Global Container Shipping Disruptions, Pop-Up Ports, and U.S. Agricultural Exports

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Abstract

This paper evaluates the impact of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports. The program, implemented by the United States Department of Agriculture in March 2022, was designed to address logistical disruptions related to the exporting of agricultural goods from the ports of Oakland, Seattle, and Tacoma. To assess the program's trade implications, we employed a good-level empirical model of bilateral trade that allowed us to estimate the counterfactual treatment effects. The dynamic treatment estimates provide limited evidence of positive trade effects after the program implementation. Specifically, we found an average post-event trade effect of 1.0% from March to September 2022, which was statistically insignificant. These results are consistent across a range of robustness checks. However, we observe considerable treatment heterogeneity, with positive trade effects for raw and prepared meat products. Between March and September 2022, the program incurred costs of $2.8 million, while we estimate that monthly containerized agricultural exports from participating ports were about $18.6 million above the counterfactual during that period. These findings suggest that the program had limited success in facilitating U.S. containerized agricultural exports.

Keywords: Supply chain disruptions, commodity container assistance program, agricultural exports, containerized shipments

JEL codes: F14; Q17; Q18

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1. Introduction

The coronavirus pandemic has immensely impacted agricultural production and trade, leading to sizable disruptions in global food supply chains (Laborde et al. 2020; Hobbs 2021; Verschuur et al. 2021). Ex-post estimates suggest that agricultural trade declined by between 7% and 9% as a result of the coronavirus pandemic and the accompanying economic downturn (Arita et al. 2022). In addition, the increased U.S. demand for durable goods from Asia following the initial pandemic shock led to a surge in shipping container demand, skyrocketing maritime freight rates, and congested ports along the U.S. West Coast (Carter et al. 2022a; Steinbach 2022). The unparalleled port congestion resulted in disruptions to vessel schedules and prioritization of empty container returns to Asia, leading to increasing barriers to exporting agricultural commodities in containers and lost market opportunities for U.S. farmers and ranchers (Carter et al. 2022b). In response to the maritime shipping challenges, the United States Department of Agriculture implemented the Commodity Container Assistance Program (CCAP), which partners with the Port of Oakland in California and the Northwest Seaport Alliance to overcome the maritime supply chain disruptions and regain lost market access for U.S. agricultural exporters.

Containerized shipments are vital for U.S. agriculture. Between 2019 and 2021, they made up about 21% of total agricultural exports, with containerized shipments being exceedingly relevant for the export of meat, soybeans, and tree nuts according to data from the United States Census Bureau (2022). The 2021 maritime shipping disruptions resulted in a shortage of shipping containers available for U.S. agricultural commodities, particularly at Western ports, as ocean carriers prioritized the return of empty containers to Asia over traditional marketing channels (Carter et al. 2021). This shortage led to a suspension of maritime services to traditional agricultural export ports, such as the Port of Oakland, resulting in a decline of containerized agricultural shipments through those ports (Carter et al. 2022a). According to Carter et al. (2022b), containerized agricultural exports from California ports were 22% or $3.2 billion below the counterfactual level from May 2021 to November 2022. To resolve the supply chain bottlenecks, the Biden administration announced the allocation of considerable funds to improve the U.S. maritime and port infrastructure in November 2021. A cornerstone of this initiative is the Commodity Container Assistance Program, which is supposed to provide short-term relief to agricultural exporters through “pop-up” container yards. The program provides payments to cover the additional logistics costs of handling containers shipped from U.S. ports. In addition to these per-container payments, the program also provided about $1.8 million in start-up costs for the "pop-up" site at the Port of Oakland. Between March and September 2022, the program approved funds for 5,500 containers, leading to payments of approximately $1 million to eligible owners or designated marketing agents of U.S. agricultural commodities.

A growing literature investigates the drivers and implications of maritime shipping disruptions for various economic outcomes. Areas of inquiry include shipping delays and backlogs (Pratson 2023), freight rates (Gray 2020; Beghin and Schweizer 2021; Bai et al. 2022), port pricing (Grater and Chasomeris 2022), containerized trade (Carter et al. 2021, 2022a,b; Steinbach 2022), supply chain resilience and risk (Notteboom et al. 2021; Baldwin and Freeman 2022), shipping costs and inflation (Carrière-Swallow et al. 2023; Isaacson and Rubinton 2022), commodity prices (Ayasli et al. 2023), and invasive alien species (Ruiz et al. 2022). Steinbach (2022) estimated that the 2021 port congestion and container shortages reduced U.S. containerized exports by 24.5% or $15.7 billion between May and November 2021. Carter et al. (2022a) focus on agricultural commodities and show that the 2021 container shipping disruptions caused a 22% decline in containerized agricultural exports from U.S. ports between May 2021 and January 2022, resulting in export losses of more than $10 billion. Although the Commodity Container Assistance Program has raised considerable interest in the public eye and is a cornerstone of the Biden administration's response to the maritime shipping disruptions, little is known about how the program impacted containerized agricultural exports from U.S. ports. The program's aim is to alleviate short-run bottlenecks caused by port congestion and container shortages by facilitating access to containers at major West Coast ports used by agricultural exporters.

We use a good-level empirical model of bilateral trade to assess the impact of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports.[1] We sourced monthly containerized export data at the Harmonized System (HS) section (4-digit) level for all U.S.

[1] Note that we use the term "good" to refer to agricultural commodities and products listed under HS chapters 1 to 24.

ports from September 2014 to September 2022. Our panel event study design allows us to include leads and lags relative to the event of interest and control for potential unobserved confounders through high-dimensional fixed effects. The identification strategy compares ports that participated in the Commodity Container Assistance Program with those that did not. The dynamic treatment estimates provide limited evidence of positive trade effects on containerized agricultural exports after the program implementation in March 2022. Specifically, our results show a statistically insignificant average post-event trade effect of 1.0% from March to September 2022 for the ports of Oakland, Seattle, and Tacoma. These findings hold up to a series of robustness checks. However, we find evidence of treatment heterogeneity across commodity and product groups, with statistically significant positive trade effects for raw and prepared meat products. Overall, the program incurred costs of $2.8 million between March and September 2022. We estimate that monthly containerized agricultural exports from participating ports were about $18.6 million above the counterfactual level during that period. These findings suggest that the program had limited success in achieving the goal of facilitating U.S. containerized agricultural exports at U.S. ports that participated in the Commodity Container Assistance Program.

