COVID-19 Trade Actions and Their Impact on the Agricultural and Food Sector

Soojung Ahn, University of Connecticut, soojung.ahn@uconn.edu

Sandro Steinbach, University of Connecticut, sandro.steinbach@uconn.edu

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Soojung Ahn Sandro Steinbach

Abstract

This paper assesses the determinants of temporary non-tariff measures (NTMs) in response to the coronavirus pandemic and their implications for agricultural and food trade. Using a control function approach, we show that economic and pandemic considerations played an essential role in implementing such NTMs. Relying on variation between treated and untreated varieties, we estimate a dynamic post-event trade response of 29.9 percent for import facilitating and -10.7 percent for export restricting NTMs. After revoking them, their trade effects fade away, implying that they were effective in achieving the set policy goals, causing only a limited degree of long-term trade disruptions.

JEL: F13, Q17

Keywords: COVID-19, non-tariff measures, determinants, trade effects, control function, dynamic treatment effects, agricultural and food sector

[*] Soojung Ahn, Department of Agricultural and Resource Economics, University of Connecticut, email: soojung.ahn@uconn.edu; Sandro Steinbach, Corresponding Author, Department of Agricultural and Resource Economics, University of Connecticut, email: sandro.steinbach@uconn.edu. This work is supported by the National Institute of Food and Agriculture through the Agriculture and Food Research Initiative Award 2019-67023-29343. Any opinions, findings, conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the United States Department of Agriculture. We are thankful to Colin A. Carter, Steven Zahniser, and participants of the 2022 ASSA Annual Meeting for comments on an earlier version of this paper.

1. Introduction

The agricultural and food sector is highly integrated into the global economy (Lim, 2021; Yi et al., 2021). Although trade frictions between countries have been lowered by eliminating tariffs through multilateral and regional integration, this shift coincided with the growing use of various new trade measures (Shepotylo et al., 2021; Santeramo & Lamonaca, 2019). Among them, non-tariff measures (NTMs) are particular concern for their potentially adverse trade effects (Curzi et al., 2020; Beghin et al., 2015). NTMs are defined as trade policies that can have an economic effect on international trade (Hoekman & Nicita, 2011). Among others, trade restricting NTMs include quotas, embargoes, sanctions, and levies (Gruère & Brooks, 2021; Beckman & Arita, 2017). In contrast, trade facilitating NTMs are put in place to promote the exchange of goods across international borders (Ahn & Steinbach, 2021; Grübler & Reiter, 2021). Amid the ongoing debate over the role of NTMs, the pandemic has been used by various countries to justify the use of additional NTMs (Chen & Mao, 2020). The rapid increase in COVID-19 cases resulted in a growing demand for certain products directly related to human health and disease prevention, prompting several governments to attempt to secure priority access to these products by imposing import facilitating or export restricting NTMs (World Trade Organization, 2020). These COVID-19 related NTMs are distinct from the more traditional NTMs. They were imposed temporarily in response to the public health crisis and fears about supply chain bottlenecks, targeting various agricultural and food products (Ker & Cardwell, 2021).

A substantial literature assesses the diverse trade effects of NTMs, paying particular attention to the NTM type and both industry and regional differences (e.g., Curzi et al., 2020; Peterson et al., 2013; Disdier et al., 2008). These studies reveal substantial heterogeneity in the trade response to NTMs. For example, Curzi et al. (2020) find that the most restrictive standards raised as specific trade concerns (STCs) negatively affect firm-level trade margins, while sanitary and phytosanitary (SPS) and technical barriers to trade (TBT) can have positive effects on such margins. Peterson et al. (2013) find that SPS measures reduce trade, but the negative impact diminishes over time as exporters adapt to the new trading standards. According to Disdier et al. (2008), SPS and TBT significantly reduce exports from developing to developed countries, revealing considerable treatment heterogeneity. The coronavirus pandemic acted like a trade impediment as governments implemented public health and trade policies to combat the disease (Evenett et al., 2021). In response to the disease, agricultural and food trade fell by 5 to 10 percent, while the estimated trade effects are more substantial for the non-agricultural sector (Arita et al., 2022). Even for countries that are part of the same trading block, the overall reduction in trading volumes was considerable (Barbero et al., 2021). **Figure 1** provides an overview of import facilitating and export restricting NTMs implemented in response to the pandemic. Panel (A) shows that NTM implementations clustered around April and May 2020, while Panel (B) indicates that most policies were revoked after five months. Several studies analyzed the drivers of these temporary trade measures. Gruère and Brooks (2021) find strong justification for COVID-19 related NTMs implemented in the first quarter of 2020, pointing toward their potential to cause market disruptions. Lee and Prabhakar (2021) discuss implications for Sustainable Development Goals (SDG), while Ahn and Steinbach (2021) examine the determinants of COVID-19 NTMs. Focusing on NTMs implemented in Spring 2020, their results show that countries reacted to COVID-19 case numbers when implementing trade facilitating or restricting NTMs.

This paper assesses the determinants and trade effects of COVID-19 related NTMs targeting the agricultural and food sector. We compiled a comprehensive dataset on temporary trade measures and linked it to a unique dataset on monthly trade flows at the HS subheading level for a large set of countries. Our identification strategy relies on variation between treated and untreated *varieties* (product-country pairs), which allows us to tease out the treatment effects of COVID-19 related NTMs. First, we used a control function approach to investigate the determinants of COVID-19 related NTMs. Our results show that higher domestic COVID-19 case numbers reduce the probability of a country implementing an import facilitating NTM against a specific *variety*. In contrast, we find that an elevated foreign COVID-19 prevalence has a large and significant impact on import facilitating NTMs. The estimates for export facilitating NTMs are lower and statistically less significant. We also find that a higher domestic COVID-19 prevalence correlates positively with export restricting NTMs, while the oppositive effect holds for foreign COVID-19 case numbers. Second, turning to the trade effects of COVID-19 related NTMs for the agricultural and food sector, we find that import facilitating NTMs caused an average post-event increase of 29.9 percent in import volumes. In comparison, we find a 10.7 percent reduction in trade volumes for export restricting NTMs. These dynamic treatment effects are most substantial within the first five months after implementing a temporary trade measure, leading to average post-event treatment effects of 55.7 percent for import facilitating and -35.2 percent for export restricting NTMs on targeted *varieties* during the same period. These results hold up to a battery of robustness checks and point toward the presence of treatment dynamics that the traditional static regression approach for assessing NTMs cannot address. Note that the dynamic trade effects of import facilitating and export restricting NTMs fade away after the revocation of these temporary trade measures, implying that they effectively achieved the set policy goals and caused only a limited degree of long-term trade disruptions.

