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COVID-19 Trade Actions in the Agricultural and Food Sector

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Abstract

This study investigated the determinants of trade actions in the agricultural and food sector related to the coronavirus pandemic. These emergency trade measures aimed to prevent the inflow of certain products and promote the import of others. We investigated the determinants of such measures using product-level trade action data for WTO members. Applying an instrumental variable approach that accounts for high-dimensional fixed effects, we found that trade actions relate negatively to the applied tariff level and the domestic pandemic severity. Countries implemented fewer trade facilitation actions considering increased domestic COVID-19 cases, but this was done more in response to spiking foreign case numbers.

Keywords: Coronavirus pandemic, trade actions, agricultural and food sector, control function approach, product level

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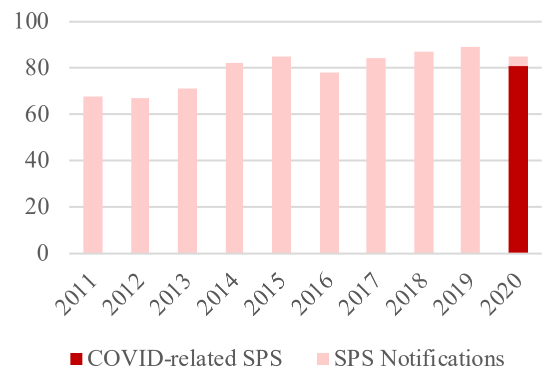
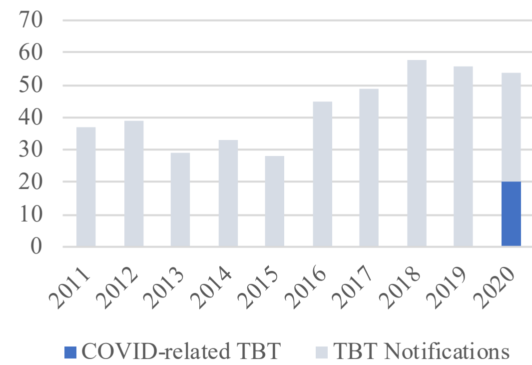
Introduction

As the coronavirus (COVID-19) pandemic began to spread in spring 2020, several countries implemented trade actions to reduce the virus's cross-border movement (Chen and Mao, 2020; Kerr, 2020). Because cross-border movement is a significant source of coronavirus spread, international trade was also affected (Adda, 2016). Non-tariff measures (NTMs) related to COVID-19 were initiated as emergency measures by 38 countries in 2020 (United Nations, World Trade Organization, 2021b). The first NTM notification to the World Trade Organization (WTO) banned the import of exotic species and decorative animals from China to the Russian Federation (United Nations, World Trade Organization, 2021b). Various other nations have taken similar measures to prevent the transmission of the virus by wild animals. The coronavirus pandemic caused a suspension of food production activities in several countries, and the production level was unable to keep up with demand (Aday and Aday, 2020). The decline in production resulted in supply shortages and higher prices for some food products (Peel, 2021). In response to this market failure, several countries notified the WTO of emergency measures, enabling them to adopt trade actions immediately, without the usual 60-day comment period or 6-month transition period before entry into force.

COVID-19-related NTMs were implemented to either restrict or facilitate trade, targeting mostly personal protective equipment, food, medical equipment, plant products, and live animals (United Nations, World Trade Organization, 2021b). Our study focused on the agricultural and food sector as it is closely related to human health and food security. This sector faced severe impacts from the pandemic because the global food system is highly integrated (Chen and Mao, 2020). Major NTMs in the agricultural and food sector are Sanitary and Phytosanitary (SPS) and Technical Barriers to Trade (TBT) measures. According to the United Nations Conference on Trade and Development (2019), SPS measures intend to protect human or animal health from risks by additives, contaminants, toxins, or disease-causing organisms in food. TBT refers to technical regulations and procedures for conformity assessment with technical rules and standards. Over the last decade, SPS and TBT measures have been on the rise. In 2020, the total number of SPS and TBT notifications decreased compared to those of the previous year, but the notifications are different from the previous years. As shown in Figure 1, more than 95% of the SPS notifications are related to COVID-19, which is not surprising considering that the pandemic is directly related to the health of humans and animals. About 40% of the TBT notifications in the agricultural and food sector were implemented under the emergency response to COVID-19. TBT is less likely to affect the agricultural and food industry than SPS, but it is closely related to food standards and technical regulations (United Nations, World Trade Organization, 2021a). The COVID-19-related TBTs include strengthening technical regulations and standards on imports, most of which were implemented to mitigate the existing rules and facilitate imports.





Source: Collected from WTO and calculated by the authors. Notes: The graphs show NTMs in the agricultural and food sector (HS01-24).

Figure 1. Number of General and COVID-19-related SPS and TBT Notifications

Somewhat counterintuitively, NTMs can promote trade by reducing asymmetric information and externalities through opening information on standard requirements (Xiong and Beghin, 2017; Gourdon, Stone, and van Tongeren, 2020). According to the WTO agreement, these measures should not be used as a source of restricting trade. Yet, despite this limitation, some researchers argue that NTMs technically substitute for tariffs in the free trade era (Looi Kee, Nicita, and Olarreaga, 2009). They can be utilized to protect the domestic market (de Almeida, da Cruz Vieira, and da Silva, 2012). The notifications to SPS and TBT agreements imposed as an emergency response to COVID-19 are different from those notifications before. Since this event was directly related to the health of humans and animals, most measures had a clear purpose, such as restricting or facilitating trade. Most studies investigating their impact on international trade or their determinants disregard the stated purpose of the NTM notification (Orefice, 2017; Santeramo and Lamonaca, 2019; Webb et al., 2020). There has been no research on the determinants of COVID-19-related NTMs taken considering the aim of each notification. To fill this gap, we analyzed the determinants of SPS and TBT in response to COVID-19 trade actions in the agricultural and food sector, considering their stated purpose when filing notification to WTO.