The paper makes three contributions to the growing literature on the economic consequences of the 2021 global container shipping disruptions. Firstly, we show that participation in the Commodity Container Assistance Program was limited. After the program was implemented in March 2022, containerized agricultural exports from participating ports remained below the counterfactual level. Although the program represents a cornerstone of the Biden administration's short-run response to maritime shipping disruptions at the ports of Oakland, Seattle, and Tacoma, the program did little to strengthen agricultural exports from those Western ports. Secondly, the paper shows that containerized agricultural exports remained depressed in 2022. These insights expand on earlier work concerned with the trade implications of maritime shipping disruptions for U.S. agriculture (Carter et al. 2021, 2022a,b; Steinbach 2022). Although some evidence of trade recovery is observable, the level of exports from Western ports remains only slightly above the counterfactual, pointing toward systemic challenges to trade competitiveness at those ports that remain unresolved by the Commodity Container Assistance Program. Lastly, the paper speaks to the growing importance of maritime transportation and the reliance of U.S. agriculture on containerized shipments to Asian markets (Gray 2020; Beghin and Schweizer 2021; Carter and Steinbach 2022). Investments in port and transportation infrastructure are essential for U.S. agriculture to regain lost ground in foreign markets and compete in an increasingly uncertain global market environment.

2. The Commodity Container Assistance Program

The United States Department of Agriculture implemented the Commodity Container Assistance Program in response to market disruptions that caused logistical challenges in transporting agricultural commodities to foreign markets. The program, which Agriculture Secretary Tom Vilsack announced on January 31, 2022, includes partnerships with the Port of Oakland in California and the Northwest Seaport Alliance. The Northwest Seaport Alliance comprises the ports of Seattle and Tacoma in Washington state. To address the shipping challenges, the Commodity Container Assistance Program established "pop-up" sites at Howard Terminal in the Port of Oakland, Terminal 46 in the Port of Seattle, and West Hylebos Terminal in the Port of Tacoma, where the Farm Service Agency provides per-container payments to cover additional logistics costs. The Farm Service Agency makes payments to eligible owners or designated marketing agents of U.S. agricultural commodities based on the number of eligible shipping containers used from March 1 to December 31, 2022. As of December 2022, the Commodity Container Assistance Program plans to expand its partnership to include the Port of Houston, which handles a significant portion of container cargo coming through the Gulf of Mexico.[2]

The Agricultural Marketing Service provided 60% of the $3 million start-up costs for the "pop-up" site at Howard Terminal in the Port of Oakland as part of the Commodity Container Assistance Program. In addition, the Farm Service Agency offers a payment of $125 per container to assist agricultural commodity owners with the extra logistical expenses of obtaining empty shipping containers. The program provides payments of $200 per dry container and $400 per refrigerated (or reefer) container to help offset the additional logistical costs involved in moving the shipping

[2] The United States Department of Agriculture announced plans to expand the partnership to the Port of Houston in June 2022. The Texan port handles over two-thirds of container cargo coming through the Gulf of Mexico. Using Commodity Credit Corporation funds, the Agricultural Marketing Service will cover 50% of the cost of obtaining and leasing chassis at the Port of Houston.

container twice, first to the preposition site and then to the terminal loading the vessel, as well as the cost of temporary storage. The Northwest Seaport Alliance provides access to a 49-acre near-dock facility "pop-up" site at Terminal 46 in Seattle and a 16-acre site at the West Hylebos Terminal in Tacoma. The Farm Service Agency also offers payments of $200 per dry container and $400 per reefer container for the Northwest Seaport Alliance to cover the logistical costs of moving the container to the preposition site and then to the terminal, as well as the cost of temporary storage. These "pop-up" sites at the Ports of Seattle and Tacoma did not require cost-share assistance from the Agricultural Marketing Service, as they already have the handling equipment and reefer plugs.

Eligible commodities for the Commodity Container Assistance Program include those grown or produced in the United States for food, feed, or fiber, as well as products made from these commodities, including forestry products, that are shipped in a container, picked up from the Port of Oakland or contained within a filled shipping container stored at the Port of Oakland or the Northwest Seaport Alliance locations from March 1 to December 31, 2022. Applications for the Commodity Container Assistance Program are accepted through January 31, 2023, by the National Offices of Farm Service Agency. They require applicants to complete Form FSA-862, which includes information on the number and type of containers used for eligible agricultural commodities. We obtained data on the Commodity Container Assistance Program from Form FSA-862 through Freedom of Information Act requests 2023-FSA-00758 and 2023-AMS-00023, completed in December 2022. Table 1 summarizes the approved CCAP applications by port from March to September 2022. During this period, almost 5,500 containers were approved, leading to payments of approximately $1 million to eligible owners or designated marketing agents of U.S. agricultural commodities. 70% of these payments were made for containers shipped through the Port of Oakland, 28% for those shipped through the Port of Seattle, and less than 1% for those shipped through the Port of Tacoma.[3]

The distribution of CCAP payments, as depicted in Figure 1, reveals that most of these funds were directed toward agricultural commodities from California. Specifically, 83% of payments went to such producers, with containerized hay exports, almonds, walnuts, and potatoes being

[3] The Port of Oakland shipped about 35,000 containers filled with agricultural commodities monthly from 2019 to 2021, while the Port of Tacoma shipped 22,300 and the Port of Seattle 17,800 containers (IHS Markit 2022).

the top four commodity groups. Of these, containerized hay exports received the largest share of payments at 28%, followed by almonds at 18%, meats at 18%, walnuts at 14%, and potatoes at 11%, respectively. Refrigerated or reefer containers made up a relatively small proportion of total payments, accounting for less than 20% of payments from March to September 2022. In terms of the number of companies that applied for CCAP funds, 33 firms did so, with the five largest recipients receiving more than 54% of all payments. These data suggest a concentration of CCAP funds approved among a relatively small number of applicants, with a considerable proportion of those funds being directed toward agricultural producers registered in California.

The evolution of U.S. containerized agricultural exports from March 2020 to September 2022 is depicted in Figure 2. The color scheme indicates the ports of Oakland, Seattle, and Tacoma, as well as the total for all other U.S. ports. The data, which include agricultural exports within HS chapters 1 to 24 obtained from the United States Census Bureau (2022), is presented relative to May 2021, when the container shipping disruptions intensified (Carter et al. 2021). The figure offers two key insights. Firstly, the container shipping disruptions that began in the Spring of 2021 significantly impacted containerized agricultural exports throughout the United States, with a 22% average decline observed at ports in California (Carter et al. 2022b). The Port of Oakland experienced the steepest slowdown in containerized agricultural exports. Secondly, the total agricultural export value between January and September 2022 was higher than in 2021, indicating a recovery of U.S. containerized agricultural exports in that year. This considerable recovery is due to higher export prices and relief from container shipping disruptions at the Western ports in the Spring and Summer of 2022 (Carter and Steinbach 2022).