The paper provides three distinct contributions to the growing literature on NTMs and the trade effects of the coronavirus pandemic for the agricultural and food sector. First, we are the first to assess the impact of COVID-19 related import facilitating and export restricting NTMs on the agricultural and food sector using a credible causal inference design that relies on variation between treated and untreated *varieties* (product-country pairs) over time. Earlier studies concerned with the impact of COVID-19 on agricultural and food trade have ignored the differential impacts caused by these temporary trade measures (Arita et al., 2022; Evenett et al., 2021; Lee & Prabhakar, 2021). Our paper is the first to show that these policies play an essential role by shaping trade patterns of targeted agricultural and food *varieties*. Furthermore, we prove that they effectively achieved the set policy goals while we are finding only limited evidence of long-term trade disruptions. These results indicate that temporary trade measures play a significant role as agricultural trade costs (Beghin & Schweizer, 2021; Disdier & Van Togeren, 2010). Second, we contribute to the empirical literature concerned about the trade effects of NTMs. All related studies rely on static regression models to assess the trade implications of temporary trade policies (e.g., Hoekman et al., 2021; Santeramo & Lamonaca, 2019). However, as we show in this paper, it is essential to consider the dynamic treatment effects caused by NTMs. We show that the static approach is incapable of accounting for the observed dynamic treatment paths, resulting in estimation bias in the presence of significant pretrends (Sun & Abraham, 2021; Rambachan & Roth, 2019). Third, we provide a nuanced discussion on trade facilitating and restricting NTMs. Most studies concerned with these temporary trade policies focus on their role in hampering international trade (Koppenberg et al., 2021; Mallory, 2021). Our paper is the first to document differential trade effects for import facilitating and export restricting NTMs. The average post-event trade effects are more significant for import facilitating than for export restricting NTMs, pointing toward the fact that a temporary trade barrier reduction can be highly beneficial in times of public emergencies to achieve particular trade policy goals.

2. Methods and Data

2.1. COVID-19 related NTM Determinants

We use a linear regression model to identify the determinants of COVID-19 related NTMs. The baseline specification includes economic and pandemic-related measures as covariates. Because we are concerned about potential unobserved confounders causing measurement error in the domestic and foreign COVID-19 case numbers, we use a control function approach to account for the potential source of endogeneity. We believe that the time-invariant product-year and time fixed effects cannot adequately address the endogeneity concern, prompting us to control for this source of time-variant endogeneity bias by modeling the endogeneity in the error term via control functions (Heckman & Robb, 1985; Telser, 1964). We deploy the two-stage approach popularized Terza et al. (2008) and include the first-stage residuals as additional regressors in the second-stage regressions. The approach requires fewer assumptions than maximum likelihood and is computationally straightforward, an essential feature for a large dataset with high-dimensional fixed effects (Wooldridge, 2015*a*). Because the second-stage errors are asymptotically biased, we bootstrapped them by replacing them within product-country pairs for 1,000 replications. The second stage regression takes the following generalized form:

$$NTM_{ikt} = \beta_E E_{ikt} + \beta_C C_{it} + \beta_R R_{ikt} + \alpha_{ik} + \gamma_t + \varepsilon_{ikt} \, , \qquad (1)$$

where we denote the country with i, the product with k, and the time with t. The model controls for the influence of unobserved factors that could confound the relationship of primary interest with product-country α_{ik} and time γ_t fixed effects. The specification resembles the classical two-way fixed effects regression (Wooldridge, 2010).[1]

The dependent variable NTM_{ikt} takes the value one if a *variety* (product-country pair) is treated with an NTM. We distinguish between import and export facilitating and restricting NTMs. Note that there are only few import restricting and export facilitating NTMs, prompting us to be cautious about the interpretation of these parameter estimates. The set of economic explanatory variables E_{ikt} includes the applied tariff level, the twelve-month lagged trade values, the one-month lagged exchange rate, and the twelve-month lagged food security level. We use the lagged domestic and foreign positive COVID-19 cases C_{it} as the primary variables of interest, as we aim to understand how COVID-19 case numbers shaped the decision of policymakers to implement COVID-19 related NTMs. Since we are concerned about the potential endogeneity of the reported COVID-19 cases, which is a particular concern for the beginning of the pandemic (Lau et al., 2020), we use three instruments to account for this source of measurement error. We include the income per capita, the agricultural employment rate, and the agricultural GDP as instrumental variables in the first stage regression. The income per capita correlates strongly with the testing and vaccine capabilities of a country (Nhamo et al., 2021), while the agricultural employment rate and the agricultural GDP account for the development stage and access to healthcare services, which are critical drivers of reported COVID-19 case numbers (Kilani & Georgiou, 2021; Giri & Rana, 2020). They are all unlikely to be correlated with the probability of a country implementing a COVID-19

[1] Note that the policy implementation is highly clustered around March and April 2020. Hence, we are not concerned about the research design being biased due to staggered adoption (Athey & Imbens, 2021) and differences in treatment timing (Goodman-Bacon, 2021).

related NTM against a particular *variety*. We use the predicted residuals R_{ikt} in the second stage regression to control for the measurement bias caused by misreported COVID-19 case numbers.