This paper presents findings from our analysis of COVID-19-related NTM determinants in the agricultural and food sector. We distinguished between trade-restricting and facilitating NTMs and constructed a balanced panel dataset for NTM actions at the 6-digit product level covering 55 countries for 2020. We added monthly information on MFN tariffs, trade flows, exchange rates, dietary supply, and new COVID-19 cases for each country and the world.[1] To assess the drivers of NTMs related to COVID-19, we estimated a high-dimensional count data regression model that controls for product and country heterogeneity, where we identified the parameters of interest with

[1] COVID-19 cases in the rest of the world can be regarded as a proxy for country awareness of the issue, which might force countries to take action.

the Poisson pseudo-maximum likelihood estimator (PML) (Silva and Tenreyro, 2011).[2] According to Silva and Tenreyro, the salient feature of Poisson PML is that it does not affect the performance of the estimator if the dependent variable has a large proportion of zeros. We accounted for potential endogeneity bias due to measurement error in the COVID-19 case with a control function approach adopted by generalizing the conditional Poisson model to an instrumental variable setting (Wooldridge, 2015). Our instruments were the 12-month lagged Gross Domestic Product (GDP) per capita, the agricultural employment rate, and agricultural GDP share. They correlate strongly with differences in diagnostic capabilities among countries and pass the weak instrument test. We then measured heterogeneity in the probability of implementing trade restricting and facilitating NTMs according to product categories. Our main coefficient of interest, COVID-19 cases, might have a country's inclination to report NTMs related to certain products, so we implemented a subanalysis for product heterogeneity.

Our IV estimates indicated a negative association among domestic COVID-19 cases and NTMs and a positive association for worldwide case numbers. These findings are driven mainly by a lower probability of trade-facilitating trade actions among countries with a significant increase in COVID-19 cases. We found that the worldwide propagation of the coronavirus pandemic related positively to the number of NTMs implemented. Depending on whether countries already implemented a COVID-19-related NTM, the probability of imposing further measures correlated negatively with the increasing number of domestic COVID-19 cases but positively with worldwide COVID-19 cases. We found no evidence for a heterogeneous effect on products of domestic COVID-19 cases and worldwide COVID-19 cases. The relationship was more pronounced for semiprocessed and bulk products than for aquaculture, horticulture, and processed products. Our results related to the work of Crivelli and Gröschl (2016) and Orefice (2017), who argue that SPS and TBT are more likely to be represented as trade barriers. However, we found that they are efficient measures for trade facilitation during an emergency. While at the beginning of the pandemic researchers worried about the trade restriction effect of NTMs (Chen and Mao, 2020; Organization for Economic Co-operation and Development, 2020), our results provide evidence that these concerns did not materialize as the effects of COVID-19 cases are correlated with facilitating trade in the agricultural and food sector.

The remainder of this paper is organized as follows. We first provide an overview of trade actions in the agricultural and food sector related to COVID-19, then introduce the empirical strategy and review data sources. The results and conclusion follow.

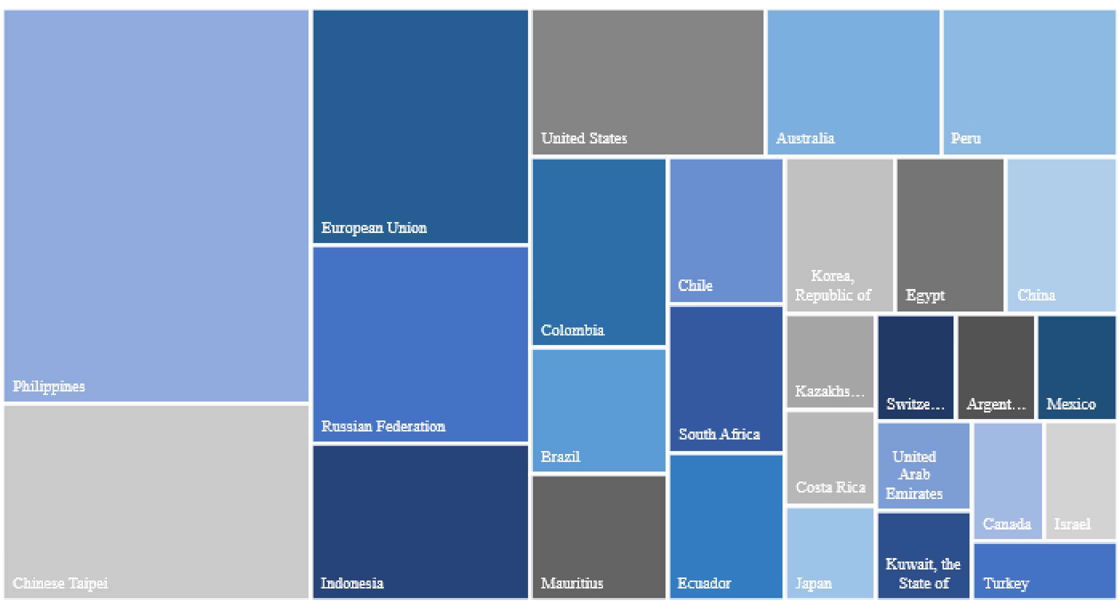
COVID-19-Related NTM in the Agricultural and Food Sector

In spring 2020, several governments reported SPS notifications to prevent the inflow of wild animals because they were known as potential hosts of viral infections. Among 101 notifications of SPS and TBT reported to the WTO for the purpose of COVID-19 emergency, 21 notifications

[2] "Pseudo" means maximizing a likelihood function with a group of probability distributions that do not necessarily contain the true distribution. Pseudo ML provides consistent and asymptotically normal estimators of parameters for the true distribution (Gourieroux, Monfort, and Trognon, 1984).

were regarding trade restriction, 80 of which were to facilitate agricultural and food trade.[3] As of December 31, 2020, 31 WTO members submitted SPS and TBT notifications in response to COVID-19. These were SPS and TBT notifications reported by several South American and African countries against the European Union.

Following the Russian Federation, which banned imports of exotic and decorative animals in February 2020, notices of import restrictions for various food products and animals from Kazakhstan, Indonesia, and Mauritius came out in March. Most of the SPS notifications in February and March related to import bans for China, Hong Kong, Italy, Iran, South Korea, Switzerland, and the European Union, where COVID-19 spread had increased rapidly during that period. After the pandemic declaration by the World Health Organization (United Nations, World Health Organization, 2020), most COVID-19-related SPS and TBT notifications were intended to facilitate trade rather than restrict trade. Countries subject to these NTMs also targeted all trading partners rather than limiting the focus to some countries. The Philippines reported the highest number of SPS and TBT notifications in the agricultural and food sector for 2020 (see Figure 2). Chinese Taipei (Taiwan), the European Union, the Russian Federation, Indonesia, and the United States followed in terms of NTMs. Most of these cases were revised notifications, including extending the application period for the same measures, or lifting the previous measures, and few countries reported other types of SPS or TBT measures.