3. Empirical Strategy and Data

We use a panel event study design to assess the impact of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports. This approach allows us to include leads and lags relative to the event of interest and control for potential unobserved confounders by including high-dimensional fixed effects. In addition, the regression framework enables us to capture pre-trends and examine treatment dynamics in the post-event period (Freyaldenhoven et al. 2021). To assess the post-event treatment effects, we follow the approach in Carter et al. (2022a), Carter et al. (2022b), and Steinbach (2022) and utilize a non-linear panel regression model for count data with dynamic treatment effects:

$$y_{ijst} = \exp\left(\alpha_{ijs,mo} + \alpha_{ijs,yr} + \sum_{k=\text{-}6}^{6} \beta_{k,c} r_{ijs,t\text{-}k} \times \text{CCAP}_{it}\right) + \epsilon_{ijst}\,, \tag{1}$$

where the port, foreign destination, good, and month are denoted by i, j, s, and t, respectively. The outcome of interest, y_{ijst}, is measured in three ways: the free on board export value (in \$), the quantity (either as a count or in kilogram), and the unit value (defined as the export value divided by the export quantity). To control for unobserved factors that could affect the relationship of interest, we include high-dimensional fixed effects at the port-destination-good-event-month ($\alpha_{ijs,mo}$) and port-destination-good-event-year ($\alpha_{ijs,yr}$) levels. These fixed effects are flexible over time, allowing us to account for shocks resulting from changes in demand and supply at the port-destination-good level. For example, seasonality patterns in agricultural exports vary widely but are mostly unobservable. In addition, the high-dimensional fixed effects also account for the impact of port infrastructure, freight rates, anchor time, and other unobserved confounders (Clark et al. 2004; Korinek and Sourdin 2010; Jacks and Pendakur 2010; de Soyres et al. 2020). The term $\sum_{k=\text{-}6}^{6} \beta_{k,c} r_{ijs,t\text{-}k} \times \text{CCAP}_{it}$ measures the dynamic treatment effects of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports. The treatment effects of the program are estimated through the interaction term. The baseline regression model is flexible to some degree, allowing the treatment effect to be dynamic before and after the program was implemented. Our baseline comparison group is agricultural exports from all U.S. ports. We center the event study around March 2022, the starting month of the Commodity Container Assistance Program, and use a symmetric event window that extends six months before and after the event. This event window choice, which is standard in the event study literature, allows us to account for potential pre-trends and delays in trade data and program reporting in the post-event period (Freyaldenhoven et al. 2021).

The non-linear regression specification addresses level differences in export values and volumes between goods and export destinations through the port-destination-good fixed effects. To account for the fixed effects and identify the dynamic treatment effects of the Commodity Container Assistance Program, we require a control group that has the same trends in the pre-treatment period and is not affected by the program. Since we cannot rely on trade data from other countries or good groups to construct a reliable counterfactual at the port-destination-good level, we resort to U.S. containerized agricultural exports at the port-destination-good level from 2016 to 2020 as the control group.[4] This choice allows us to measure the counterfactual treatment effects based on a comparison group with similar pre-trends at the port-destination-good level. This identification strategy draws on the work of Carter et al. (2022a), Carter et al. (2022b), and Steinbach (2022), who used a similar research design to evaluate the trade effects of the 2021 container shipping disruptions on containerized exports from U.S. ports. We denote the error term with ϵ_{ijst}.

The outcome, y_{ijst}, represents the non-negative integer count of containerized agricultural exports from U.S. ports at the port-destination-good level. To identify the relationship of interest, we cannot use a linear regression model because it is unable to ensure the positivity of the predicted values of the count outcome (Wooldridge 1999). Furthermore, the discrete nature of the outcome makes it difficult to find a transformation with a conditional mean that is linear in parameters, and heteroskedasticity can exacerbate this issue further by causing the transformed errors to be correlated with the covariates, leading to an inconsistent identification of the treatment effects (Cameron and Trivedi 2013). Therefore, to account for these econometric challenges, we directly model the relationship of interest between containerized agricultural exports and the treatment variables using a non-linear regression model with an exponential form equation that ensures the positivity of the covariates (Mullahy and Norton 2022).

To identify the relationship between the count outcome and the treatment variables, we follow common practice in the international economics literature and use the Poisson pseudo-maximum likelihood estimator (Gong and Samaniego 1981; Gourieroux et al. 1984). This estimator is unbiased and consistent in the presence of heteroskedasticity, even if the conditional variance is not proportional to the conditional mean (Wooldridge 1999; Cameron and Trivedi 2013). Additionally, the Poisson PML estimator has the advantage of being insensitive to the scale of the dependent variable and allowing for the consistent treatment of zero trade flows (Silva and Tenreyro 2006). As

[4] We investigate the robustness of our main results to the choice of the control group in Section 5.

shown in Appendix Table A.1, the share of zero observations is considerable at the port-destination-good level. For the unit value specification, we follow standard practice and use a linear regression model with a log transformation of the outcome. To account for the high-dimensional fixed effects, we employ a modified version of the iteratively re-weighted least-squares algorithm that is robust to statistical separation and convergence issues (Correia et al. 2020). Lastly, we address potential serial correlation by clustering observations at the port-destination-good level, following standard practice in the international economics literature (Carter et al. 2022a,b; Steinbach 2022).

We utilize detailed export data from the United States Census Bureau (2022). Their port-level trade dataset offers comprehensive monthly export statistics for all U.S. ports and export destinations from September 2014 to September 2022. The dataset includes information on the value and volume of exports, as well as the mode of transportation utilized (including air, bulk vessels, and containerized vessels). To facilitate the empirical analysis, we aggregated the trade data at the HS heading (four-digit) level and classified all goods into either agricultural (HS chapters 0 to 24) or non-agricultural (HS chapters 25 to 99) goods. To ensure the robustness of our identification strategy, we employed the approach developed by Correia et al. (2020) to identify singleton observations without variation at the port-destination-good level. The resulting balanced panel dataset covers the monthly value and quantity shipped from 153 U.S. ports handling containerized goods destined for 237 export destinations, encompassing 1,266 HS headings. The final panel consists of 592,244 unique port-destination-good pairs, which we use to construct the event study panel. Appendix Table A.1 provides the descriptive statistics, comparing the pre-event and post-event periods for ports that participated in the Commodity Container Assistance Program with those U.S. ports that did not. The data indicate a total reduction of 8.5 percent in containerized shipments of agricultural goods from Oakland, Seattle, and Tacoma comparing the six-month before and after the Commodity Container Assistance Program was implemented in March 2022.

4. Main Results

We present event study estimates for the impact of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports in Figure 3. Each subfigure shows the parameter estimates and 95% confidence intervals for the event-time of the outcome (Freyaldenhoven et al. 2021). We compare the dynamic treatment effects for the export value, quantity, and unit value. The figure notes report Wald tests for pre-trends, average post-event treatment effects, and regression statistics. Apart from the unit value specification, we find no evidence for statistically significant pre-trends, indicating that the Commodity Container Assistance Program is exogenous to the outcomes of interest (Freyaldenhoven et al. 2019; Sun and Abraham 2021; Roth 2022). Given the use of port-destination-good-event-year and port-destination-good-event-month fixed effects, the treatment group exhibits the same trends in the pre-treatment period as the control groups, validating the research design. At the same time, there is no evidence for leveling-off or increasing treatment effects for the export value and quantity specifications, but some evidence for the unit value specification.