2.2. Trade Effects

We use a gravity-type regression specification to assess the impact of COVID-19 related NTMs on agricultural and food trade. The identification strategy builds on Grant et al. (2021) and Arita et al. (2022), which used a similar research design and a static regression model to investigate the trade effects of the 2018 China-U.S. trade war and the coronavirus pandemic. The baseline model is specified as follows:

$$\log(y_{ikt}) = \beta_1 NTM\_f_{ikt} + \beta_2 NTM\_r_{ikt} + \alpha_{ik} + \gamma_{it} + \delta_{kt} + \varepsilon_{ikt}, \qquad (2)$$

where we denote the country with i, the product with k, and the time with t. The model controls for the influence of unobserved factors that confound the relationship of primary interest with product-country α_{ik}, country-time γ_{it}, and product-time δ_{kt} fixed effects. We allow the country and product fixed effects to be flexible over time because multiple unobserved factors are likely to determine product demand and supply. An advantage of this specification is that it accounts for shocks resulting from unobserved changes in the demand and supply patterns for agricultural and food products. For instance, the demand for ethyl alcohol is strongly driven by domestic demand and supply factors that are largely unobserved during the coronavirus pandemic. The same holds for restrictions on grain exports, as they were imposed by the Russian Federation in April 2020. Therefore, by allowing the fixed effects to be flexible over time, we can account for these unobserved shocks and threats to our identification strategy. We denote the additive error term by ε_{ikt}. The terms $\beta_1 NTM\_f_{ikt}$ and $\beta_2 NTM\_r_{ikt}$ measure the treatment effects of COVID-19 related NTMs on agricultural and food trade. We estimate the trade effects of facilitating and restricting

NTMs jointly. The baseline model is static, i.e., we assume that the treatment effects do not vary before and after the policy change.[2] The identification strategy relies on variation between treated and untreated *varieties* (product-country pairs) over time, building on earlier work by Carter and Steinbach (2020), Fajgelbaum et al. (2020), and Flaaen et al. (2020). Our approach builds on the parsimonious assumption that all latent confounders are invariant at the product-country level and are thus captured by α_{ik}, or are time-variant at the product and country level and are thus captured by γ_{it} and δ_{kt}.

The outcome variable is denoted by y_{ikt}, representing the import and export value, quantity, and unit value. Note that we address level differences between products and countries through the product-country fixed effects. We log-transformed the outcome and rely on a heteroskedasticity-robust version of the log-linear estimator to identify the parameters of interest (Wooldridge, 2015*b*). We account for the high-dimensional fixed effects by using a modified version of the iteratively re-weighted least-squares (IRLS) algorithm robust to statistical separation and convergence issues (Correia et al., 2019, 2020). Following standard practice in the international economics literature, we suspect the standard errors to be correlated at the product-country level, prompting us to cluster them at this level (Weidner & Zylkin, 2021; Yotov et al., 2017; Cameron & Miller, 2015).

2.3. Data

Data on COVID-19 related NTMs comes from the WTO's NTM database (World Trade Organization, 2021). The WTO has collected such data from member countries going back to

[2] We also conduct a robustness check that allows the treatment effects to vary before and after the policy change. The dynamic estimates for (2) are reported in Section 3.2.

January 2020. We classify them according to their purpose into trade restricting and facilitating NTMs and distinguish between export and import trade policies. Note that all NTMs are discriminatory at the *variety* level. **Figure 2** ranks countries that implemented COVID-19 related NTMs in Panel (A) and shows HS chapters targeted by these policies in Panel (B). 58 countries implemented COVID-19 related NTMs in the agricultural and food sector. These policies targeted products listed under 100 different HS subheadings. Overall, we find that 1,177 *varieties* were targeted by these temporary trade policies, equaling a treatment frequency of about 2 percent. We obtained monthly agricultural import data at the Harmonized System (HS) subheading level (HS6) for 87 countries from January 2018 to June 2021 from the Global Trade Atlas (GTA) (IHS Markit, 2021). Data on COVID-19 positive cases comes from the Center for Systems Science and Engineering at Johns Hopkins University (Dong et al., 2020). Based on their database, we generate the number of monthly domestic and foreign positive cases for each country. Applied tariff rates at the HS 6-digit product level were derived from the Tariff Analysis Online (World Bank, 2021*a*). We obtained the monthly exchange rates for each national currency per US-$ from the International Financial Statistics (International Monetary Fund, 2021). We calculated the first lag for the exchange rate and monthly COVID-19 cases. Data on food security levels comes from FAOSTAT (Food and Agriculture Organization, 2021). We used the 12-months lagged average dietary energy supply adequacy as a proxy for food security. GDP per capita, agricultural employment rates, and agricultural GDP come from the World Development Indicators (World Bank, 2021*b*). We used these variables as instruments to account for the endogeneity of monthly COVID-19 cases. We converted them into 12 months lagged weighted variables. Our final balanced dataset covers 87 countries and 920 agricultural and food products at the HS subheading level for January 2019 to June 2021.[3] We provide the descriptive statistics in **Table 1**.

3. Results and Discussion

3.1. COVID-19 related NTM Determinants

We report the control function estimates for the determinants of COVID-19 related NTMs in **Table 2**. Panel (A) shows the second stage and Panel (B) the first stage estimates. The first stage instrumental variables are highly relevant, as shown in Panel (B). The regressions explain a significant share of the observed variation, as indicated by the adjusted R-squared. The large Kleibergen-Paap F statistics prove that the instrumental variables are relevant. Focusing on Panel (B), we find that the first stage residuals are significant for import facilitating and export facilitating and restricting NTMs but not for import restricting NTMs. This limited statistical power for the import restricting policies results from the low number of NTMs implemented to restrict agricultural and food imports. We find that higher domestic COVID-19 cases reduce the probability of a country implementing a COVID-19 related import facilitating NTM against a specific *variety*. In contrast, higher foreign COVID-19 case numbers have a large and statistically significant impact on import facilitating NTMs. The results look similar for export facilitating NTMs, but the parameter estimates tend to be smaller and statistically less significant. Similarly, we find that higher domestic COVID-19 case numbers correlate positively with the implementation of export restricting NTMs. At the same time, an increased COVID-19 prevalence in foreign countries causes trade policymakers to implement fewer NTMs that restrict agricultural