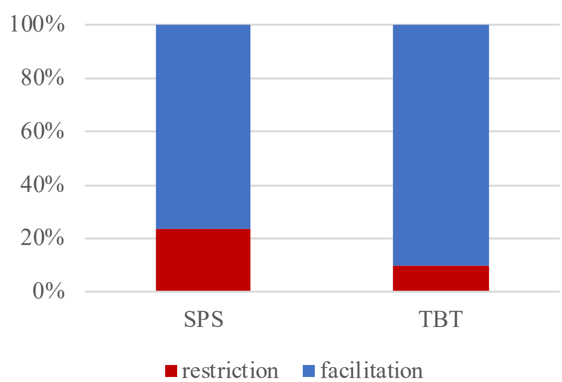


Notes: The figure shows NTMs in the agricultural and food sector (HS01-24). The box size for each country implies the proportion of NTM notifications related to the COVID-19 (SPS and TBT) in agricultural sector, 2020. The color of the box identifies the country.

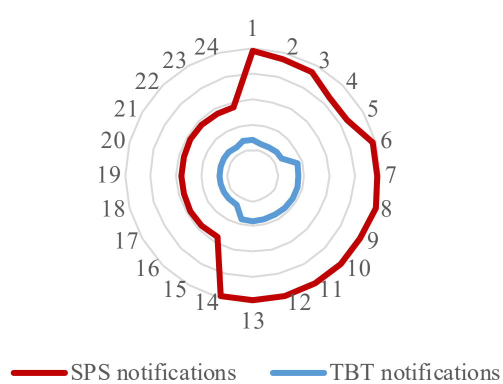
Figure 2. Countries with the COVID-19-related SPS and TBT in the Agricultural Sector for 2020

[3]The purpose of notification is listed in most of the WTO documents as a category and if there is no indication, they are classified by referring to other notifications.

Most TBT notifications facilitate imports (see Figure 3 [a]). With the pandemic declaration, countries adopted lockdown orders, implying that there were restrictions on the movement of labor, which would have disrupted trade-related work. TBTs include the reduction of labeling requirements on certain food products, the change of maximum residue levels of agricultural products, and online verification of certificates. On the other hand, SPS notifications include more import restrictions than TBTs. Unlike the early stage of COVID-19-related SPSs, which were mostly import bans of wild animal products from China and the neighboring countries, they were about the requirement of COVID-19 testing of imported food and animal products. For instance, Indonesia, the United States, and South Korea notified that they strengthened additional inspection measures for meat products. In China's case, their notification included a requirement of COVID-19 testing for imported cold chain foods from certain producers in Ecuador. Some countries took SPS measures against a single country. The Philippines notified a temporary ban on poultry meat from Brazil and Chile and strengthened requirements for phytosanitary certificates on blueberries imported from Peru. The SPS notifications on the purpose of trade facilitation were similar to TBTs, with respect to alternative measures for the submission of certificates for food safety and sanitation. Some SPS notifications included lifting their former SPS measures that were used to restrict imports from other countries. Among the SPS and TBT measures implemented in the agricultural and food sector, 41.6% were applied to all products. The second-largest number of notifications was related to wild animals, fish, and meat products (see Figure 3 [b]). Even though most of the early notifications were concentrated on wild animals and meat products, the focus expanded in the second half of 2020 to include measures covering plants, fruits, and whole items. These characteristics of NTMs imply that the determinants of SPS and TBT may be different across product space and according to the stated purpose.



(a) Purpose of notifications



(b) Product heterogenity

Source: Collected from WTO and calculated by the authors.
Note: The right figure shows a distribution of SPS and TBT notifications in 2020 according to HS2 code.

Figure 3. Heterogeneity of COVID-19 related SPS and TBT in Agricultural Sector for 2020

Methodology

Empirical Strategy

The baseline regression model investigates factors that correlate with the probability of implementing NTMs in response to the COVID-19 pandemic. We specify the count data regression model in its generalized form as follows:

$$\begin{aligned} NTM_{ikt} = \exp\Bigg(& \beta_1 \ln(1+MFN_{ikt}) + \beta_2 \ln(Imports_{ikt-12}) + \beta_3 \ln(Exports_{ikt-12}) \\ & + \beta_4 \ln(Exchange\ Rate_{it-1}) + \beta_5 \ln(Dietary\ Supply_{it-12}) \\ & + \beta_6 \ln(COVID_{it-1}) + \beta_7 \ln\left(\sum_j COVID_{it-1}\right) + \gamma_i + \delta_k \Bigg) \varepsilon_{ikt}, \end{aligned} \tag{1}$$

where the dependent variable is the number of NTMs (SPS and TBT) imposed by country i on product k at time t. The baseline regression model includes the applied tariff level $\ln(1+MFN_{ikt})$, the 12-month lagged imports $\ln(Imports_{ikt-12})$ and exports $\ln(Exports_{ikt-12})$, the one-month lagged exchange rate $\ln(Exchange\ Rate_{it-1})$ and the food supply level $\ln(Dietary\ Supply_{it-12})$. The variables $\ln(COVID_{it-1})$ and $\ln\left(\sum_j COVID_{it-1}\right)$ measure new COVID-19 cases in country i and in the rest of the world. We include country γ_i and product δ_k fixed effects to account for systematic differences in the implementation probability and indicate the multiplicative error term with ε_{ikt}.[4] The descriptive statistics of all variables are provided in Table 1.

[4] We excluded time fixed effects from the regression model because they would have prohibited us from measuring the impact of worldwide COVID-19 cases. This variable would be highly correlated with the time fixed effects.