The estimation results indicate that containerized agricultural exports from U.S. ports participating in the Commodity Container Assistance Program were about 1.0% above the counterfactual between March and September 2022.[5] The average post-event treatment effects for the export value and quantity are statistically indifferent from another at conventional levels. There is also no evidence for significant unit value effects using containerized agricultural exports from non-treated ports as the comparison. None of the average post-event treatment effects is statistically significant, implying that containerized agricultural export from treated ports likely did not benefit from additional trade gains above the counterfactual level in the post-event period. Between March and September 2022, the Commodity Container Assistance Program incurred costs of $2.8 million, while we estimate that monthly containerized agricultural exports from treated ports were about $18.6 million above the counterfactual during that period. These findings suggest that the program had limited success in achieving the set goal of facilitating containerized agricultural exports at the ports of Oakland, Seattle, and Tacoma.

5. Robustness Checks

Different Comparison Group — A potential concern regarding our identification strategy relates to the comparison group used to estimate the net trade effects of the Commodity Container As-

[5] We calculated the average post-event trade effects using the formula $\big(\exp(\bar{\beta}_{k,c} - 1)\big) \times 100$.

sistance Program on containerized agricultural exports from U.S. ports. For the main analysis, non-treated ports were used as the comparison group. Although Wald tests did not strongly support the existence of significant pre-trends, it is possible that an unobserved shock specific to containerized agricultural exports could have also impacted non-treated ports during the post-event period (Freyaldenhoven et al. 2019). To address this concern, we compared the treatment effects of the Commodity Container Assistance Program using two alternative comparison groups. Non-agricultural exports from treated ports were used as the comparison group in panels (a) to (c) and non-agricultural exports from non-treated ports in panels (d) to (e) of Figure 4. Wald tests from these alternative comparison groups showed some evidence of significant pre-trends, particularly with the non-agricultural exports from non-treated ports. However, none of the average post-event treatment effects were statistically significant at conventional levels. In addition, we found more prominent and positive average post-event treatment effects when comparing the main results for the quantity specification with the alternative specifications. Therefore, our main results likely represent the lower bound of the treatment range.

Extrapolated Linear Pre-Trends — It is important to exercise caution when interpreting the estimated trade effects as causal due to the potential for pre-trends before the Commodity Container Assistance Program was implemented (Freyaldenhoven et al. 2019). To account for this identification challenge, we apply the approach proposed by Dobkin et al. (2018), which estimates Equation (1) under the alternative assumption that the linear pre-trends of the treated units would have continued along their pre-event paths. The results of this analysis are presented in Figure 5. The dotted red line overlays the estimated linear trend on the baseline event study estimates for the net treatment effects of the Commodity Container Assistance Program. The linearity assumption is reasonable for the export quantity and unit value, as the estimated trend growth falls within the 95% confidence intervals of the non-parametric event study estimates throughout the pre-treatment period. However, the trend coefficient for the quantity specification is not statistically significant, leading us to reject the hypothesis that pre-trends drive the observed trade effects. In contrast, we find a statistically significant linear pre-trend of 0.003 log points for the unit value specification. Subtracting this pre-trend from the estimated post-event treatment estimates results in an average post-event trade effect of -4.1% for the unit value specification, which is statistically significant at conventional levels. Since we cannot rule out that the Commodity Container Assistance Program is correlated with an unrelated trend break in U.S. containerized agricultural exports, the actual trade effects may lie between the main results and the pre-trend robust treatment estimates.

Zero Trade Flows — In panel (b) of Table 2, we present estimates for a log-linear regression to examine the robustness of our results. While the standard practice in the related literature is to model the relationship between the outcome and treatment directly and retain zero observations to estimate marginal treatment effects (Silva and Tenreyro 2006; Mullahy and Norton 2022), we also consider an alternative specification without zero trade flows for robustness. Our findings provide evidence of significant pre-trends for all three outcomes using the log-linear regression specification. As a result, the average post-event treatment effects for those regressions are almost three times as large as the ones for the main results presented in panel (a). However, when controlling for linear pre-trends using the approach proposed by Dobkin et al. (2018), the estimated post-event treatment effects for the main event studies and the log-linear event studies are not statistically different from each other at conventional levels.[6]

Different Control Groups — We show estimates for different control groups in panel (c) of Table 2. As we cannot utilize trade data from other countries or good groups to create a reliable counterfactual at the port-destination-good level, we instead use U.S. containerized agricultural exports at the port-destination-good level from 2016 to 2020 as the control group for our main analysis. This control group was chosen due to its trend similarities with the treatment group in the pre-treatment period, thereby ensuring the validity of our research design. To assess the robustness of our main results, we compare them to those obtained using different control groups. In most cases, the average post-event treatment effects do not differ significantly from those of the baseline results. When using trade data from 2014 to 2017 as the control group, we find evidence for statistically significant yet adverse post-event treatment effects that are larger than those obtained in the main analysis. However, this control group exhibits statistically significant pre-trends, rendering it inappropriate for causal inference. Overall, the estimates obtained using different control groups are consistent in indicating that ports participating in the Commodity Container Assistance Program

[6] Event studies for the linear pre-trend adjusted post-event treatment paths are provided in Appendix Figure A.2.

did not experience statistically significant export growth beyond the counterfactual from March to September 2022.

Transport Mode — In addition to its impact on domestic inventory and sales, the use of bulk carriers to transport agricultural goods is one potential mechanism of adjustment to container shipping disruptions. The Commodity Container Assistance Program could encourage the substitution of bulk for containerized agricultural exports at treated ports. However, our analysis of the average post-event treatment effects for bulk agricultural exports, as presented in panel (d) of Table 2, does not provide strong statistical evidence for such substitution effects. The treatment effects for export quantity, export value, and unit value are statistically insignificant at a conventional level, yet they are adverse and large in magnitude. These findings suggest that there is limited substitution by transport mode and no significant changes in import competition as a result of the program.

Treatment Heterogeneity across HS Chapters — We show the average post-event treatment effects by HS chapter in Figure 6. The estimates provide evidence of considerable treatment heterogeneity after the Commodity Container Assistance Program was implemented in March 2022. While the exports of raw (HS chapter 2) and prepared meats (HS chapter 16) from treated ports were 5.7% and 51.2% above the counterfactual between March and September 2022, other goods experienced adverse trade effects. For instance, the average trade effects for dairy produce (HS chapter 4) and edible fruits and nuts (HS chapter 8) were adverse during the post-event period. However, since most of these estimates are insignificant at conventional levels of statistical significance, we can conclude that the Commodity Container Assistance Program did not benefit trade in any particular good group while causing heterogeneous trade effects across HS chapters.[7]

6. Conclusion

This paper examines the impact of the Commodity Container Assistance Program on containerized agricultural exports from U.S. ports. Using monthly trade data from September 2014 to Septem-

[7] Appendix Figure A.1 shows the estimated trade effects in millions of $ by HS chapter. The trade effects were calculated based on constant unit values for February 2022. We find that raw and prepared meat exports from ports that participated in the Commodity Container Assistance Program were $380 million and $160 million above the counterfactual level from March and September 2022.

ber 2022, we employ a panel event study design that compares CCAP ports with those that did not participate in the program to infer the counterfactual treatment effects. The results show a statistically insignificant average post-event trade effect of 1.0% on containerized agricultural exports from the ports of Oakland, Seattle, and Tacoma. However, there is evidence of treatment heterogeneity, with statistically significant positive trade effects found for raw and prepared meat products. The program incurred costs of $2.8 million from March to September 2022. We estimated that monthly containerized agricultural exports from participating ports were approximately $18.6 million above the counterfactual level during this period. These findings suggest that the Commodity Container Assistance Program had limited success in achieving the set goal of facilitating containerized agricultural exports at the participating ports.

