption are 70%–100% higher than in the early 2000s (Espitia et al., 2020; Martin & Glauber, 2020; Voegele, 2020). Compared to 2007/2008, global food prices have been relatively stable in recent years and they remained low in the first months of 2020 (Voegele, 2020). Moreover, new issues have arisen during the COVID-19 pandemic that did not play a role in earlier crises. These include the supply-side disruption of access to labor (Hobbs; Larue, 2020; Ridley & Devadoss, 2020) or demand-side shocks such as panic purchases and hoarding of essential, durable food products (Hobbs, 2020).

In previous research, impact analyses often rely on gravity models to evaluate the ultimate effect of an export ban on trade flows and social welfare in exporting and importing countries (e.g., Cheptea & Gaigné, 2020; Zongo & Larue, 2019). Various effects have been identified concerning the impact of an export ban on both the individual countries imposing the ban and the importing countries affected (e.g., Martin & Anderson, 2012). For the exporting country, some studies find that an export ban can shield domestic prices from world market prices and dampen domestic price volatility. For example, the Russian wheat export ban in 2010/2011 resulted in Russian domestic wheat prices between 35% and 67% lower compared to the situation where no ban was imposed, with significant variations across regions (Götz et al., 2016). In contrast, other studies have detected no, or even opposite, effects on price levels and volatility. For example, Djuric et al. (2015) analyze the Serbian wheat export ban in 2007 and find that the ban did not succeed in reducing the volatility and absolute value of domestic prices. The latter even rose above world market price levels, for example, in April 2008 the wheat price in Serbia was approximately 440 Euros per metric ton while the world market price was 360 Euros per metric ton (Djuric et al., 2015). Moreover, Liefert et al. (2012) show that producers in those countries imposing export restrictions are adversely affected by an export ban since they (i) are forced to sell at domestic price levels, which are below world market prices, and (ii) must reduce their production quantities as they only have to meet domestic requirements and there is no export demand.

In the case of importers, which are the main focus of this article, the negative consequences of temporary export restrictions imposed by trade partners are expected to be stronger for countries with a high import dependency and inversely related to the substitutability of a commodity (Deuss, 2017). For instance, Deuss (2017) finds that after the Vietnamese rice export ban in 2007, the degree of price transmission from world market to domestic prices decreased by 49.4 percentage points (p.p.) compared to the pre-ban status for those importers with high dependency (e.g., Cameroon, Senegal, or Côte d′Ivoire) In contrast, importers with low dependency (e.g., Benin, South Africa, or Peru) exhibit no significant change in the price transmission process.

3 | METHODOLOGY AND DATA

A country's dependency on imports (or a lack thereof) has been identified in the food security literature via the food self-sufficiency ratio (SSR; e.g., Clapp, 2017; Puma et al., 2015). The SSR measures the share of food produced domestically in a country's total supply of food, where food supply equals the sum of domestic production and imports, minus exports plus changes in stock (FAO, 2012). The lower the SSR, the more a country relies on food imports to cover domestic food consumption. The SSR can be defined on the commodity/product level, or for food in general based on each commodity's caloric contribution.

We use a measure of import dependency (ID), which can be derived as 1-SSR, given that exports of the importing country are zero, to identify potential disruptions of a (temporary) export ban imposed by a particular country on importing trade partners. However, calculating the ID as 1-SSR does not indicate on which trade partner the importing country relies or the degree to which it relies on a particular trade partner. To obtain a measure of a country's ID with respect to each trade partner who has banned exports for a specific product during the COVID-19 pandemic, we define the ID measure as

$$ID_{ijk} = \frac{Q_{ijk}}{FS_{ij}}, \tag{1}$$

where i denotes the importing country, j denotes the product, and k denotes the exporting country. Q is i's imported quantity of product j with origin k while FS represents the total food supply of product j in the importing country i. That is, for each food product under an export ban, we compute the share of imports from the prohibiting country in the total supply of that product in the importing country. Total food supply is defined as domestic production of agri-food product j in country i, plus imports minus exports plus changes in stock (FAO, 2020a; Puma et al., 2015). We calculate median IDs over the three precrisis years 2015, 2016, and 2017[4] to obtain an estimate of the ID, which is not driven by exceptional events in a single year.

To derive the IDs, we first identify all COVID-19 export bans on agri-food products using the ITC Market Access Map COVID-19 (ITC, 2020). We compile data on the enacting country, affected products, affected countries, start date and end date if known for each of the 104[5] export prohibition measures imposed (see Table A1 in the online appendix for the complete list of agri-food export bans imposed).

We then use the UN Comtrade database (United Nations, 2020) to compile data on imports of the affected agri-food products (variable Q in Equation 1). Product selection is based on Harmonized System (HS) codes.[6] The ITC Market Access Map COVID-19 only provides the product name but not the corresponding HS code for some commodities subject to an export ban. The UN Comtrade database was scanned for the names of these

[4]More recent data on food supply was not available at the time of analysis.

[5]We count each ban imposed by the Eurasian Economic Union as a single ban for each country since some of the countries such as Kazakhstan and Kyrgyzstan have imposed additional restrictions, partly on the same commodities. For ease of interpretation, we also present the results for each country separately.

[6]The Harmonized System (HS) is a globally adopted classification system for products and product groups.

products to check whether there is an exact match of the product defined by ITC and products defined according to the HS. We used the corresponding HS code from UN Comtrade to obtain exact matches. Sixteen country-product combinations have been excluded as we could not identify a match in the HS.[7] Moreover, trade data for Tajikistan (eight bans) are not available on UN Comtrade.

We obtain data on total food supply (FS) for the importing countries based on the selected commodity groups from FAOSTAT (FAO, 2020a). It is not possible to compute the ID for some countries over all three precrisis years due to the absence of food supply data for this period, or because no imports were reported on UN Comtrade. In these cases, we use the median ID of 2 years or the value of the 1 year available, respectively. Since the UN Comtrade database only contains data up to the 6-digit level,[8] we exclude 22 export bans referring to the 8-digit level. Moreover, the FAO does not publish the corresponding data applying to 22 bans on buckwheat, carrots, garlic, and pasta. In the case of a further 17 bans, it appears that no country imported that particular product in the 2015–2017 period. This led to a final number of 21 export bans for agricultural commodities (out of 104) imposed by 11 countries that are included in the analysis (Table 1). Note that Table 1 already contains the imputed HS codes for commodities for which we have found an exact match in UN Comtrade while Table A2 in the online appendix contains the original data from ITC. Moreover, in the case of the bans imposed by the Eurasian Economic Union (EAEU), we show the results for each member state, since some of them, for example, Kazakhstan and Kyrgyzstan have installed additional export restrictions, partly covering the same commodities.