Table 1. Summary Statistics of Variables

Dependent Variables	**N**	**Mean**	**SD**	**Min**	**Max**
NTM (Dummy)	1,356,240	0.380	0.485	0	1
Facilitation (Dummy)	1,356,240	0.373	0.483	0	1
Restriction (Dummy)	1,356,240	0.026	0.158	0	1
NTM (Cumulative)	1,356,240	0.804	1.312	0	12
Facilitation (Cumulative)	1,356,240	0.781	1.301	0	12
Restriction (Cumulative)	1,356,240	0.027	0.175	0	3
SPS (Dummy)	1,356,240	0.364	0.481	0	1
TBT (Dummy)	1,356,240	0.139	0.346	0	1
SPS (Cumulative)	1,356,240	0.687	1.108	0	12
TBT (Cumulative)	1,356,240	0.139	0.346	0	1
E (Sample)					
Control function					
NTM (Dummy)	1,356,240	0.380	0.485	0	1
Facilitation (Dummy)	1,318,104	0.383	0.486	0	1
Restriction (Dummy)	230,400	0.151	0.358	0	1
SPS (Dummy)	1,327,200	0.372	0.483	0	1
TBT (Dummy)	987,360	0.191	0.393	0	1
Control function conditional on NTM					
NTM (Dummy)	1,305,984	0.395	0.489	0	1
Facilitation (Dummy)	1,273,527	0.397	0.489	0	1
Restriction (Dummy)	168,801	0.205	0.404	0	1
Control function conditional on product					
NTM (Dummy)	1,356,240	0.380	0.485	0	1
Facilitation (Dummy)	1,318,104	0.383	0.486	0	1
Restriction (Dummy)	230,400	0.151	0.358	0	1
Explanatory variables					
Log (MFN +1)	1,356,240	1.065	1.270	0	8.007
Log (Export values), 12 months lag	1,356,240	5.119	6.056	0	22.332
Log (Import values), 12 months lag	1,356,240	6.503	6.297	0	22.162
Log (COVID-19 cases, home country), 1 month lag	1,356,240	3.422	4.590	0	15.319
Log (COVID-19 cases, rest of the world), 1 month lag	1,356,240	6.253	7.465	0	16.664
Log (Exchange rate), 1 month lag	1,356,240	1.986	2.001	0	9.672
Dietary supply, 12 months lag	1,356,240	124.018	28.490	0	152
Instruments					
Log (GDP per capita), 12 months lag	1,356,240	9.967	0.885	7.805	11.667
Agricultural employment rate, 12 months lag	1,356,240	8.348	8.938	0.060	32.140
Agricultural GDP (share of GDP), 12 months lag	1,356,240	3.247	2.914	0	13.128

Note: The medians for all NTM variables are zero.

We used the Poisson PML estimator to identify the relationship between COVID-19 case numbers and NTMs (Gong and Samaniego, 1981; Gourieroux, Monfort and Trognon, 1984).[5] The estimator is unbiased and consistent in the presence of heteroskedasticity. Even if the conditional variance is not proportional to the conditional mean, the estimator is still consistent (Wooldridge, 1999; Cameron and Pravin, 2013). Because the estimator does not make a specific assumption on the dispersion of the fitted values, we did not have to test for this aspect of the data. A further advantage of the Poisson PML estimator is that the scale of the dependent variable has no effect on the parameter estimates, which is a particular concern for the Negative Binomial PML estimator. If the conditional mean is correctly specified, the Poisson PML estimator yields parameter estimates that have a similar magnitude to the estimates of both the Gaussian and Negative Binomial PML estimators (Silva and Tenreyro, 2011). We accounted for high-dimensional fixed effects using the approach outlined in Correia, Guimarães, and Zylkin (2020). Because we suspected the presence of residual correlation at the HS-heading level (HS4), we addressed the potential heteroskedasticity and serial correlation in the error term using a robust variance estimator that accounts for clustering at the year-month level (Cameron and Miller, 2015).

A potential concern regarding the identification strategy relates to endogeneity caused by "measurement error" in the COVID-19 numbers (Kilani and Georgiou, 2020; Kisa and Kisa, 2020). First, only for those countries that reported COVID-19-related SPS and TBT notifications in 2020, we observed whether NTMs were imposed to facilitate or restrict trade. Second, COVID-19 case reporting and testing varies across countries and time, and the number of cases might be affected by various factors. Thus, this measurement error of the COVID-19 variables becomes part of the error term in the regression, creating an endogenous bias. Therefore, we are suspicious that the baseline results are biased due to this source of measurement error (Semykina and Wooldridge, 2010). To account for endogeneity concerns, we applied the control function approach, a two-step procedure developed by Heckman and Robb (1985). This procedure is adopted by generalizing the conditional Poisson model to an instrumental variable (IV) setting (Wooldridge, 2015). For the first stage, the instrumental variables are regressed on the endogenous variable (COVID-19 cases). In addition to the instruments, fixed effects for country and product and all covariates from the baseline specification were included in this linear regression. Our instruments included the 12-month lagged GDP per capita, the agricultural employment, and the agriculture GDP share. These log variables correlate strongly with COVID-19 case numbers and misreporting (Nguimkeu, Pierre, and Tadadjeu, 2021). Countries with high agricultural employment and agricultural GDP share, such as many developing countries, are likely to underreport COVID-19 cases because of inadequate diagnostic and reporting capabilities. Countries that have a higher income level are more likely to test for COVID-19, so the measurement error in the COVID-19 case is more elevated (Hasell et al., 2020). The descriptive statistics of the instrumental variables are provided in Table 1. For the second stage, the baseline specification is adjusted by including the first-stage

[5] Although we could also rely on the standard Poisson regression model to estimate the relationship, this estimator has two properties that could complicate the identification of the exchange rate volatility treatment effect. First, this regression is known to suffer from convergence problems which can result in spurious estimation results. Second, it is sensitive to numerical difficulties, which is a particular issue for regressions with high-dimensional fixed effects and highly disaggregated data (Silva and Tenreyro, 2011). Therefore, we used the PML estimator as it circumvents these cavities of the standard Poisson regression.

residuals in the regression specification. All parameters are identified with the Poisson PML estimator. Although a correct identification of the COVID-19 case number effects is ensured with the control function approach, it is necessary to adjust the standard errors for the estimation error in the first stage (Cameron and Miller, 2015). To account for this error, we applied a block-bootstrap procedure with replacement, randomly drawing 1,000 samples from the entire history of each country-product-pair (Gonçalves and Kilian, 2004).