The global container shipping disruptions of 2021 had considerable consequences for containerized agricultural exports from U.S. ports (Carter et al. 2022b). This paper contributes to the growing body of literature on this unparalleled logistic challenge by examining the effectiveness of the Commodity Container Assistance Program, a short-term response implemented by the Biden administration in March 2022 to address the container shipping disruptions at the ports of Oakland, Seattle, and Tacoma. Our analysis shows that the Commodity Container Assistance Program had limited success in boosting containerized agricultural exports from participating ports. Moreover, despite the program's implementation, exports grew only slightly above the counterfactual, suggesting that the Commodity Container Assistance Program was insufficient in addressing the systemic challenges to trade competitiveness that U.S. agricultural exporters face at Western ports.

In addition to examining the effectiveness of the Commodity Container Assistance Program, our research also shows that containerized agricultural exports remained depressed in 2022. This finding builds on previous research that has explored the trade implications of maritime shipping disruptions for U.S. agriculture (Carter et al. 2021, 2022a,b; Steinbach 2022). While some evidence of trade recovery is evident, the level of containerized agricultural exports from Western ports is still below the counterfactual, indicating ongoing challenges to trade competitiveness at these ports that the Commodity Container Assistance Program has not adequately addressed. These insights highlight the need for further efforts to address the systemic challenges facing U.S. agriculture in international trade.

Our results also speak to the growing importance of maritime transportation and the reliance of U.S. agriculture on containerized shipments to Asian markets (Gray 2020; Beghin and Schweizer 2021; Carter and Steinbach 2022). Investing in port and transportation infrastructure is essential to regain lost ground for U.S. agriculture in foreign markets and compete in a rapidly changing global market environment. Moreover, these investments are necessary to ensure that U.S. agriculture can participate effectively in international trade and maintain its competitive position worldwide. Without such investments, U.S. agriculture may continue to face trade challenges and struggle to take full advantage of emerging export opportunities.

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Figures and Tables

Table 1: Approved CCAP Containers and Payments.

	Oakland		Seattle		Tacoma	
	Containers	Payments	Containers	Payments	Containers	Payments
March 2022	1,205	$218,775	291	$58,300	7	$2,200
April 2022	895	$149,250	376	$96,775	2	$600
May 2022	788	$134,275	171	$45,000	3	$800
June 2022	389	$62,850	198	$39,600	8	$2,000
July 2022	462	$77,600	232	$47,200	6	$2,000
August 2022	243	$38,525	7	$1,400	0	$0
September 2022	119	$18,750	50	$10,000	0	$0
Total	4,101	$700,025	1,325	$286,875	26	$7,600

Note. The table shows the number of containers and payments approved under the Commodity Container Assistance Program for the ports of Oakland, Seattle, and Tacoma between March and September 2022.

Table 2: Robustness Checks.

	Value	Quantity	Unit Value
Panel (a): Main Results			
Average post-event	-0.016	0.011	-0.008
	0.040	0.042	0.009
Observations	1,427,587	1,427,587	630,157
Pseudo/Adjusted R-squared	0.935	0.942	0.829
Panel (b): Zero Trade Flows			
Average post-event	-0.045**	-0.037	-0.008
	(0.022)	(0.023)	(0.009)
Observations	630,157	630,157	630,157
Adjusted R-squared	0.791	0.811	0.829
Panel (c): Different Control Group			
Average post-event (2014-2017)	-0.083**	-0.154***	-0.006
	(0.042)	(0.057)	(0.010)
Average post-event (2014-2018)	-0.047	-0.097	-0.003
	(0.040)	(0.049)	(0.010)
Average post-event (2015-2018)	-0.023	-0.055	-0.001
	(0.042)	(0.046)	(0.010)
Average post-event (2015-2019)	-0.023	-0.032	-0.002
	(0.039)	(0.041)	(0.010)
Average post-event (2016-2019)	-0.023	-0.030	-0.006
	(0.038)	(0.041)	(0.010)
Average post-event (2016-2020)	-0.016	0.011	-0.008
	(0.040)	(0.042)	(0.009)
Average post-event (2017-2020)	0.001	0.049	-0.005
	(0.041)	(0.046)	(0.010)
Panel (d): Transport Mode			
Average post-event	0.319	-0.120	-0.031
	(0.316)	(0.241)	(0.038)
Observations	258,035	258,032	72,428
Pseudo/Adjusted R-squared	0.891	0.897	0.884

Note. The table shows robustness checks for the impact of the Commodity Container Assistance program on U.S. containerized agricultural exports. All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The average post-event treatment effects were calculated following de Chaisemartin and D'Haultfœuille (2020). The standard errors are adjusted for within-cluster correlation at the port-destination-good level. *** , ** , and * indicate statistical significance at the 1, 5, and 10 percent confidence levels, respectively.

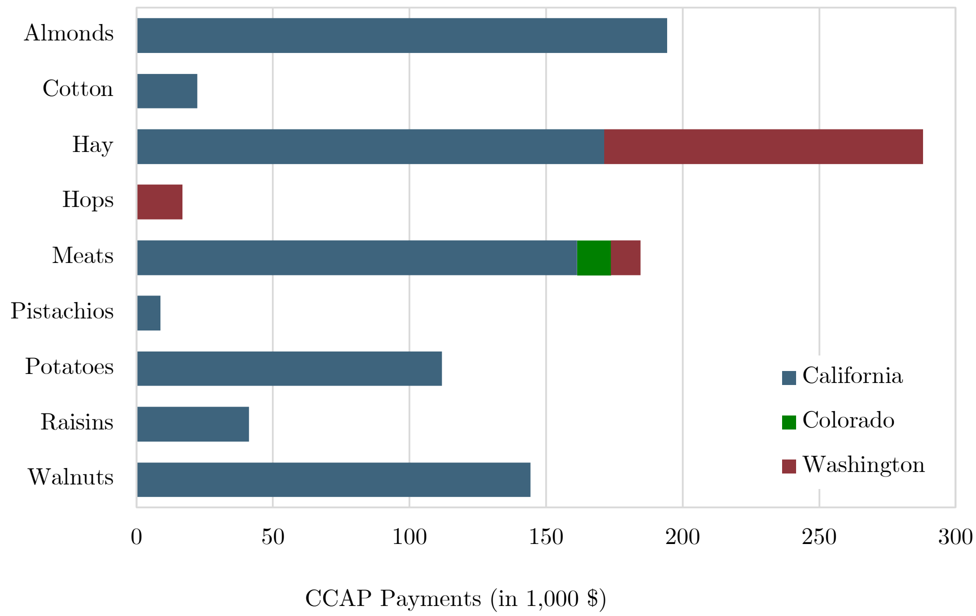


Figure 1: CCAP Payments by Commodity Group and State.