The 21 bans included lead to 399 median IDs, each reflecting an importer–exporter pair (see Table A2 in the online appendix). The IDs are illustrated using global trade maps (Figures 1–5 and Figure A1 in the online appendix). We discuss the results for export bans affecting at least one importer with a median import dependency of at least 20% since these cases would be of interest for future, in-depth research investigating the potential impacts on social welfare and food security in the importing countries. This includes Cambodia/Myanmar (rice), Russia (millet, rice, and soy), Romania (cereals, outside European Economic Area [EEA]), Kazakhstan (soy), and Sudan (sorghum).

4 | RESULTS AND DISCUSSION

Our results are presented in Tables 2–6 and the global trade maps (Figures 1–5). Tables 2–6 include the minimum, median, and maximum ID values for the top 10 importers of the eight examples selected, while Figures 1–5 show the global trade maps where at least one importer has an ID > 20%. Given the potential relevance of the eight examples for social welfare and food security in the importing countries, we discuss them in greater detail below.[9] In general, we observe heterogeneous results depending on the ban imposed and the countries involved. In some cases, a large number of countries have been importing the respective commodity, but at low rates in relation to the importers' domestic supply quantities (e.g., Philippines [rice]; cf. Figure A1 and Table A2 in the online appendix). However, in other cases, only a small number of countries has been importing the commodity, whereby they depend heavily on these imports as indicated by large median ID values (e.g., Russia [soy]; cf. Figure 2 and Table 3).

We find that several European countries are highly dependent on rice imports from Cambodia and Myanmar with ID values up to 90% during the precrisis period (cf. Figure 1 and Table 2). The Czech Republic (21.86%), the Netherlands

[7]These are Algeria (food products), Cambodia (fish), Egypt (beans, peas), Jordan (food products), Kazakhstan (white sugar, white and red cabbages), Kuwait (foodstuffs), Mali (food products), Oman (flour and wheat), Pakistan (food products), Romania (flour, sugar, vegetable oil), Russia ((processed) grain), and the Syrian Arab Republic (food commodities).

[8]The number of digits of an HS code increases with the level of disaggregation. For instance, 10 is the code for cereals, 1001 is the code for cereals: wheat and meslin, 100119 is the code for cereals: wheat and meslin: durum wheat: other than seed. Moreover, individual countries can add further digits to disaggregate 6-digit classifications beyond the 6-digit level in their tariff schedules. However, these are not standardized across all countries, and it is therefore not possible to include them in UN Comtrade.

[9]Table A2 contains the ID values for all 21 export bans and Figure A1 in the online appendix shows the remaining trade maps where the ID for all importing countries is <20%.

TABLE 1 International Trade Center (ITC) data for export bans included in the analysis

Enacting country	Affected products	HS code(s)	Affected countries	Start date	End date if known
Belarus	Rye	1002	Non-EAEU[a] countries	March 31, 2020	June 30, 2020
	Crushed and uncrushed soybeans	1201			
Cambodia	Rice	1006	All	April 05, 2020	May 20, 2020
Kazakhstan	Potatoes	0701	All	March 22, 2020	June 01, 2020
	Crushed and uncrushed soybeans	1201	Non-EAEU countries	March 31, 2020	June 30, 2020
	Millet	100821, 100829	Non-EAEU countries	March 31, 2020	June 30, 2020
Kyrgyzstan	Wheat and meslin	1001	All	March 23, 2020	September 22, 2020
	Rice	1006			
	Sunflower seed	1512			
	Cane or beet sugar and chemically pure sucrose, in solid form: other	170199			
Myanmar	Rice	1006	All	April 03, 2020	May 01, 2020
Oman	Onions	07310	All	April 02, 2020	
Philippines	Rice	1006	All	March 27, 2020	
Romania	Cereals	10	Non-EEA[b] countries	April 10, 2020	April 16, 2020
Russian Federation	Rye	1002	Non-EAEU countries	March 31, 2020	June 30, 2020
	Rice	1006			
	Soybeans	1201			
	Millet	100821, 100829			
Sudan	Maize	1005	All	April 15, 2020	
	Sorghum	1007			
Thailand	Eggs	040721	All	March 26, 2020	April 30, 2020

[a]The Eurasian Economic Union (EAEU) consists of Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia. We present the results for each country separately.
[b]EEA, European Economic Area. Data are retrieved from ITC (2020), as of June 20, 2020.