Since the estimates from the first step are the same as the 2SLS estimates, one might wonder what difference it makes compared to the 2SLS. However, compared to the 2SLS approach, it produces a hypothetical heteroscedasticity-robust Hausman test, which implies that the COVID-19 variables become exogenous by including the residuals from the first stage (Wooldridge, 2015).

Data

The raw data on COVID-19-related NTMs came from the WTO's NTM database (United Nations, World Trade Organization, 2021a). We focused on SPS and TBT related to agricultural and food trade announced in 2020. There are 101 COVID-19-related SPS and TBT notifications, of which we used import-related NTMs implemented by countries for which detailed trade data were available for the study period. We classified these trade actions according to trade facilitation and restriction policies. Our final policy dataset included 86 SPS and TBT notifications imposed by 55 countries[6] on agricultural and food trade in 2020.[7]

We constructed a panel dataset for imports and exports at the country level for 2018 to 2019, based on tariff-line level trade data for 91 countries from the Global Trade Information Services (2021). Export and import data were disaggregated at the product level using the Harmonized System (HS) 6-digit code. Since we focused on agricultural and food trade, we included trade flows categorized in sections HS 01 to HS 24 for 55 countries. Tariff data came from the Tariff Analysis Online (United Nations, World Bank, 2021a). This dataset offered tariff-line duties by countries on specific goods based on the HS code system. We used MFN tariffs defined at the tariff-line level and imposed on imports from other WTO members, except when the country is part of a preferential trade agreement.

Monthly data on confirmed COVID-19 cases came from the Data Repository of the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (Dong, Du, and Gardner, 2020). Using daily COVID-19 cases, we calculated the lag of monthly cases for each country and the world. We included monthly exchange rate data from the International Financial Statistics (United Nations, International Monetary Fund, 2021). These exchange rates were based on national currency per U.S. dollar, period average, one of the most used as selected indicators. For the food security level, we used one of the food security indicators from FAOSTAT (United Nations, Food and Agricultural Organization, 2021). The FAO offers several indicators for each country, and among them, average dietary energy supply adequacy (normalized) is used for the

[6]The country list is provided in Table 2.
[7]Data for the European Union are disaggregated to individual countries (27 countries plus the United Kingdom). Kuwait and United Arab Emirates are excluded due to trade data limitations.

relation with the imposition of NTMs. We used a 1-year lagged term because a country with a low level of dietary supply might have decided to notify certain NTMs to facilitate trade. We included interaction terms for the heterogeneity analysis based on the Regmi et al. (2005) product classification. This classification categorizes agricultural and food products in aquaculture, primary bulk commodities, produce/horticulture, semiprocessed, and processed products. Instrumental variables, such as GDP per capita, agricultural employment, and agricultural GDP share, came from the World Development Indicator (United Nations, World Bank, 2021b). We constructed a 12-month lagged weighted average for all instrumental variables.

The summary statistics are presented in Table 1. Our dependent variables are distinguished in two ways, a dummy and a cumulative variable. The average number of NTMs indicates that our sample contained many zero NTMs. Based on the food dietary variable, we found that our sample countries tend to have a high food security level. Our instruments, GDP per capita, agricultural employment, and agricultural GDP share, indicate that most advanced economies are not heavily dependent on the agricultural sector, but the sample included various countries with high agricultural employment and GDP shares.

Table 2. Country List

Argentina	Japan
Australia	Kazakhstan
Austria	Latvia
Belgium	Lithuania
Brazil	Luxembourg
Bulgaria	Malta
Canada	Mauritius
Chile	Mexico
China	Netherlands
Colombia	Peru
Costa Rica	Philippines
Croatia	Poland
Cyprus	Portugal
Czech Republic	Romania
Denmark	Russia
Ecuador	Slovakia
Egypt	Slovenia
Estonia	South Africa
Finland	South Korea
France	Spain
Germany	Sweden
Greece	Switzerland
Hungary	Taiwan
Indonesia	Thailand
Ireland	Turkey
Israel	United States
Italy	

Results and Discussion

Baseline Results

Table 3 shows the baseline regression results for the determinants of COVID-19-related trade actions and compares the dummy with a cumulative outcome variable specification. MFN tariff rates matter for NTM all-purposes with different magnitude and direction of the estimated effects. Facilitating-purpose NTMs show a negative correlation with the tariff rate. For the positive relationships among tariffs and NTMs, our general results contrasted with Beverelli, Boffa, and Keck (2014), who found that tariff and NTMs are substitutes. This is caused by the fact that COVID-19 NTMs were imposed as emergency measures. Export values show a positive correlation with the NTMs, but the impact is low, and import values are statistically insignificant. The exchange rate affects restricting-purpose NTMs at the 1% significance level. An increase in exchange rates (a falling currency) leads to a higher likelihood of imposing NTMs for trade restrictions. The dietary supply level affects only restricting-purpose NTMs. The estimates indicate that a 1% increase in dietary supply level leads to a 56.5% decrease in NTM cases. These results are consistent with our initial hypothesis that countries with higher dietary supply levels have a lower probability of imposing NTMs for trade facilitation during the pandemic. The effects of COVID-19 cases vary across the type of dependent variables. When we considered NTMs as dummy variables, a 1% increase of domestic COVID-19 cases decreased the number of NTMs for trade facilitation by 9.3%, while the coefficients are insignificant for cumulative NTMs. On the other hand, the effect for COVID-19 cases in the rest of the world is high for both purposes of NTMs with similar effects and direction. Since all COVID-19 variables suffer from endogeneity concerns, we employed control function estimation methods and compared the results with the baseline results.