Note. The figure shows CCAP payments by commodity group and state. The commodity group was assigned based on the primary business occupation and the state based on the primary business address of the CCAP payment recipient.

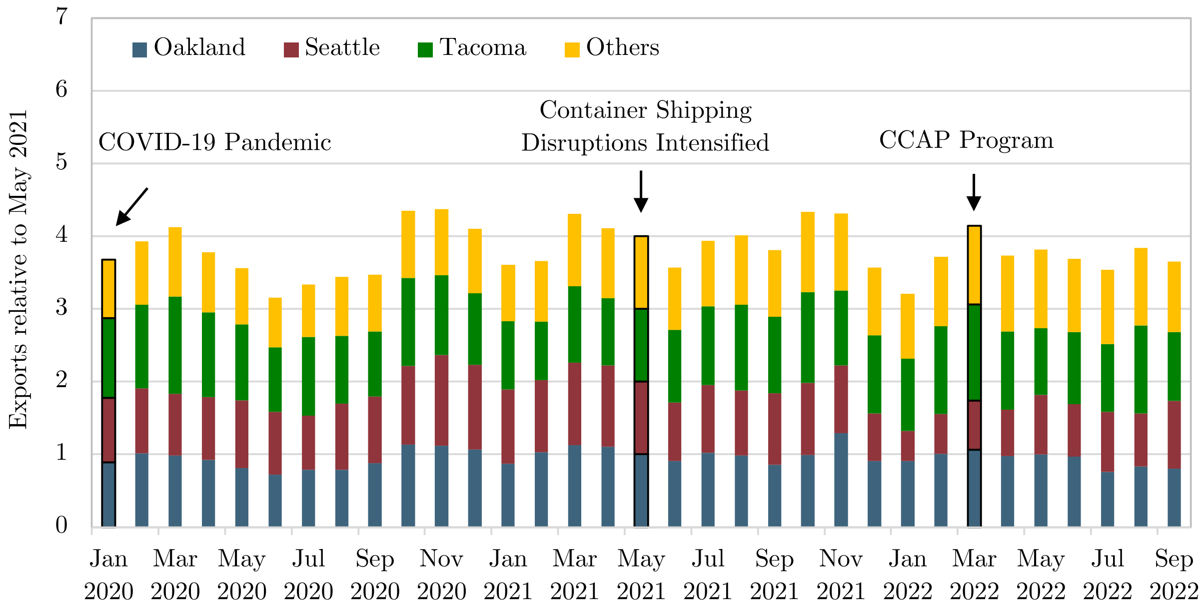
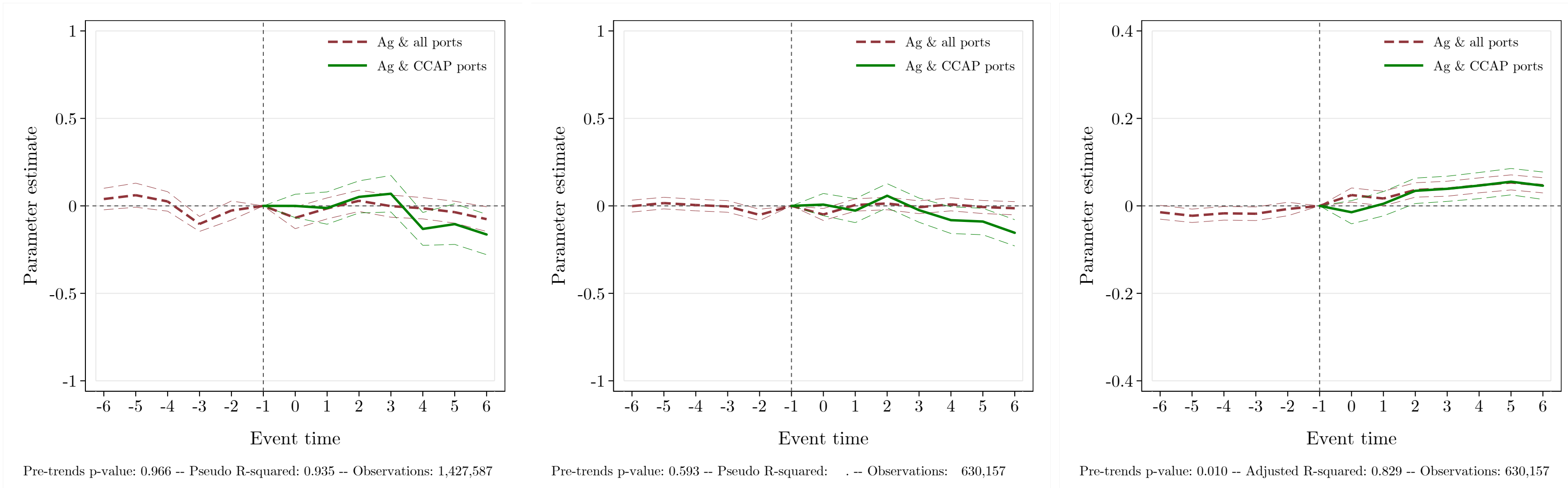
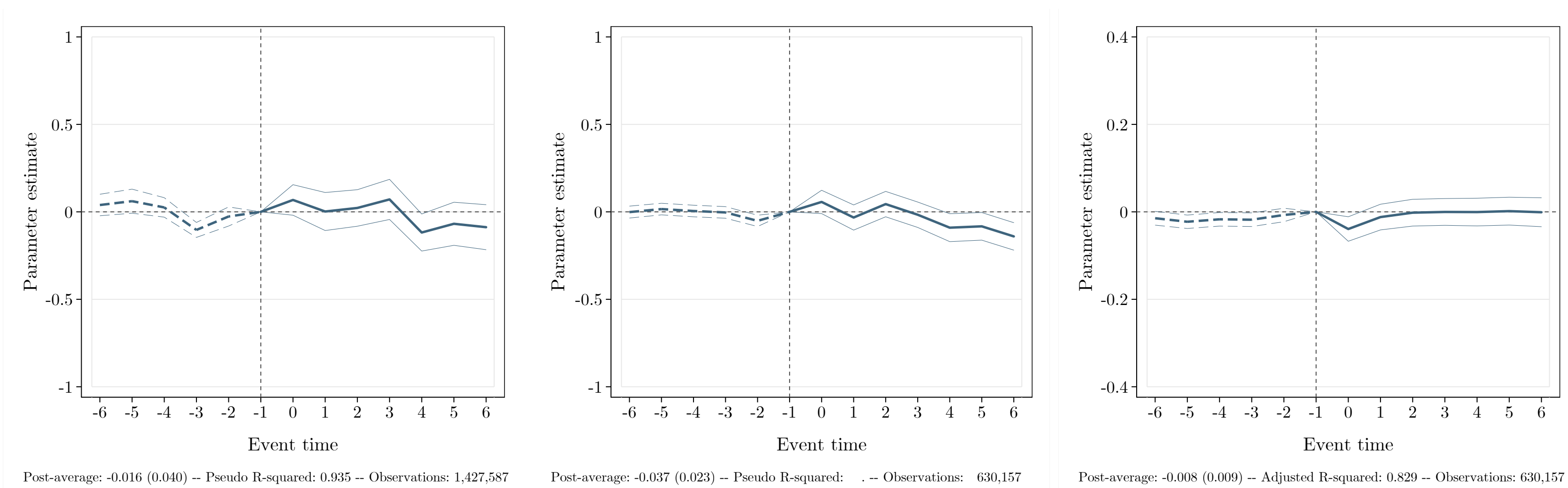