[3] Note that we dropped singletons at the *variety* level from this dataset following the approach outlined by (Correia et al., 2019, 2020).

and food exports. These results indicate that countries react to COVID-19 case numbers when implementing trade facilitating or restricting NTMs (Evenett et al., 2021). It is worth noting the observed correlations for some of the economic explanatory variables. We find that *varieties* with a higher MFN ad-valorem tariff are less likely to be targeted with a trade facilitating NTM. Similarly, we find that countries target *varieties* more with trade facilitating NTMs when they trade less in them and are more likely to restrict their export. In addition, note that countries with a stronger domestic currency are more likely to implement import facilitating and export restricting NTMs. Lastly, we find that countries that are more food secure tend to be more likely to implement import and export facilitating NTMs. Overall, these results reveal essential correlations about the factors that determine the implementation of COVID-19 related NTMs on specific agricultural and food *varieties*.

3.2. Trade Effects

We report the treatment effects of COVID-19 related NTMs for agricultural and food trade in **Table 3**. The table is organized according to import and export and distinguishes between quantity, value, and unit value. Note that all regression includes product-country, country-time, and product-time fixed effects. We find positive trade effects of trade facilitating NTMs for import quantity and value.[4] The trade effects are more pronounced for import quantity (30 percent) than for import value (21.3 percent), pointing toward an adverse price effect for targeted *varieties*. However, the price effect (-7.1 percent) is insignificant at conventional levels of statistical significance. We also find strong evidence for adverse treatment effects of trade restricting NTMs for import quantity,

[4] We obtained the trade effects for the log-linear regression by transforming the parameter estimates with the formula $\exp(\hat{\beta}_k) * 100$ (Silva and Tenreyro, 2006). Note that the static approach could lead to estimation bias in the presence of dynamic treatment effects.

value, and price. Imports of targeted *varieties* are 58.9 percent lower than for the comparison group. The import value reacted stronger to restricting NTMs. We find a negative trade effect of -67.1 percent, pointing toward significant adverse price effects for targeted *varieties* of -18.8 percent. Overall, the results indicate that COVID-19 related NTMs targeting agricultural and food imports were effective in achieving the policy goals. In contrast, we find no evidence that export facilitating NTMs had a positive impact on agricultural and food exports. All parameter estimates are insignificant at conventional levels of statistical significance. We find that export restricting NTMs had no impact on the export quantity and value. Although the quantity trade effect (-10.3 percent) has the expected sign, the static model does not allow us to reject the null hypothesis, implying that there is no effect of trade restricting NTMs on agricultural and food exports. Note that the parameter estimate for export value is smaller than that for export quantity, providing some evidence for positive price effects. This effect is likely caused by higher unit values for targeted *varieties*, as indicated by the positive parameter estimate for unit value. In addition, it could be that the export restricting NTMs were effective in the early month after implementation, as the static regression approach could hide such treatment dynamics.

To assess the treatment dynamics underlying the observed trade effects, we implemented a linear panel regression approach with dynamic treatment effects (Freyaldenhoven et al., 2021):

$$\log\left(y_{ikt}\right) = \sum_{l=-12}^{12} \beta_{1,l} NTM\_f_{ik,t-k} + \sum_{l=-12}^{12} \beta_{2,l} NTM\_r_{ik,t-l} + \alpha_{ik} + \gamma_{it} + \delta_{kt} + \varepsilon_{ikt}\,, \qquad (3)$$

where we use the same subscripts and fixed effects as in (2). Instead of assuming static paths of the treatment coefficients, we now allow them to be dynamic before and after the treatment month. We center the event study according to the month when a *variety* was targeted by a facilitating or restricting NTM. The trade effects for facilitating and restricting NTMs are identified jointly. We use an event window of twelve months before and after the policy shift to measure the dynamic treatment effects, binning time periods outside of the event window. Deploying the parsimonious assumption that all latent confounders are either invariant at the product-country level or captured by the country-time and product-time fixed effects, we identify the dynamic treatment effects by relying on variation between treated and untreated *varieties* over time (Carter & Steinbach, 2020; Fajgelbaum et al., 2020). All standard errors are clustered at the product-country level.

Figure 3 depicts the dynamic parameter estimates for import facilitating and export restricting NTMs. We plot the event study coefficients, 95 percent confidence intervals, and uniform sup-t bands for the event-time of outcome y_{ikt} (Freyaldenhoven et al., 2021). We also overlay estimates from the static model and report the corresponding p-value for a Wald test. We conducted a Wald test for pre-event trends and tested for anticipatory behavior and the presence of a confound (Freyaldenhoven et al., 2019).[5] Because the treatment effect could be dynamic beyond the endpoints of the event window, we also conducted a Wald test for the null that the treatment dynamics level off. We find no evidence for significant pre-event trends at conventional levels of statistical significance for both outcomes. However, there is some evidence for leveling off treatment effects for policies still in effect. We find evidence for consistently increased agricultural

[5] Because a failure to reject the null hypothesis of no pre-event trends does not imply that there is no confound, we also estimate a devil's advocate model which assumes that the true value of the treatment effect is zero (Roth, 2020). We follow Rambachan and Roth (2021) and identify the least "wiggly" event-time path, which is, among polynomial confounds consistent with the estimated event-time path, the least "wiggly" path with the lowest polynomial order, and the coefficients with the lowest possible magnitude. We find that the event-time path for each outcome is "wiggly", making the existence of a confounding and unobserved variable implausible and implying that import facilitating and export restricting NTMs do causally affect agricultural and food trade. The corresponding parameter estimates are available upon request from the authors.