Table 3. Baseline Regression Model

	Dummy Variables			**Cumulative Variables**		
Dependent variables	**NTM**	**Facilitation**	**Restriction**	**NTM**	**Facilitation**	**Restriction**
Explanatory variables						
Log (MFN +1)	-0.005**	-0.005*	0.102***	-0.042***	-0.049***	0.095***
	(0.002)	(0.003)	(0.014)	(0.002)	(0.003)	(0.012)
Log (Export values), 12 months lag	0.000**	0.000**	0.004***	0.001***	0.002***	0.003***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Log (Import values), 12 months lag	0.000	0.000	-0.002	-0.001***	-0.001***	0.000
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.001)
Log (Exchange rate), 1 month lag	-0.017	0.037	-12.446***	-0.256***	-0.220*	-12.945***
	(0.148)	(0.163)	(1.711)	(0.118)	(0.126)	(1.651)
Dietary supply, 12 months lag	0.038	0.048	-0.833*	-0.069	-0.056	-0.546
	(0.107)	(0.132)	(0.482)	(0.073)	(0.084)	(0.463)
Log (COVID-19, home country), 1 month lag	-0.098***	-0.096***	0.047	-0.027	-0.026	0.048
	(0.026)	(0.026)	(0.038)	(0.031)	(0.031)	(0.037)
Log (COVID-19, rest of the world), 1 month lag	0.353***	0.353***	0.460***	0.436***	0.438***	0.453***
	(0.032)	(0.033)	(0.137)	(0.042)	(0.043)	(0.128)
Constant	-9.345	-10.662	95.098**	3.365	1.685	76.160**
	(13.167)	(16.268)	(39.104)	(8.595)	(10.130)	(38.832)
Pseudo R2	0.885	0.893	0.863	0.929	0.935	0.852
N	1,356,240	1,318,104	230,400	1,356,240	1,318,104	230,400

Notes: Standard errors are presented in parentheses with clustering at year-month level. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Control Function Estimates

We present the control function estimation results in Table 4. The upper part shows the second stage, and the lower part shows the first stage regression results. The F-statistics imply that our instruments passed the weak identification test, while the coefficient significance in the first stage and the residuals in the second stage indicate that the instrumental variables were relevant.

They are highly correlated with the two COVID-19 endogenous regressors. The control function estimates for the MFN tariffs have the same direction as the baseline regression model for all NTM purposes. The effect of export values is significant for restricting-purpose NTMs, while the coefficients for import values are insignificant. The exchange rate parameters show a similar magnitude and direction, as indicated in the baseline model. The dietary supply-level coefficient is significant for facilitating NTMs. This result implies that the higher a country's dietary supply level, the lower the likelihood of imposing facilitating-purpose NTMs, which is in line with our hypothesis on the role of dietary supply. We also found that a higher number of domestic COVID-19 cases related negatively to NTM notifications for trade facilitation, consistent with the results shown in the baseline model. An increase in the number of worldwide COVID-19 cases has a positive effect on facilitating and restricting NTMs, and these effects are more considerable than those in the baseline model.

Table 4. Control Function Estimation

	Dummy Variables		
Dependent variables	**NTM**	**Facilitation**	**Restriction**
Explanatory variables			
Log (MFN +1)	-0.008*	-0.008**	0.103***
	(0.004)	(0.004)	(0.025)
Log (export values), 12 months lag	0.000	0.000	0.004*
	(0.000)	(0.000)	(0.002)
Log (import values), 12 months lag	0.000	0.000	-0.002
	(0.000)	(0.000)	(0.002)
Log (exchange rate), 1 month lag	-0.400*	-0.349	-12.170***
	(0.328)	(0.361)	(3.300)
Dietary supply, 12 months lag	-0.289***	-0.260***	-0.813
	(0.065)	(0.062)	(0.482)
Log (COVID-19, home country), 1 month lag	-0.425***	-0.425***	0.146
	(0.101)	(0.093)	(0.793)
Log (COVID-19, rest of the world), 1 month lag	0.593***	0.593***	0.400
	(0.060)	(0.057)	(0.588)
Residual (COVID-19, home country)	0.332**	0.335***	-0.100
	(0.133)	(0.123)	(0.801)

Table 4. (continued)

	Dummy Variables		
Dependent variables	**NTM**	**Facilitation**	**Restriction**
Explanatory variables			
Residual (COVID-19, rest of the world)	-0.249***	-0.248***	0.050
	(0.066)	(0.063)	(0.440)
Constant	31.382***	27.751***	92.691
	(8.200)	(6.454)	(65.779)
Pseudo R2	0.889	0.896	0.841
N	1,356,240	1,318,104	230,400
Instruments	COVID-19, home	COVID-19, world	
Log (GDP per capita), 12 months lag	14.493	53.407***	
	(8.784)	(16.658)	
Agricultural employment rate, 12 months lag	-2.800***	-3.951***	
	(0.703)	(1.101)	
Agricultural GDP (percent of GDP), 12 months lag	-7.134***	-8.508***	
	(0.619)	(0.540)	
Constant	-392.488***	-1,034.764	
	(104.285)	(209.162)	
F-statistics	42.164	87.562	
Adjusted R^2	0.282	0.298	
N	1,356,240	1,356,240	

Notes: The lower part of the table indicates the instruments used in the first stage, and the upper part of the table shows the outcome of the second stage. Standard errors are presented in parentheses, with clustering at year-month level and 1,000 replications of bootstrapping. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.

Table 5 shows control function estimates conditional on COVID-19-related NTMs implemented earlier. The coefficients for MFN tariff rates and the trade values were insignificant, but the exchange rate coefficients correlated strongly with NTMs. We found that a 1% increase in the exchange rate is associated with a 0.97% decrease for restricting-purpose NTMs. Dietary supply level also becomes significant for both NTM types, implying that higher dietary supply level in a country correlates with COVID-19-related NTMs. The COVID-19 coefficients show similar magnitude, as indicated in the first control function, meaning that the number of COVID-19 cases is associated with implementing additional NTMs.

Table 5. Control Function Estimation Conditional on NTMs

		Dummy Variables		
Dependent variables		**NTM**	**Facilitation**	**Restriction**
Explanatory variables				
Log (MFN +1)		-0.004*	-0.004	-0.002
		(0.002)	(0.002)	(0.006)
Log (Export values), 12 months lag		0.000	0.000	0.000
		(0.000)	(0.000)	(0.001)
Log (Import values), 12 months lag		0.000	0.000	-0.001**
		(0.000)	(0.000)	(0.000)
Log (Exchange rate), 1 month lag		0.244	0.274	-3.612**
		(0.168)	(0.266)	(1.731)
Dietary supply, 12 months lag		-0.299***	-0.257***	-1.406***
		(0.048)	(0.049)	(0.305)
NTM (Dummy) X Log (COVID-19 cases, home country), 1 month lag				
	0	0	0	0
		(omitted)	(omitted)	(omitted)
	1	-0.515***	-0.522***	-0.374*
		(0.078)	(0.078)	(0.235)
NTM (Dummy) X Log (COVID-19 cases, rest of the world), 1 month lag				
	0	0	0	0
		(omitted)	(omitted)	(omitted)
	1	0.618***	0.623***	0.661***
		(0.055)	(0.056)	(0.160)
Residual (COVID-19 cases, home country)		0.398***	0.405***	0.304
		(0.111)	(0.112)	(0.235)
Residual (COVID-19 cases, rest of the world)		-0.261***	-0.264***	-0.205
		(0.064)	(0.064)	(0.114)
Constant		31.699***	26.336***	117.032***
		(6.575)	(6.198)	(30.977)
Pseudo R2		0.939	0.943	0.981
N		1,305,984	1,273,527	168,801

Notes: The instruments are presented in Table 4. Standard errors are presented in parentheses with clustering at year-month level and 1,000 replications of bootstrapping. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.