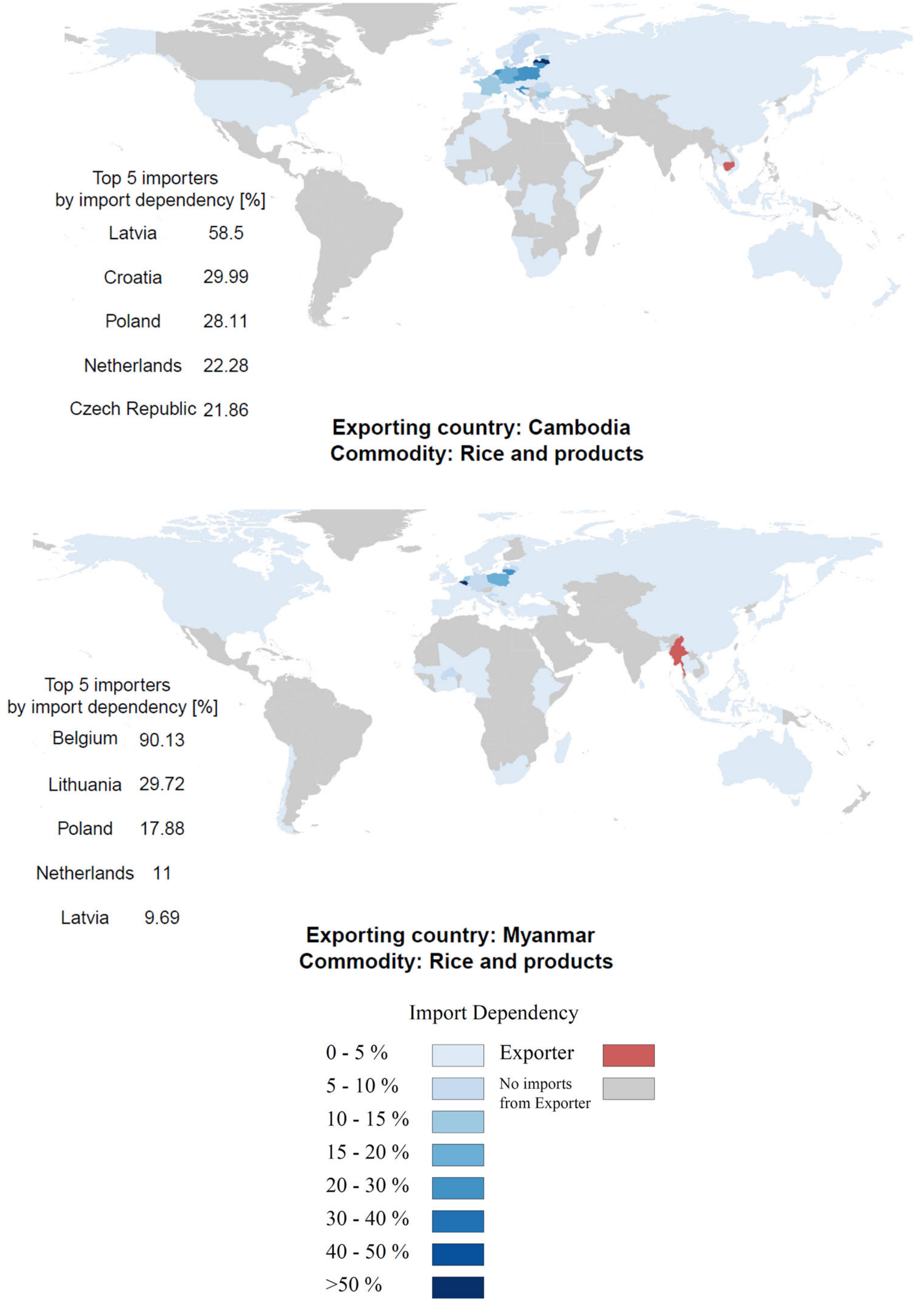

FIGURE 1 Dependency on rice imports (share of imports in total food supply) from Cambodia and Myanmar by exporter and importer [Color figure can be viewed at wileyonlinelibrary.com]

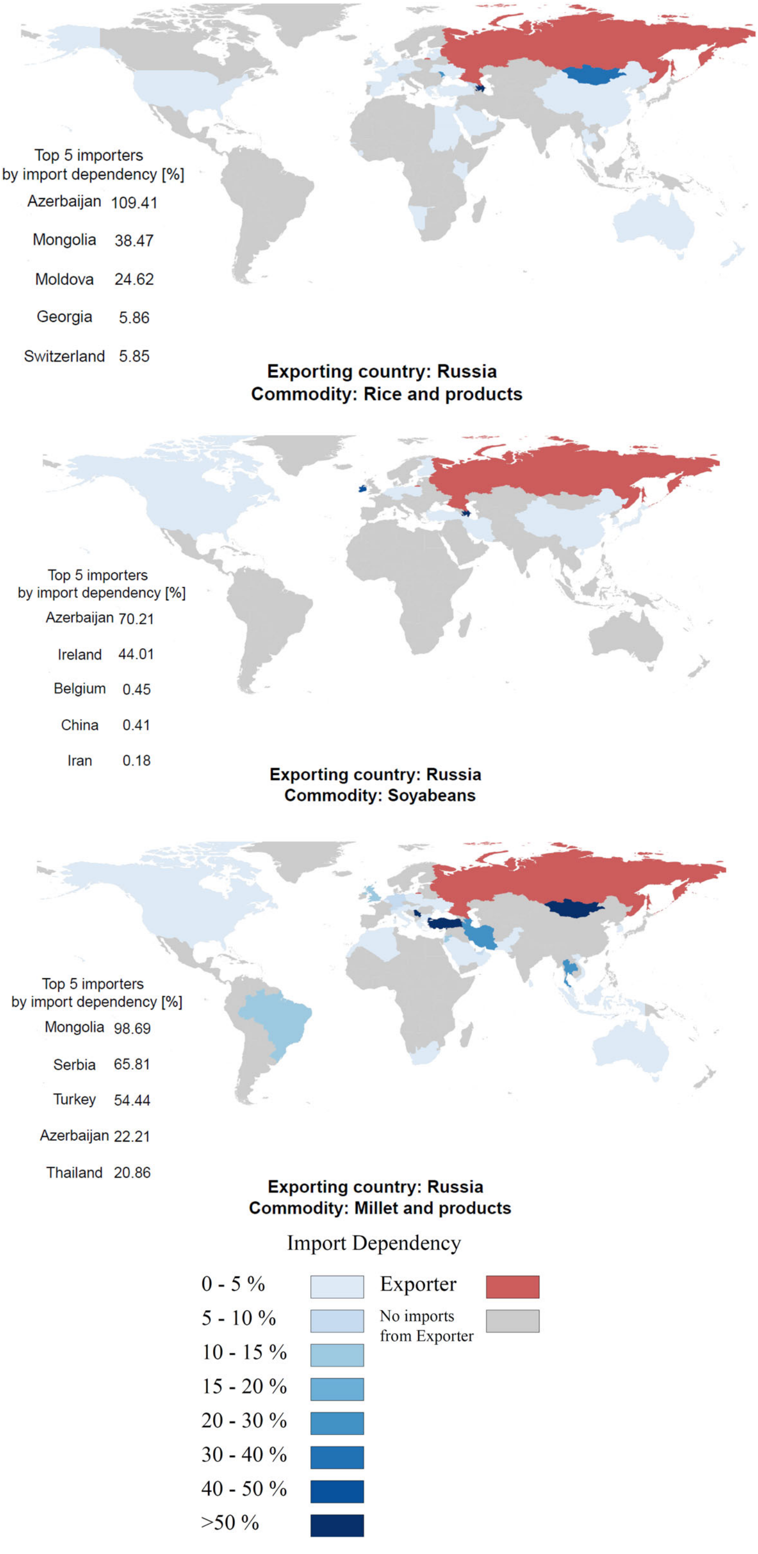

FIGURE 2 Dependency on imports (share of imports in total food supply) from Russia by commodity and importer [Color figure can be viewed at wileyonlinelibrary.com]