Figure 2: U.S. Containerized Agricultural Exports.

Note. The figure shows U.S. containerized agricultural exports from January 2020 to September 2022. Exports from selected port groups are measured relative to their trade values in May 2021, when the container shipping disruptions intensified. Data for the CCAP ports and the national aggregation for all other ports are presented.



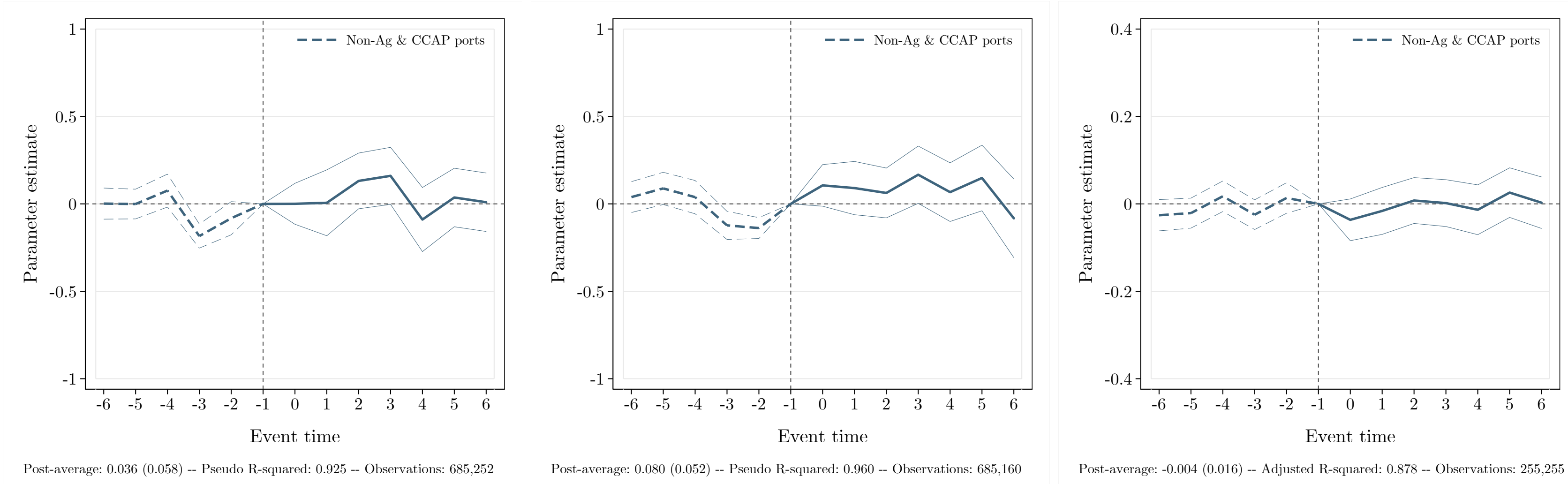
(a) Value. (b) Quantity. (c) Unit Value.



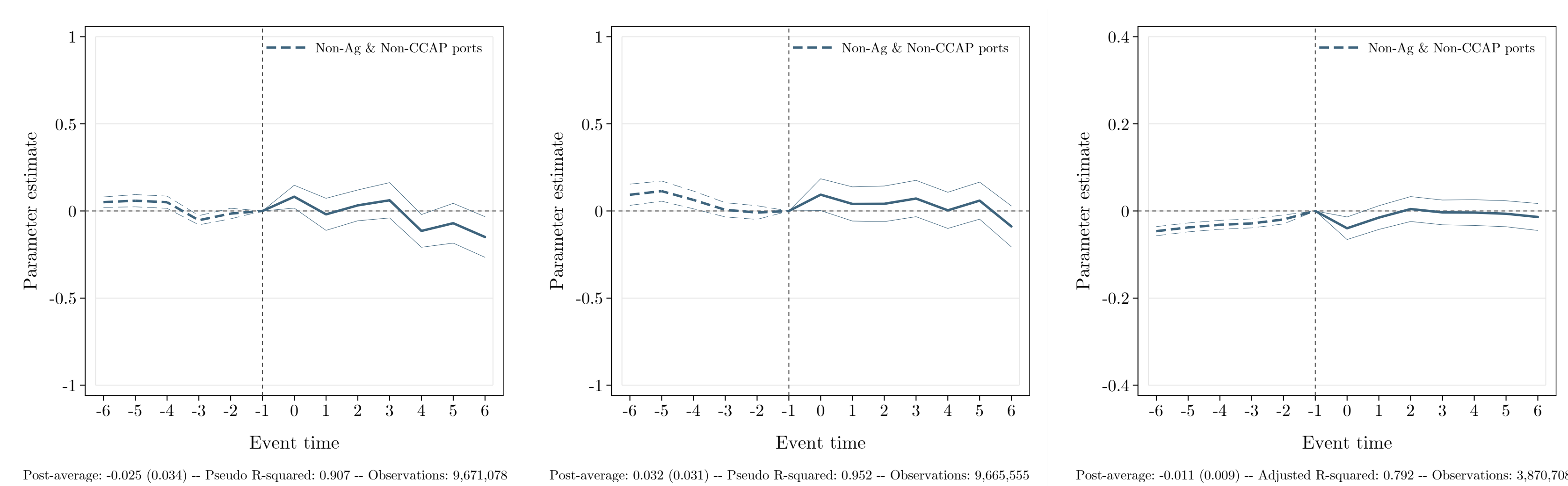
(d) Net Value Effect. (e) Net Quantity Effect. (f) Net Unit Value Effect.

Figure 3: Baseline Event Studies.