A comparison of the control function results for SPS and TBT is shown in Table 6. MFN tariff rates are positively correlated with SPS notification, but the effect is small, whereas the impact of MFN is negligible for TBT. A 1% increase in the exchange rate is associated with a 0.6% decrease in the likelihood of implementing a TBT. Exchange rates are also negatively correlated with both SPS and TBT, but the TBT effect is larger compared to that for SPS. The dietary supply level affects TBT more than SPS, implying that TBT measures are more likely to decrease the food security level. COVID-19 cases in the home country are associated with SPS but not with TBT, whereas those in the rest of the world tend to increase both SPS and TBT. These findings indicate that countries with an increasing number of COVID-19 cases domestically are more likely to respond with SPS notifications. The response to the growing number of foreign COVID-19 cases shows that both SPS and TBT are the trade actions of choice for most trade policymakers.

Table 6. Control Function Estimation on SPS and TBT

	Dummy Variables	
Dependent variables	**SPS**	**TBT**
Explanatory variables		
Log (MFN +1)	-0.010**	-0.006**
	(0.004)	(0.012)
Log (Export values), 12 months lag	0.000	0.002***
	(0.000)	(0.001)
Log (Import values), 12 months lag	0.000	0.001
	(0.000)	(0.001)
Log (Exchange rate), 1 month lag	-0.405*	-26.064***
	(0.338)	(8.043)
Dietary supply, 12 months lag	-0.312***	-0.779***
	(0.064)	(0.800)
Log (COVID-19 cases, country), 1 month lag	-0.428***	0.165
	(0.105)	(0.278)
Log (COVID-19 cases, rest of the world), 1 month lag	0.597***	0.552**
	(0.066)	(0.383)
Residual (COVID -19 cases, home country)	0.340**	-0.081
	(0.138)	(0.560)
Residual (COVID-19 cases, rest of the world)	-0.257***	0.198***
	(0.068)	(0.277)
Constant	34.287***	133.159***
	(8.015)	(109.376)
Pseudo R^2	0.878	0.868
N	1,327,200	987,360

Notes: The instruments are presented in Table 4. Standard errors are presented in parentheses with clustering at year-month level and 1,000 replications of bootstrapping. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.

Product Heterogeneity

Figure 4 summarizes control function estimates including interaction terms composed of product category and the COVID-19 variables. The corresponding coefficients and bootstrap standard errors are presented in Table 7. The interaction effects allowed us to investigate the product heterogeneity depending on the number of COVID-19 cases in the home country and the rest of the world. The estimates provide no evidence for differences in the product effects for domestic COVID-19 cases. The results indicate that trade facilitation NTMs have been imposed across all types of products. In the presence of increasing COVID-19 numbers in the rest of the world, all interaction terms are statistically significant. The interaction effects do not vary across product categories for facilitating-purpose NTMs, while some evidence of product heterogeneity is observed for restricting-purpose NTMs. Semiprocessed products tend to be correlated with restricting-purpose NTMs, followed by primary bulk commodities and processed products. Aquaculture and horticulture are less likely to affect the incidence of NTMs for trade restrictions than the other products. These estimation results allow us to conclude that product heterogeneity does not play a significant role for COVID-19-related NTMs.

Table 7. Product Heterogeneity in the COVID-Related NTMs

	Dummy Variables		
Dependent variables	**NTM**	**Facilitation**	**Restriction**
Explanatory variables			
Log (MFN +1)	-0.008**	-0.008**	0.099***
	(0.004)	(0.004)	(0.018)
Log (Export values), 12 months lag	0.000	0.000	0.004*
	(0.000)	(0.000)	(0.002)
Log (Import values), 12 months lag	0.000	0.000	-0.002
	(0.000)	(0.000)	(0.002)
Log (Exchange rate), 1 month lag	-0.415	-0.361	-11.566***
	(0.326)	(0.358)	(3.299)
Dietary supply, 12 months lag	-0.294***	-0.265***	-0.951
	(0.068)	(0.064)	(0.641)
Product X Log (COVID-19 cases, home country), 1 month lag			
Aquaculture	-0.436***	-0.433***	-0.048
	(0.101)	(0.094)	(0.744)
Primary Bulk Commodities	-0.430***	-0.427***	-0.066
	(0.103)	(0.095)	(14.641)
Horticulture	-0.435***	-0.432***	-0.048
	(0.101)	(0.093)	(0.740)
Semi-processed	-0.430***	-0.427***	-0.062
	(0.104)	(0.095)	(14.684)
Processed	-0.437***	-0.434***	-0.048
	(0.100)	(0.092)	(0.739)
Product X Log (COVID-19 cases, rest of the world), 1 month lag			
Aquaculture	0.581***	0.584***	0.421
	(0.059)	(0.057)	(0.504)
Primary bulk commodities	0.613***	0.606***	1.059
	(0.063)	(0.060)	(84.807)
Horticulture	0.608***	0.603***	0.677
	(0.064)	(0.061)	(0.508)
Semi-processed	0.613***	0.607***	1.108
	(0.063)	(0.060)	(85.123)
Processed	0.607***	0.601***	0.794
	(0.064)	(0.061)	(0.497)
Residual (COVID-19 cases, home country)	0.342**	0.341***	0.069
	(0.133)	(0.124)	(0.764)
Residual (COVID-19 cases, rest of the world)	-0.257***	-0.253***	-0.020
	(0.067)	(0.064)	(0.428)
Constant	32.077***	28.309***	99.998
	(8.484)	(8.131)	(95.591)
Pseudo R^2	0.890	0.897	0.870
N	1,356,240	1,318,104	230,400

Notes: The instruments are presented in Table 4. Standard errors are presented in parentheses with clustering at year-month level and 1,000 replications of bootstrapping. Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 10%, 5%, and 1% level.