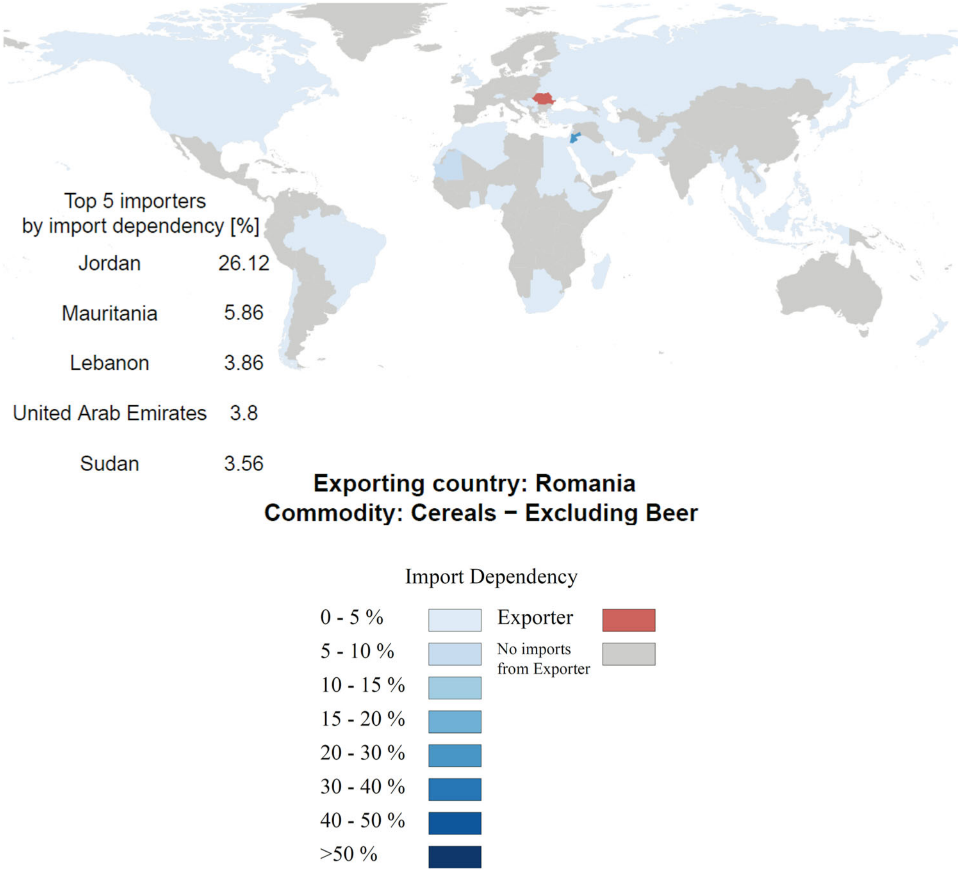

FIGURE 3 Dependency on cereal imports (share of imports in total food supply) from Romania by the importer [Color figure can be viewed at wileyonlinelibrary.com]

(22.28%), Poland (28.11%), and Croatia (29.99%) imported between one-fifth and one-third of their rice supply from Cambodia, while the Latvian ID with respect to rice imports from Cambodia is highest with 58.5%. On average, Belgium and Lithuania imported 90.13% and 29.72% of their respective total rice supply during the precrisis period from Myanmar. Moreover, Poland (17.88%), the Netherlands (11%), and Latvia (9.69%) are among the top five importers of rice from Myanmar in terms of their ID (cf. Figure 1 and Table 2). The ID values for importers of rice from the Philippines are below 1% for all importing countries (cf. Figure A1 and Table A2 in the online appendix). Note that the Philippines have banned rice exports despite being one of the world's largest rice producers (FAO, 2020b). However, in contrast to Cambodia and Myanmar, the Philippines are not a major rice exporter, but were the world's largest rice importer in 2019 illustrating the country's own requirements for this commodity (United Nations, 2020).

A large difference between the maximum and the minimum ID measure indicates that the importing country has been able to switch smoothly between sources for the commodity under consideration in the past, while a small difference points toward well-established trading relationships and a higher dependency. The difference between the maximum and minimum ID is over 10 p.p.[10] in the case of five countries that import rice from

[10]We focus on absolute changes, that is, percentage points, rather than relative changes, that is, percentages, since relative changes do not reveal much about flexibility. For instance, consider country A having a minimum ID of 1% and a maximum ID of 2%, and country B with a minimum ID of 20% and a maximum of 40%. Both countries exhibit a relative difference of 100% between minimum and maximum but they are hardly comparable since the overall level of dependence is completely different.