and food imports for treated *varieties* in the first five months post the treatment for trade facilitating NTMs. On average, imports increased by 55.7 percent during that period. In contrast, export restricting NTMs caused a reduction of trade flows for treated *varieties* by -35.2 percent during the same period.[6] The average post-event estimates are similar for the static and the dynamic model. We find a static effect of 29.9 percent and a dynamic effect of 30.8 percent for import facilitating NTMs. For export restricting NTMs, the static trade effect is -10.4 percent, while the dynamic trade effect is -10.7 percent. These results imply the presence of treatment dynamics that the traditional static regression approach cannot credibly address. Note that the dynamic trade effects of import facilitating and export restricting NTMs fade away after the corresponding policies were revoked, indicating that they are effective in achieving the set policy goals and cause a limited degree of long-term trade disruptions.[7]

Table 4 summarizes a robustness analysis for the trade effects of import facilitating and export restricting NTMs. We compare the baseline results in Panel (A) with regressions in which we limit the identifying variation to either cross-country in Panel (B) or cross-product variation in Panel (C). We report the average post-event treatment effects in Specification (1) and the ones for the first five months after NTM implementation in Specification (2). We find consistent evidence across Panels for positive trade effects of import facilitating NTMs in both specifications and

[6] We computed the average post-event estimates to summarize post-treatment dynamics following de Chaisemartin and D'Haultfoeuille (2020). An alternative approach is to report the contemporaneous treatment effect for β_1 and β_2 from the static model as overlayed in **Figure 3** (Gentzkow et al., 2011). Note that this statical approach is biased in the presence of dynamic treatment effects.

[7] Most COVID-19 related NTMs were revoked by Fall 2020. See **Figure 1** for the timeline of import facilitating and export restricting NTMs targeting the agricultural and food sector.

adverse trade effects of export facilitating NTMs in Specification (2). These effects operate primarily through trade volumes as we find no evidence for statistically significant price effects.

4. Conclusions

Modern agricultural and food trade policy involves the frequent use of NTMs to achieve a wide array of trade, such as restricting imports or exports, and non-trade policy goals, such as ensuring product safety, environmental protection, and national security (Grundke & Moser, 2019; Herghelegiu, 2018). Regardless of their purpose, NTMs can have various implications for the direction and volume of international trade (Santeramo & Lamonaca, 2019; Arita et al., 2017; Disdier & Van Tongeren, 2010). Since the coronavirus pandemic began, more than 58 countries have implemented NTMs that targeted the agricultural and food sector. This paper is the first to thoroughly examine the determinants and trade effects of these temporary trade measures. Combining a comprehensive NTM dataset with a unique dataset on monthly trade flows at the product level, we teased out the treatment effects of COVID-19 related NTMs relying on variation between treated and untreated *varieties* (product-country pairs) over time. Implementing a control function approach, we find that an increase in domestic COVID-19 case numbers reduces the probability of a country implementing an import facilitating NTM. In comparison, we find that an increase in the foreign COVID-19 prevalence rate has a large and significant impact on import facilitating NTMs. We also show evidence for a positive correlation between the domestic COVID-19 prevalence and export restricting NTMs. These findings point toward the interplay between public health and trade policies, indicating that the pandemic progression played an essential role in the decision of countries to implement import facilitating and export restricting NTMs against agricultural and food *varieties*.

By using a credible causal inference design that relies on variation between treated and untreated *varieties* over time to assess the impact of COVID-19 related import facilitating and export restricting NTMs on the agricultural and food sector, we documented a heterogeneous response of international trade to COVID-19 related NTMs. We find that import facilitating NTMs caused an average post-event increase of 29.9 percent in import volumes. In contrast, we find evidence for an adverse trade effect for export restricting NTMs, which is with -10.7 percent significantly smaller than that observed for facilitating NTMs for imports. These static estimates of trade effects caused by temporary trade measures hide substantial heterogeneity across time. The dynamic treatment effects are more substantial within the first five months after implementing a temporary trade measure. The average post-event treatment effects for import facilitating (55.7 percent) are more pronounced than those for export restricting NTMs (-35.2 percent). The static regression approach cannot credibly address these considerable treatment dynamics. The average post-event trade effects are more significant for import facilitating than for export restricting NTMs, pointing toward the fact that a temporary trade barrier reduction can be highly beneficial in times of public emergencies to achieve trade policy goals. After revoking these temporary trade measures, the dynamic trade effects fade away, implying that COVID-19 related NTMs caused only a limited degree of long-term trade disruptions.

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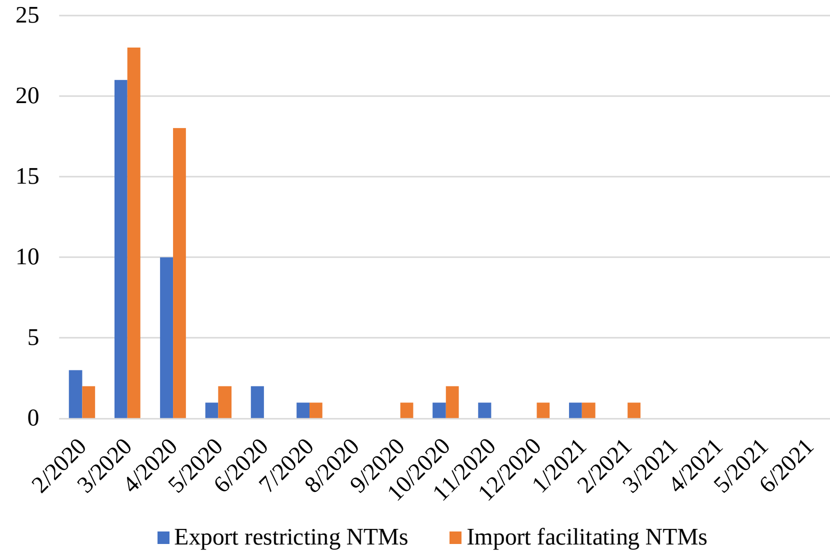
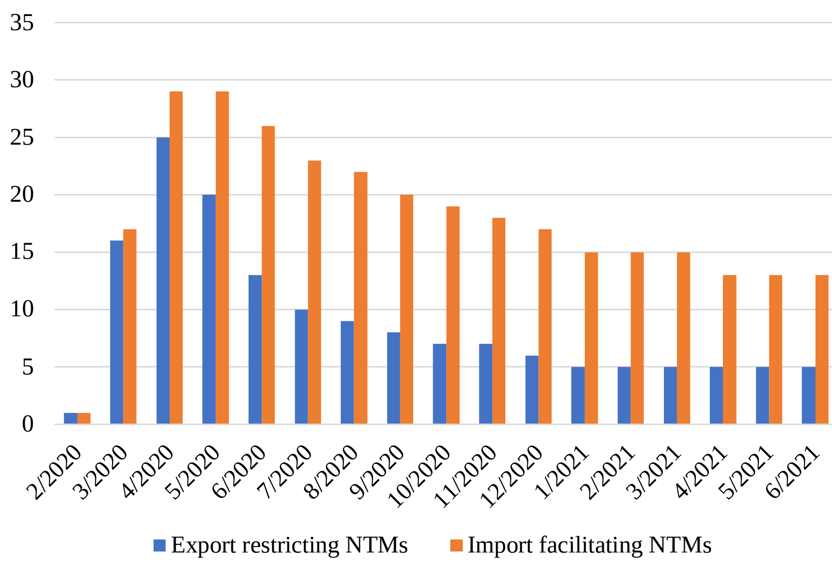
5. Figures and Tables