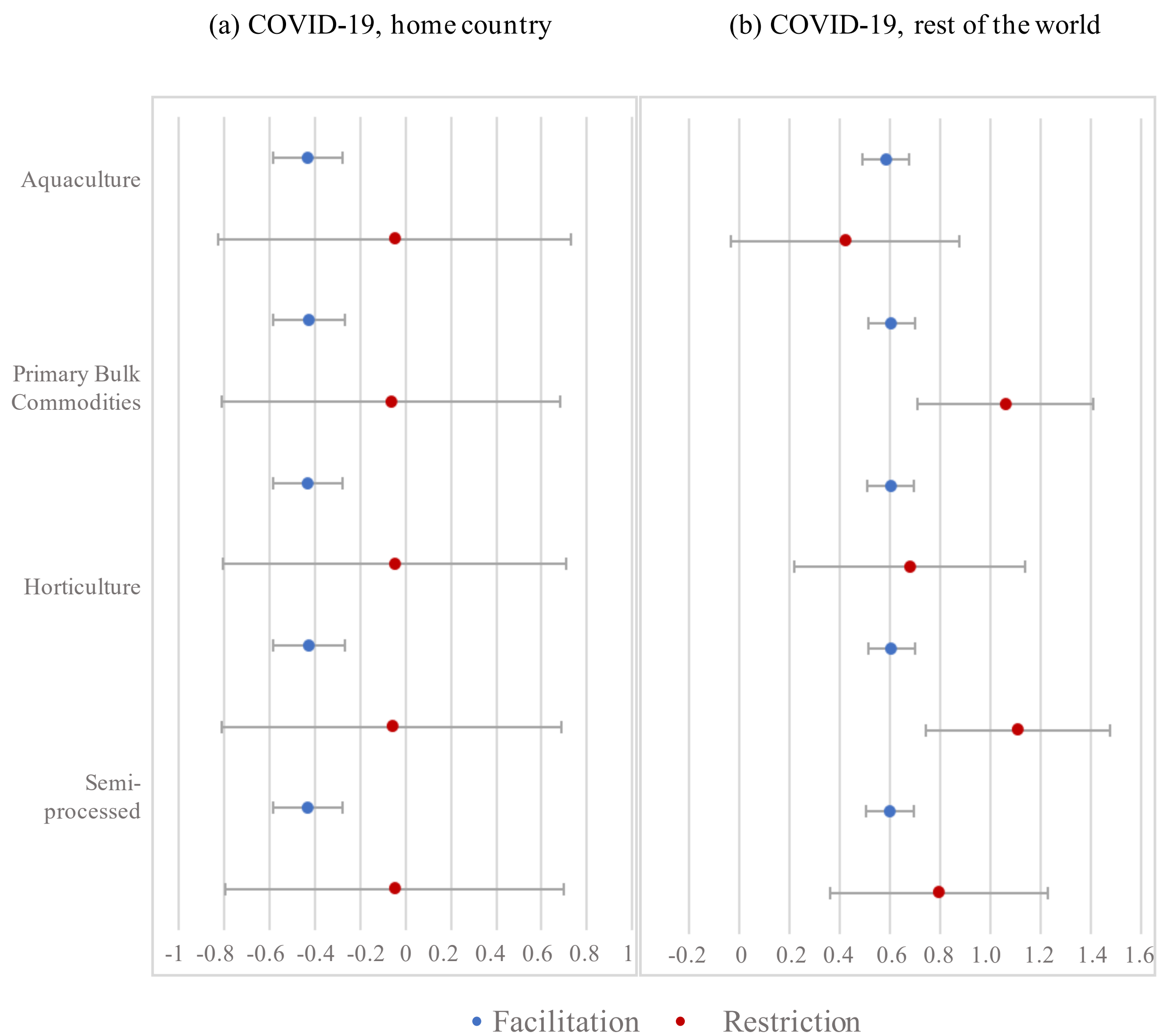


Figure 4. Product Heterogeneity of the COVID-related NTMs

Conclusion

This paper presents results of an analysis of the relationship between COVID-19 case numbers and NTMs in the agricultural and food sector implemented in response to the coronavirus pandemic. We estimated the association based on a product-level dataset on trade-restricting and facilitating-NTMs for 2020. Our count data regressions controlled for product and country fixed effects. We used a control function approach to account for endogeneity concerns caused by measurement error in the COVID-19 case numbers. Our IV estimates indicated a negative association between COVID-19 cases numbers and NTMs in the implementing country and a positive association for the rest of the world, which is an indication of countries' awareness on the pandemic circumstance. Our main findings were driven by a lower probability of trade-facilitating trade actions among countries with a significant increase in COVID-19 numbers. The effect on trade-restricting NTMs has the opposite sign but is statistically insignificant. We found that the further propagation of the coronavirus pandemic relates positively to the number of NTMs implemented. Depending on whether countries already implemented a COVID-19-related NTM, the probability to impose further measures correlates negatively with the number of COVID-19 cases in the country. Our results indicate that countries tend to impose COVID-19-related NTMs based on their dietary supply level for trade facilitation actions. We found limited evidence for a heterogeneous effect of COVID-19 cases in the home country on NTMs. Similar patterns can be observed for differences among SPS and TBT measures. These findings shed light on the role of COVID-19 trade actions by investigating factors that drive countries to implement NTMs during the coronavirus pandemic. Although NTMs are considered trade barriers (Crivelli and Gröschl, 2016; Orefice, 2017), they can be reasonable measures for trade facilitation during an emergency. At the beginning of the pandemic, policymakers were concerned about trade restrictions. Our findings show that the effects of COVID-19 numbers are more correlated with facilitating trade than restricting it in the agricultural and food sector. These results highlight the government's efforts to keep the supply chain running smoothly, especially in the presence of panic-buying during the early stages of the pandemic (Kerr, 2020).

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