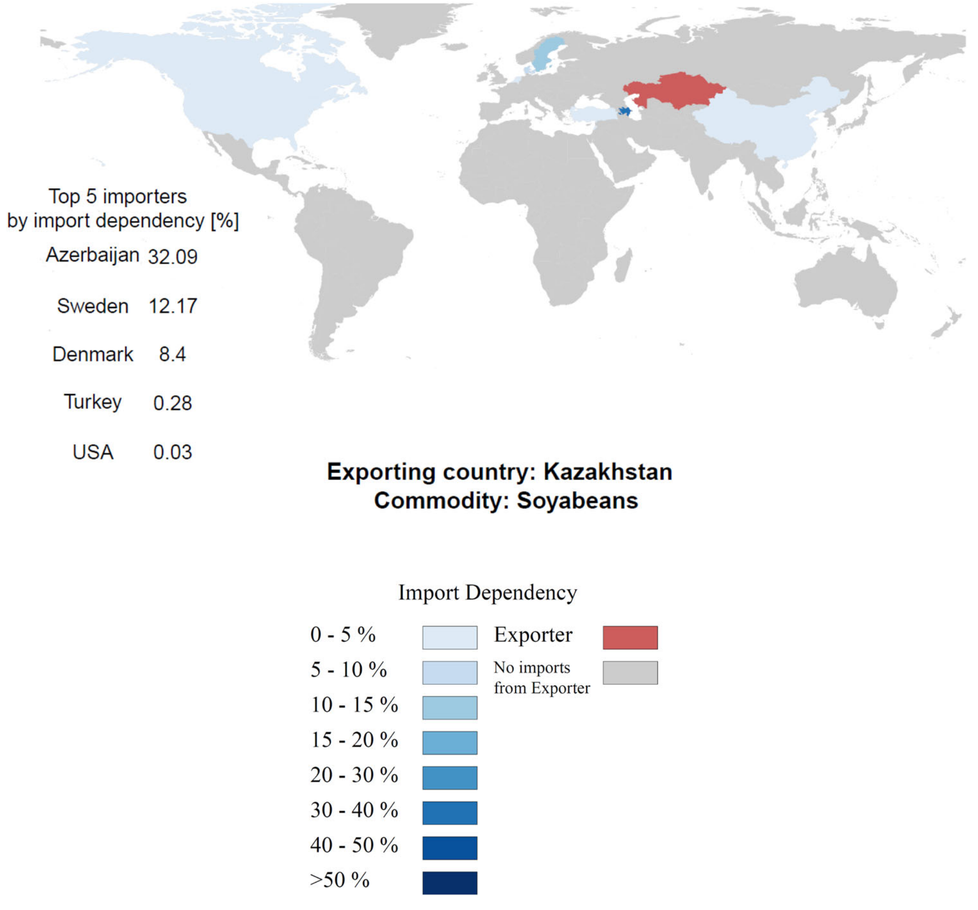

FIGURE 4 Dependency on soy imports (share of imports in total food supply) from Kazakhstan by the importer [Color figure can be viewed at wileyonlinelibrary.com]

Cambodia (Lithuania 18.90 p.p., Croatia 13.94 p.p., Estonia 13.81 p.p., Poland 13.68 p.p., and the Netherlands 12.33 p.p.), and three countries that import rice for Myanmar (Belgium 79.16 p.p., Lithuania 39.41 p.p., and Bulgaria 16.60 p.p.; cf. Table 2). Hence, although the majority of the aforementioned countries are among the most dependent in terms of the median ID, our findings suggest a certain degree of flexibility in the sourcing of rice.

Therefore, although the bans on rice exports imposed by Cambodia and the Philippines mainly affect higher income European countries that can be expected to adapt more ably to any potentially detrimental impacts, these export bans could still create trade distortions between some major Asian producers of staple crops and Europe. First, European countries might switch sources, which could involve higher transaction costs and thereby lead to higher prices for consumers. Second, producers and exporting companies could lose their access to the European market if the importing countries stick to the alternative sources they switched to while the ban was in place. Moreover, the high ID values for Belgium and the Netherlands are also driven by the fact that both countries are among the largest transshipment points for goods in Europe (Eurostat, 2020). Future studies examining the impact of the export bans of Cambodia and Myanmar should therefore also consider the potential impact on third countries, such as France or Germany, which traditionally rely heavily on importing Belgian and Dutch rice re-exports (United Nations, 2020).

In the case of Russian export bans on millet, rice, and soy, we find the highest median ID values for countries located close to Russia (Figure 2 and Table 3). In terms of the ID, Azerbaijan (109.41%) is most heavily dependent

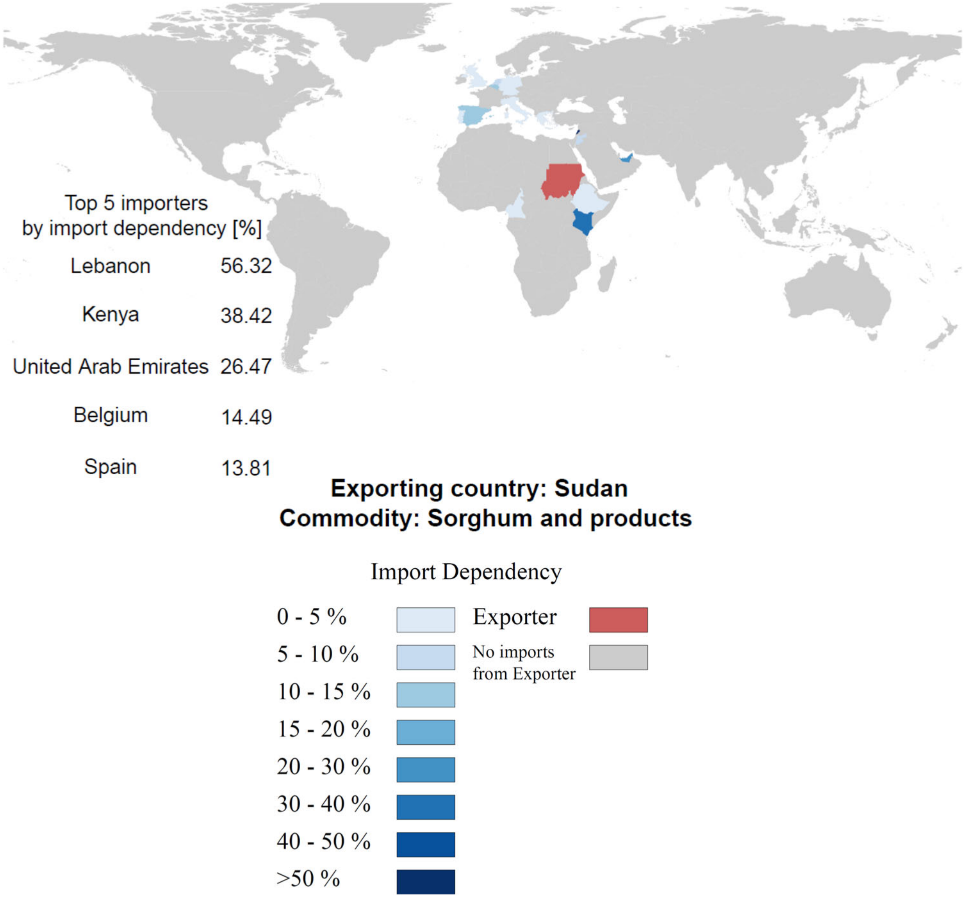

FIGURE 5 Dependency on sorghum imports (share of imports in total food supply) from Sudan by the importer [Color figure can be viewed at wileyonlinelibrary.com]