Figures

Figure 1. COVID-19 related NTMs in the agricultural and food sector.



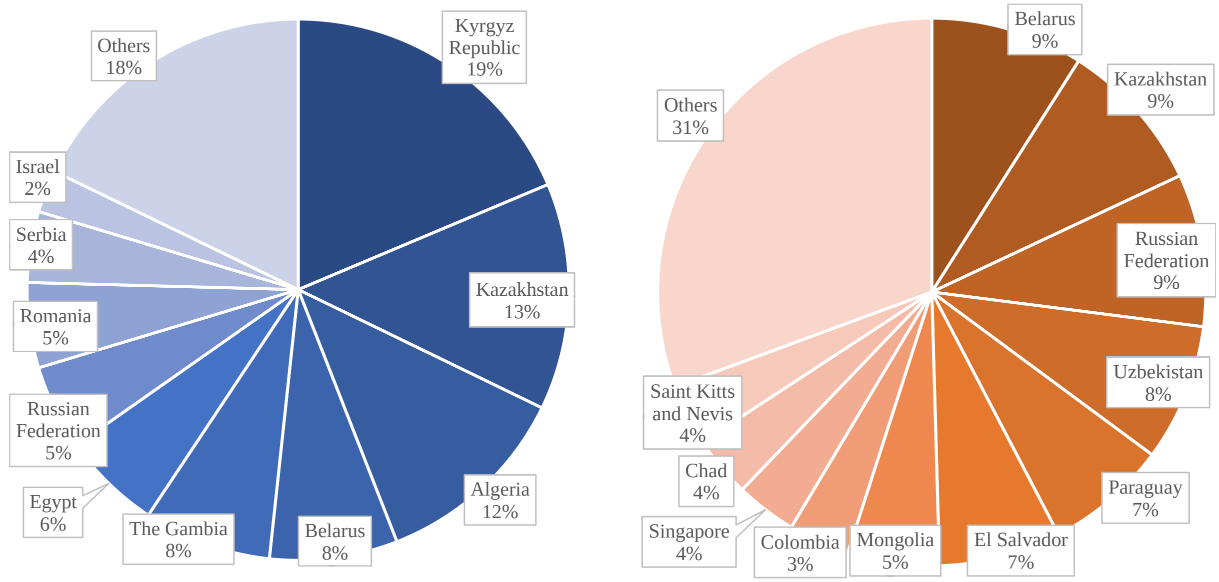
Panel (A): Newly enforced NTMs



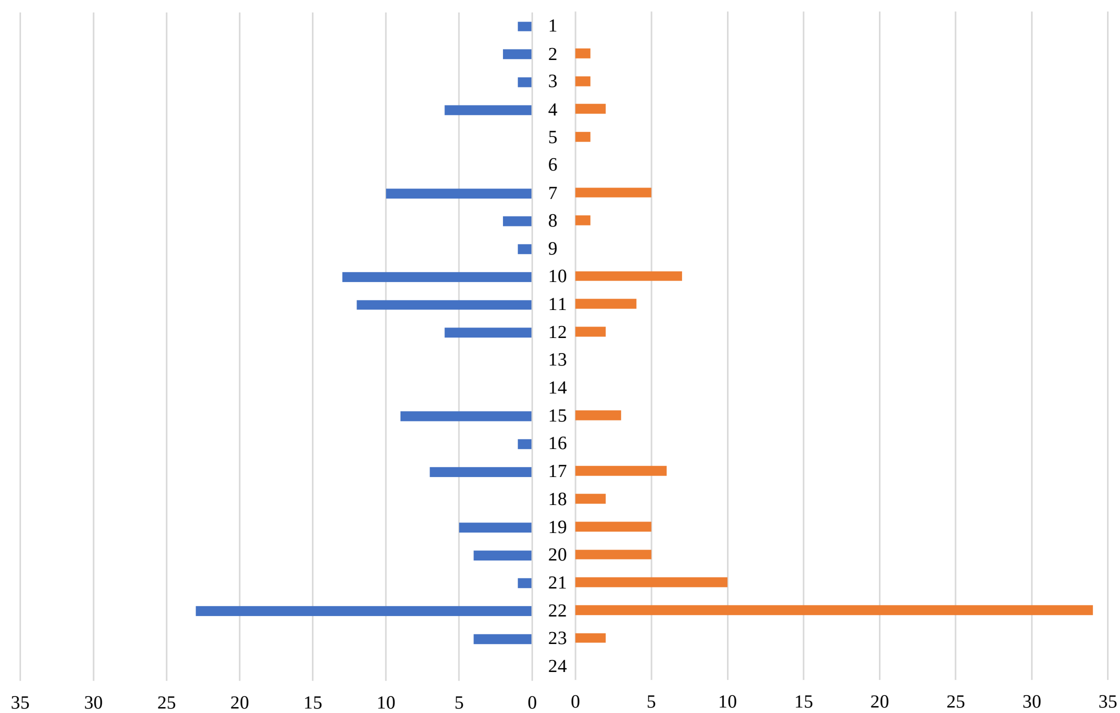
Panel (B): Number of NTMs in force

Notes. The figure shows the timeline of newly enforced and in-force COVID-19 related NTM from February 2020 to June 2021. Blue indicates import facilitating and orange export restricting NTMs.

Figure 2. COVID-19 related NTM implementing countries and targeted HS chapters.



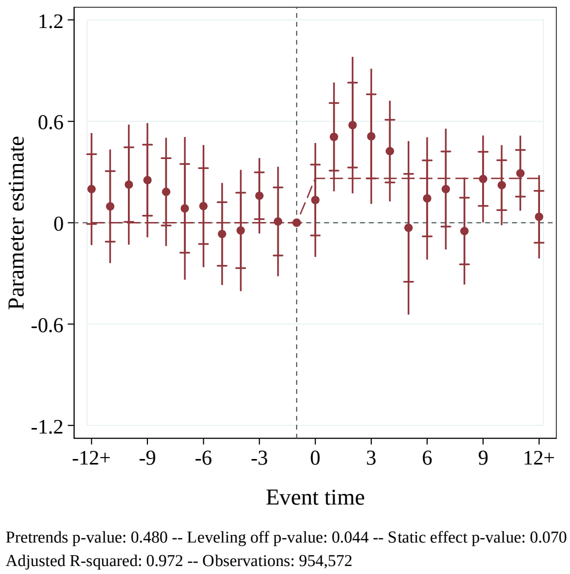
Panel (A): Import facilitating (blue) and export restricting (orange) NTMs by country



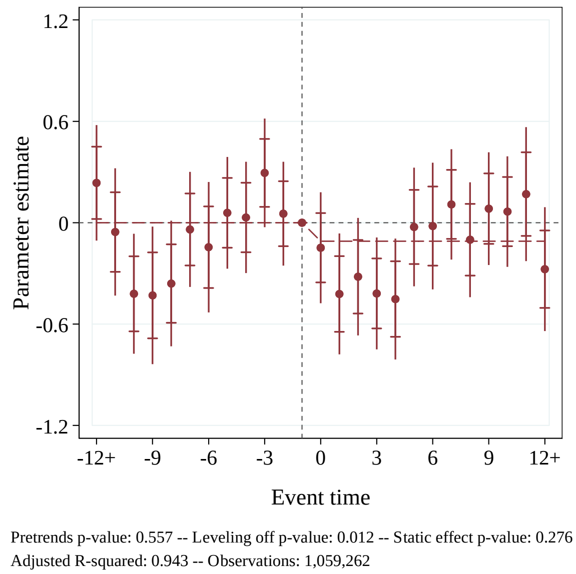
Panel (B): Import facilitating (blue) and export restricting (orange) NTMs by HS chapter

Notes. The figure shows COVID-19 related NTM implementing countries and targeted HS chapters in the agricultural and food sector. Blue indicates import facilitating and orange export restricting NTMs.

Figure 3. Event studies for import facilitating and export restricting NTMs.



Panel (A): Import facilitating NTMs



Panel (B): Export restricting NTMs

Notes. The figures show event studies for import facilitating and export restricting NTMs. The outcome of this regression is import or export quantity. All regressions include product-country, product-time, and country-time fixed effects. Standard errors are adjusted for within-cluster correlation at the product-country level. We plot the dynamic treatment parameters, 95 percent confidence intervals, and uniform sup-t bands for the event-time coefficients. Results from a static model are overlaid, and the corresponding p-value for a Wald test is provided in the figure note. We also computed Wald test results for pretrends and leveling off dynamic treatment effects. The figure note reports the adjusted R-squared and the observation numbers.

Tables

Table 1. Descriptive statistics.

N=2,233,680	Mean	Standard Deviation	Min	Max	Trend
Panel (A): Trade data					
Log (Import value)	12.568	2.404	-1.109	22.529	0.012
Log (Import quantity)	8.742	4.621	-4.605	25.992	0.001
Log (Import unit value)	3.840	3.664	-15.305	15.935	0.008
Log (Export value)	10.960	3.423	-4.605	22.626	0.008
Log (Export quantity)	7.393	5.093	-4.605	23.503	0.000
Log (Export unit value)	3.688	3.651	-14.322	18.057	0.007
Panel (B): NTM data					
Import facilitation	0.000	0.014	0.000	1.000	0.010
Import restriction	0.000	0.002	0.000	1.000	0.001
Export facilitation	0.000	0.006	0.000	1.000	0.005
Export restriction	0.000	0.016	0.000	1.000	0.005
Panel (C): Covariates					
Log (COVID-19 cases, domestic), 1 month lag	7.076	7.229	0.000	20.745	0.898
Log (COVID-19 cases, foreign), 1 month lag	11.043	9.952	0.000	22.337	0.922
Log (MFN+1)	0.299	0.863	0.000	6.686	-0.071
Log (Import value), 12 months lag	5.309	6.403	0.000	22.162	-0.001
Log (Export value), 12 months lag	5.340	5.991	0.000	22.339	-0.006
Log (Exchange rate), 1 month lag	2.437	2.231	0.537	9.672	0.002
Food Security, 12 months lag	129.112	11.905	97.083	159.108	0.034
Panel (D): Instruments					
Ag GDP, 12 months lag	5.538	5.806	0.000	34.770	-0.018
Ag Employment rates, 12 months lag	12.837	12.601	0.035	55.795	-0.020
Log (GDP per capita), 12 months lag	9.547	1.100	7.122	11.666	0.006

Note. The table shows descriptive statistics for the trade data, NTM dataset, covariates, instrumental variables for the balanced panel dataset.