on rice imports from Russia, followed by Mongolia (38.47%) and Moldova (24.62%). We observe the fourth and fifth largest median IDs for Georgia (5.86%) and Switzerland (5.85%), which are already below 10%. Azerbaijan is not only the most heavily dependent rice importer but also the most dependent importer of soy (70.21%; cf. Figure 2 and Table 3). In this case, Ireland has the second largest ID (44.01%) while all other countries have IDs below one percent. Mongolia (98.69%), Serbia (65.81%), and Turkey (54.44%) imported over 50% of their millet supply from Russia. In addition, Azerbaijan (22.21%), Thailand (20.86%), and Iran (20.41%) show high median ID values of slightly above a fifth. Hence, we see that Azerbaijan (rice, soy, and millet) and Mongolia (rice and millet) in particular are highly dependent on imports from Russia.

As regards sourcing flexibility, compared to the bans for rice of Cambodia and Myanmar, the variation of the ID is larger for the Russian bans (cf. Table 2 and Table 3). Table 3 illustrates that in the case of millet, rice, and soy: There are 13 countries with a difference between the maximum and minimum ID of over 10 p.p., namely Azerbaijan 83.17 p.p., Serbia 80.70 p.p., Mongolia 52.49 p.p., Turkey 37.00 p.p., Germany 16.87 p.p., United Kingdom 14.23 p.p., the Netherlands 12.38 p.p., South Africa 10.68 p.p. for millet, Azerbaijan 54.95 p.p., Mongolia 46.67 p.p., Moldova 22.67 p.p., Belgium 19.24 p.p. for rice, and Azerbaijan 102.28 p.p. for rice. Moreover, in seven of these 13 cases, the minimum ID is well below 10% suggesting a higher degree of sourcing flexibility and a lower dependency on imports from Russia (cf. Table 3). The large variation in the ID indicates sourcing flexibility for Azerbaijan and Mongolia. However, the minimum IDs amount to 11.82% and 84.53% for millet and 55.05% and

TABLE 2 Top 10 importers of rice from Cambodia and Myanmar by import dependency

Rank	Importer	Exporter	Median ID (%)	Minimum ID (%)	Maximum ID (%)	Range (p.p.)
1	Latvia	Cambodia	58.500	54.000	58.750	4.750
2	Croatia	Cambodia	29.993	23.024	36.963	12.939
3	Poland	Cambodia	28.111	17.711	31.394	13.683
4	Netherlands	Cambodia	22.281	19.880	32.206	12.326
5	Czechia	Cambodia	21.863	18.397	24.152	5.755
6	Lithuania	Cambodia	20.411	19.470	38.367	18.897
7	Germany	Cambodia	16.518	15.045	22.129	7.084
8	Estonia	Cambodia	12.672	10.494	24.302	13.808
9	Bulgaria	Cambodia	12.087	8.889	18.833	9.944
10	France	Cambodia	11.918	11.204	12.169	0.965
1	Belgium	Myanmar	90.127	51.054	130.214	79.160
2	Lithuania	Myanmar	29.722	24.200	63.611	39.411
3	Poland	Myanmar	17.876	12.383	19.562	7.179
4	Netherlands	Myanmar	11.004	8.968	17.414	8.446
5	Latvia	Myanmar	9.688	5.000	14.375	9.375
6	Burkina Faso	Myanmar	7.018	3.069	10.967	7.898
7	Germany	Myanmar	6.951	6.023	7.628	1.605
8	Czechia	Myanmar	6.514	5.648	11.659	6.011
9	Croatia	Myanmar	5.643	2.045	9.241	7.196
10	Bulgaria	Myanmar	4.196	2.966	19.565	16.599

Note: The complete data are given in Table A2 in the online appendix.
Abbreviations: ID,import dependency; p.p., percentage points.

16.06% for rice, respectively. Therefore, these two countries might be particularly vulnerable to adverse effects resulting from the Russian export bans.

We find that most of the countries with the highest ID values resulting from Romania's ban on cereal exports outside of the EEA are located on the Arabian Peninsula (e.g., Jordan, Lebanon, Saudi Arabia, United Arab Emirates) and in northern Africa (e.g., Mauritania, Sudan, Tunisia) (Figure 3 and Table 4). Crop production is challenging in these regions due to climatic constraints, the most important being water shortage (Fader et al., 2013). However, only Jordan shows a median ID exceeding 20% (26.12%) followed by Mauritania (5.86%), Lebanon (3.86%), and the United Arab Emirates (3.80%; Figure 3 and Table 4). With a minimum ID of 19.28% (2017), Jordan imported at least one-fifth of its cereals supply from Romania in the precrisis period (2015–2017). Indeed, it was Jordan's largest trade partner for cereals in 2015 and 2016 and second only to the United States in 2017 (United Nations, 2020). Although the ban was lifted on April 16, 2020, just 6 days after it was imposed, the major role played by Romania in Jordan's cereals supply in previous years might lead the Jordanian government to reconsider the sourcing of cereals in the future. As efforts to expand domestic production would be very costly (if at all possible) due to the natural constraints in Jordan (Fader et al., 2013), greater diversification of the set of trade partners might be an appealing option.