Table 2. Control function estimates for COVID-19 related NTM determinants.

Panel (A): Second stage estimates

	Import NTM		Export NTM	
Dependent Variable (NTM)	Facilitation	Restriction	Facilitation	Restriction
Log (COVID-19 cases, domestic), 1 month lag	-0.247***	0.001	-0.011*	0.046**
	(0.085)	(0.002)	(0.006)	(0.019)
Log (COVID-19 cases, foreign), 1 month lag	15.715***	-0.081	1.780**	-4.242**
	(6.090)	(0.135)	(0.745)	(2.038)
Log (MFN+1)	-0.128***	0.001	-0.007***	0.006
	(0.044)	(0.001)	(0.002)	(0.005)
Log (trade value), 12 months lag	-0.023**	0.001	-0.003**	0.008**
	(0.010)	(0.000)	(0.001)	(0.003)
Log (Exchange rate), 1 month lag	0.308***	0.002	0.004	0.150***
	(0.100)	(0.003)	(0.012)	(0.058)
Food Security, 12 months lag	-0.049***	0.000	-0.003***	0.005
	(0.018)	(0.000)	(0.001)	(0.004)
Residual (COVID-19 cases, domestic)	0.244***	-0.001	0.012*	-0.046**
	(0.084)	(0.002)	(0.006)	(0.019)
Residual (COVID-19 cases, foreign)	-15.717***	0.081	-1.780**	4.241**
	(6.090)	(0.135)	(0.745)	(2.038)
Adjusted R-squared	0.416	0.147	0.357	0.158
Observations	2,185,000	2,185,000	2,156,500	2,156,500

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Table 2. Control function estimates for COVID-19 related NTM determinants *Continued*.

Panel (B): First stage estimates

Dependent Variable (Log (COVID-19 cases), 1 month lag)	Import Specification		Export Specification	
	Domestic	Foreign	Domestic	Foreign
Log (GDP per capita), 12 months lag	0.304***	0.002***	0.316***	0.002***
	(0.005)	(0.000)	(0.005)	(0.000)
Agricultural employment rate, 12 months lag	-0.224***	-0.004***	-0.233***	-0.004***
	(0.009)	(0.000)	(0.009)	(0.000)
Agricultural GDP share, 12 months lag	5.258***	0.060***	5.253***	0.061***
	(0.100)	(0.002)	(0.101)	(0.002)
Adjusted R-squared	0.969	0.999	0.969	0.999
Kleibergen-Paap F statistic	1,786.4	458.5	1,686.9	434.5
Observations	2,185,000	2,185,000	2,156,500	2,156,500

Notes. The table shows control function estimates for the determinants of COVID-19 related NTMs. Panel (A) shows the second stage and Panel (B) summarizes the first stage estimates. Note that all regressions include product-country and time fixed effects. For the sake of brevity, we excluded the economic covariates from the first stage regression. These estimates are available upon request from the authors. The first-stage standard errors are clustered at the product-country level, while the second-stage standard errors are bootstrapped with replacement for 1,000 replications within product-country pairs. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Table 3. Impact of COVID-19 related NTMs on agricultural and food trade.

	Import			Export		
	Quantity	Value	Unit Value	Quantity	Value	Unit Value
NTM_f	0.262***	0.193***	-0.069	-0.323	-0.230	0.090
	(0.098)	(0.069)	(0.047)	(0.197)	(0.185)	(0.087)
NTM_r	-0.890***	-1.112***	-0.208***	-0.109	-0.022	0.041
	(0.130)	(0.114)	(0.040)	(0.081)	(0.071)	(0.036)
Adjusted R-squared	0.972	0.924	0.991	0.943	0.888	0.978
Observations	954,572	973,588	954,572	1,059,262	1,093,840	1,058,484

Notes. The table reports log-linear regression results for the trade effects of COVID-19 related NTMs on agricultural and food trade. Note that NTM_f stands for trade facilitating and NTM_r for trade restricting NTMs. All models include product-country, country-time, and product-time fixed effects. Standard errors are clustered at the product-country level. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.

Table 4. Robustness checks.

	Quantity		Value		Unit Value	
	(1)	(2)	(1)	(2)	(1)	(2)
Panel A: Control group includes cross-country and cross-product variation						
NTM_f	0.266**	0.431***	0.237**	0.376***	-0.033	-0.057
	(0.121)	(0.154)	(0.117)	(0.146)	(0.053)	(0.052)
NTM_r	-0.123	-0.352**	0.009	-0.166	0.037	0.068
	(0.133)	(0.141)	(0.124)	(0.132)	(0.043)	(0.042)
Panel B: Control group limited to cross-country variation						
NTM_f	0.308**	0.486***	0.234	0.367**	-0.072	-0.104
	(0.156)	(0.182)	(0.149)	(0.17)	(0.061)	(0.064)
NTM_r	-0.122	-0.355**	-0.002	-0.176	0.014	0.044
	(0.148)	(0.155)	(0.136)	(0.145)	(0.05)	(0.05)
Panel C: Control group limited to cross-product variation						
NTM_f	0.336**	0.429***	0.291**	0.343**	-0.054	-0.094
	(0.140)	(0.167)	(0.129)	(0.149)	(0.062)	(0.063)
NTM_r	-0.107	-0.335*	0.032	-0.140	0.035	0.062
	(0.173)	(0.177)	(0.151)	(0.155)	(0.058)	(0.059)

Notes. The table reports log-linear regression results for the trade effects of COVID-19 related NTMs on agricultural and food trade. We limit the control group to cross-country variation in (Panel B) and cross-product variation in Panel (C). (1) reports average post-event treatment effects and (2) average post-treatment effects for the first five-month after NTM implementation. Note that NTM_f stands for import facilitating and NTM_r for export restricting NTMs. All models include product-country, country-time, and product-time fixed effects. Standard errors are clustered at the product-country level. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. Additional regression statistics are available upon request from the authors.