TABLE 3 Top 10 importers for rice, soy, and millet from Russia by import dependency

Rank	Importer	Commodity	Median ID (%)	Minimum ID (%)	Maximum ID (%)	Range (p.p.)
1	Azerbaijan	Rice	109.406	55.046	109.992	54.946
2	Mongolia	Rice	38.474	16.046	62.712	46.666
3	Rep. of Moldova	Rice	24.624	4.296	26.967	22.671
4	Georgia	Rice	5.856	4.947	10.605	5.658
5	Switzerland	Rice	5.848	n.a.	n.a.	n.a.
6	Lebanon	Rice	3.827	1.685	5.179	3.494
7	Turkey	Rice	3.742	3.344	7.024	3.680
8	Latvia	Rice	2.015	2.008	3.009	1.001
9	Sudan	Rice	1.364	0.527	2.202	1.675
10	Ukraine	Rice	0.994	0.410	1.249	0.839
1	Azerbaijan	Soy	70.207	0.919	103.196	102.277
2	Ireland	Soy	44.011	40.976	47.045	6.069
3	Belgium	Soy	0.450	n.a.	n.a.	n.a.
4	China	Soy	0.408	0.394	0.474	0.080
5	Turkey	Soy	0.185	0.119	0.223	0.104
6	Iran	Soy	0.178	n.a.	n.a.	n.a.
7	Canada	Soy	0.082	<0.001	0.165	0.165
8	Rep. of Korea	Soy	0.048	0.047	0.108	0.061
9	Germany	Soy	0.020	<0.001	0.027	0.027
10	Poland	Soy	0.013	n.a.	n.a.	n.a.
1	Mongolia	Millet	98.689	84.527	137.017	52.490
2	Serbia	Millet	65.812	18.407	99.105	80.698
3	Turkey	Millet	54.443	20.296	57.296	37.000
4	Azerbaijan	Millet	22.214	11.814	94.982	83.168
5	Thailand	Millet	20.861	20.667	28.345	7.678
6	Iran	Millet	20.408	16.817	23.999	7.182
7	Brazil	Millet	11.500	n.a.	n.a.	n.a.
8	Jordan	Millet	10.915	n.a.	n.a.	n.a.
9	United Kingdom	Millet	10.700	3.587	17.813	14.226
10	Netherlands	Millet	9.210	3.019	15.400	12.381

Note: The complete data are given in Table A2 in the online appendix.
Abbreviations: ID, import dependency; n.a., not applicable; p.p., percentage points.

As regards Kazakhstan's ban on soy exports, Azerbaijan and Sweden exhibit median IDs of 32.09% and 12.17%, respectively (Figure 4 and Table 5). Sweden is the only country reporting imports of soy from Kazakhstan throughout the entire period (2015–2017; cf. Table 5). All other countries only imported soy from Kazakhstan in 1 of the 3 years considered. Therefore, the dependence on soy imports from Kazakhstan in other countries is quite

TABLE 4 Top 10 importers for cereals from Romania by import dependency

Rank	Importer	Median ID (%)	Minimum ID (%)	Maximum ID (%)	Range (p.p.)
1	Jordan	26.116	19.283	53.623	34.340
2	Mauritania	5.863	n.a.	n.a.	n.a.
3	Lebanon	3.863	3.259	6.934	3.675
4	United Arab Emirates	3.798	1.114	5.557	4.443
5	Sudan	3.556	3.257	3.854	0.597
6	Saudi Arabia	2.534	2.158	3.356	1.198
7	Tunisia	2.450	1.349	3.531	2.182
8	New Zealand	1.980	n.a.	n.a.	n.a.
9	Egypt	1.602	<0.001	3.204	3.204
10	Oman	1.304	n.a.	n.a.	n.a.

Note: The complete data are given in Table A2 in the online appendix.
Abbreviations: ID, import dependency; n.a., not applicable; p.p., percentage points.

low with only a few countries importing significant shares of their soy supply. This is similar to the case of Russia, where only two countries show median IDs of over 1% (cf. Figure 2 and Table 3). However, this must be put into perspective against the share in global production. While Kazakhstan and Russia produced approximately 255,000 and 4 million tonnes of soy in 2018, respectively, global production amounted 363 million tonnes, of which 66% was produced solely by the United States and Brazil (FAO, 2020b). Since the USA and Brazil are also the world's top soy exporters (United Nations, 2020), it is not surprising that only few countries depend on soy imports from Kazakhstan and Russia.

Lastly, we present the results of Sudan's ban on sorghum exports. As a developing country, Kenya shows a median import dependency of 38.42%, while Lebanon's dependency is even higher with a share of 56.32% of its sorghum supply stemming from Sudan (Figure 5 and Table 6). However, both countries only report sorghum

TABLE 5 Importers for soy from Kazakhstan by import dependency

Rank	Importer	Median ID (%)	Minimum ID (%)	Maximum ID (%)	Range (p.p.)
1	Azerbaijan	32.093	n.a.	n.a.	n.a.
2	Sweden	12.168	10.560	24.915	14.355
3	Denmark	8.400	n.a.	n.a.	n.a.
4	Turkey	0.282	n.a.	n.a.	n.a.
5	USA	0.028	n.a.	n.a.	n.a.
6	China	0.006	n.a.	n.a.	n.a.
7	Canada	0.002	n.a.	n.a.	n.a.
8	Lebanon	0.001	n.a.	n.a.	n.a.
9	Netherlands	<0.001	n.a.	n.a.	n.a.

Note: The complete data are given in Table A2 in the online appendix.
Abbreviations: ID, import dependency; n.a., not applicable; p.p., percentage points.

TABLE 6 Top 10 importers for sorghum from Sudan by import dependency

Rank	Importer	Median ID (%)	Minimum ID (%)	Maximum ID (%)	Range (p.p.)
1	Lebanon	56.318	n.a.	n.a.	n.a.
2	Kenya	38.421	n.a.	n.a.	n.a.
3	United Arab Emirates	26.474	15.841	211.218	195.377
4	Belgium	14.488	9.735	15.631	5.896
5	Spain	13.809	0.004	27.613	27.609
6	Netherlands	6.430	4.706	8.153	3.447
7	Jordan	6.284	1.636	10.931	9.295
8	Greece	4.500	n.a.	n.a.	n.a.
9	Italy	4.038	0.009	8.067	8.058
10	Germany	3.845	3.357	5.716	2.359

Note: The complete data are given in Table A2 in the online appendix.
Abbreviations: ID, import dependency; n.a., not applicable; p.p., percentage points.

imports from Sudan in 2017. Hence, they are able to satisfy the domestic demand from other sources as well. The United Arab Emirates have a median ID of 26.47% followed by Belgium with 14.49% and Spain with 13.81%. While all of them report sorghum imports from Sudan more than once, the minimum IDs are either below 10% (Belgium and Spain) or the difference between the maximum and minimum is very large (United Arab Emirates) suggesting that the importers are very flexible in sourcing sorghum from other countries (Table 6). In addition, while Sudan was the third largest producer of sorghum in 2018 with a volume of approximately 5 million tonnes (behind the United States and Nigeria), only 77,000 tonnes were exported, which is <2% of its production (FAO, 2020b; United Nations, 2020). In contrast, the United States produced slightly over 9 million tonnes and exported approximately 4 million tonnes in 2018, which is equivalent to 44% (FAO, 2020b; United Nations, 2020). It follows that most of Sudan's sorghum production is used for domestic consumption and only small shares are exported, potentially making Sudan unattractive as a trade partner for sorghum imports.

5 | CONCLUSION AND FUTURE RESEARCH

In this study, we identify potential disruptions in the food supply of importing countries caused by temporary export bans enacted in reaction of the COVID-19 pandemic using pre-pandemic trade flows. We use data from the ITC, UN Comtrade, and the FAO to calculate an import dependency measure and evaluate the historic reliance of importing countries on those countries restricting exports and provide examples from both developed and developing countries.

We find that importers often rely on a particular trade partner for a significant share of the supply of a given commodity. These countries are particularly vulnerable to sudden export restrictions imposed by their main trade partners, even if these restrictions are only a temporary measure. However, the implications for importing countries are more complex. The ultimate impact on the trade partners of countries which impose export bans is determined by several other factors, such as further COVID-19-related supply- and demand-side issues, the commodity's share in the country's total domestic caloric supply, or its access to alternative trade partners to source the commodity. Nevertheless, and especially from a short-term point of view, every export ban is likely to distort supply chains that rely heavily on imports from a particular country.

Based on these findings, we encourage future researchers to use the cases/dependencies identified in our study as a starting point for further analyses of the effects of COVID-19-related export bans on the importing and exporting countries and to include third countries, which might be affected, for example, due to world market price fluctuations. Our results indicate that the comparability of different country/commodity combinations is limited, so that further investigations should be conducted case-by-case. In addition, it would be valuable to examine whether countries which have made efforts to increase their food self-sufficiency after the food price crisis 2007/2008, have been successful and improved the resilience of their food systems against such risks. We recognize that import dependency is a first indication of the varying extents to which countries seek to satisfy the quantity and diversity of the food demands of their population. However, a more nuanced understanding of food self-sufficiency and how it is impacted by temporary trade restrictions could lead to a more targeted policy dialogue (Clapp, 2017). To this end, our analysis could be extended using alternative indices to capture the link between trade and food and nutrition security in importing countries. Finally, it might be interesting to investigate further how high-income countries such as Belgium or the Netherlands have responded to the lack or reduction of supplies from their traditional main trade partners.

When considering the consequences of export bans on food security in importing countries, there may be doubts as to whether a lack of imports from, for example, Myanmar (rice) or Russia (soy) jeopardizes the availability of an adequate caloric supply for the population in Europe. Firstly, there might be alternative suppliers for the respective commodity, such as China in the case of rice. Secondly, the contribution of a product to the overall caloric food supply must be taken into consideration when drawing conclusions on the impact of the trade measures on food security. Nevertheless, if a country sources a high share of any commodity from just one producer, and all imports of the commodity are suddenly stopped, this will probably distort well-established and coordinated global supply chains in both developing and industrialized countries—at least in the short term.

Another potential implication is rising world market prices, especially for thinly traded commodities, that is, commodities where a small number of producers supply most of the global production and small shares of this global production are traded, such as rice (Clapp, 2017). Coinciding with the imposition of most of the trade measures, world market prices for rice rose by over 25 p.p. between February and April 2020 (World Bank, 2020). Hence, third countries might be effected by import bans due to increments of market prices, which in turn can jeopardize food security in poorer countries (Baquedano & Liefert, 2014). Moreover, in the absence of affordable substitutes, the ban on the export of cereals from Romania might very well cause issues regarding food security for its trade partners, particularly in the short-term and in countries like Jordan, which lack natural resources to expand domestic production.

Lastly, we present a brief discussion of aspects that future research should highlight when quantifying the impact of export bans on importing countries. In general, when reviewing the impact of the export bans on prices, production, and trade, there are several other issues in the context of the COVID-19 pandemic that affected the global food systems, which need to be considered complementarily with export bans. First, supply-side access to labor for the primary production of crops relying on a seasonal workforce has been disrupted due to travel restrictions (Larue, 2020; Ridley & Devadoss, 2020). Food processing and retailing have also been affected by worker illness and restrictions in public life (Hobbs, 2020). Second, a phenomenon observed in many different countries at the beginning of the crisis involved panic purchases and hoarding of essential durable food products, for example, flour, pasta, and rice, producing a strong demand-side shock which, in some cases, led to empty supermarket shelves (Hobbs, 2020). Third, countries with a historically high tourist volume might be facing very different food demand patterns during the crisis compared to previous years since the absence of tourists leads to a decline in demand from the hospitality industry. Fourth, the COVID-19 pandemic has led many countries to impose a temporary shutdown of their economy resulting in lower economic activity, a sharp increase in unemployment, for example, in the United States (Bureau of Labor Statistics, 2020), and thereby to sinking income, which might have unforeseeable effects on food demand. While the aforementioned aspects might influence the impact of an export ban, they may in turn also be a driver of the decision to ban exports. In particular, consumers' panic purchases could cause governments to prohibit exports of these goods to avoid the danger of running out of stocks of certain commodities in the short-term. Hence, the causal effect could be reversed.

DATA AVAILABILITY STATEMENT

The data used in our study are publicly available and retrieved from the International Trade Center, FAOSTAT, and UN Comtrade as indicated in the manuscript.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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