Note. The figure shows event studies for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports. All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The standard errors are adjusted for within-cluster correlation at the port-destination-good level. We plot the dynamic treatment parameters and 95 percent confidence intervals for the event-time coefficients. We report Wald tests for pre-trends, average post-event treatment effects, the pseudo/adjusted R-squared, and the panel size in the subfigure notes. The event time is measured in months relative to February 2022.



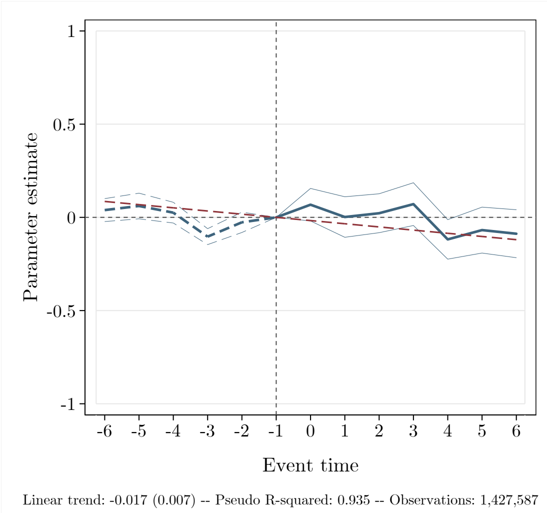
(a) Net Value Effect. (b) Net Quantity Effect. (c) Net Unit Value Effect.



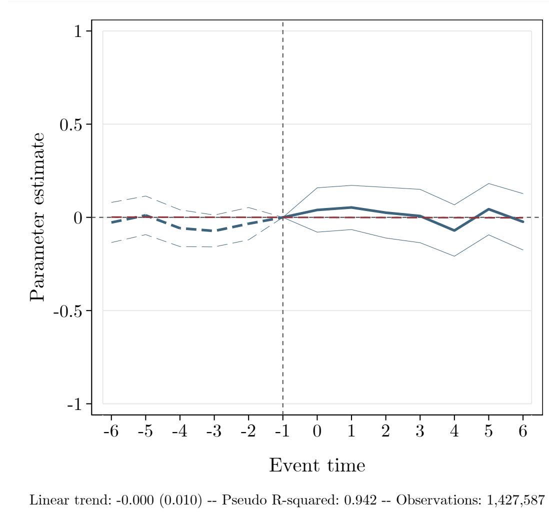
(d) Net Value Effect. (e) Net Quantity Effect. (f) Net Unit Value Effect.

Figure 4: Robustness to Different Comparison Groups.

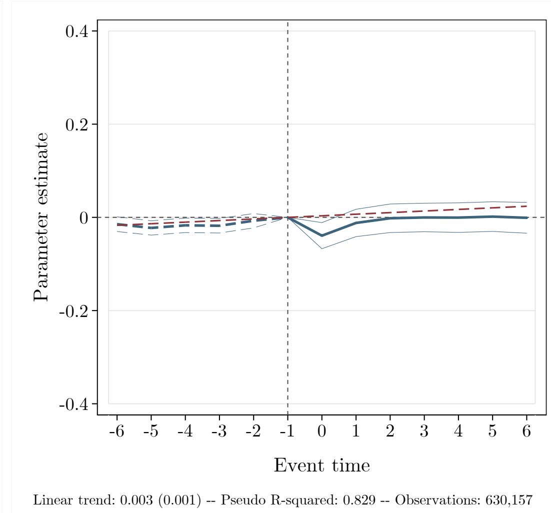
Note. The figure shows event studies for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports. We compare net treatment estimates for non-agricultural exports from treated ports as a comparison group in panels (a) to (c) with those for non-agricultural exports from non-treated ports in panels (d) to (f). All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The standard errors are adjusted for within-cluster correlation at the port-destination-good level. We plot the dynamic treatment parameters and 95 percent confidence intervals for the event-time coefficients. We report the average post-event treatment effects, the pseudo/adjusted R-squared, and the panel size in the subfigure notes. The event time is measured in months relative to February 2022.



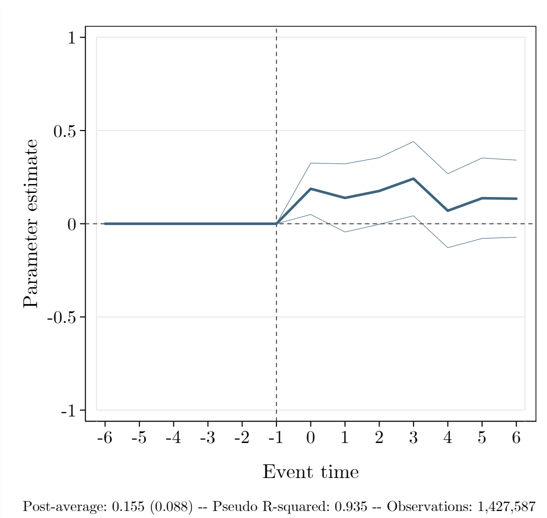
(a) Value with Overlaid Trend.



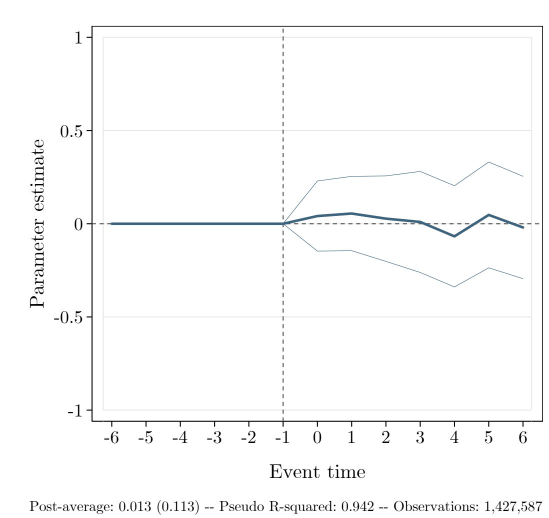
(b) Quantity with Overlaid Trend.



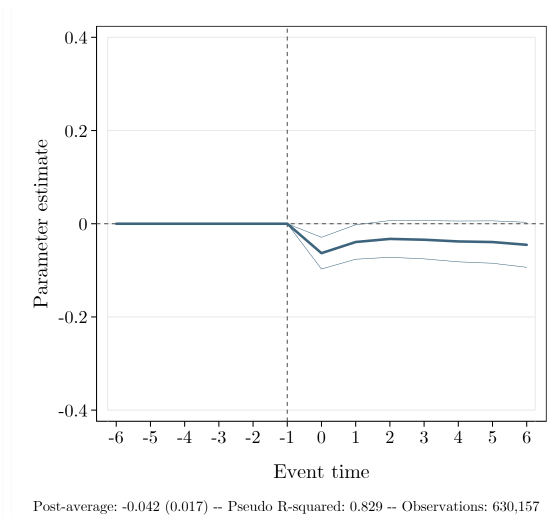
(c) Unit Value with Overlaid Trend.



(d) Value with Subtracted Trend.



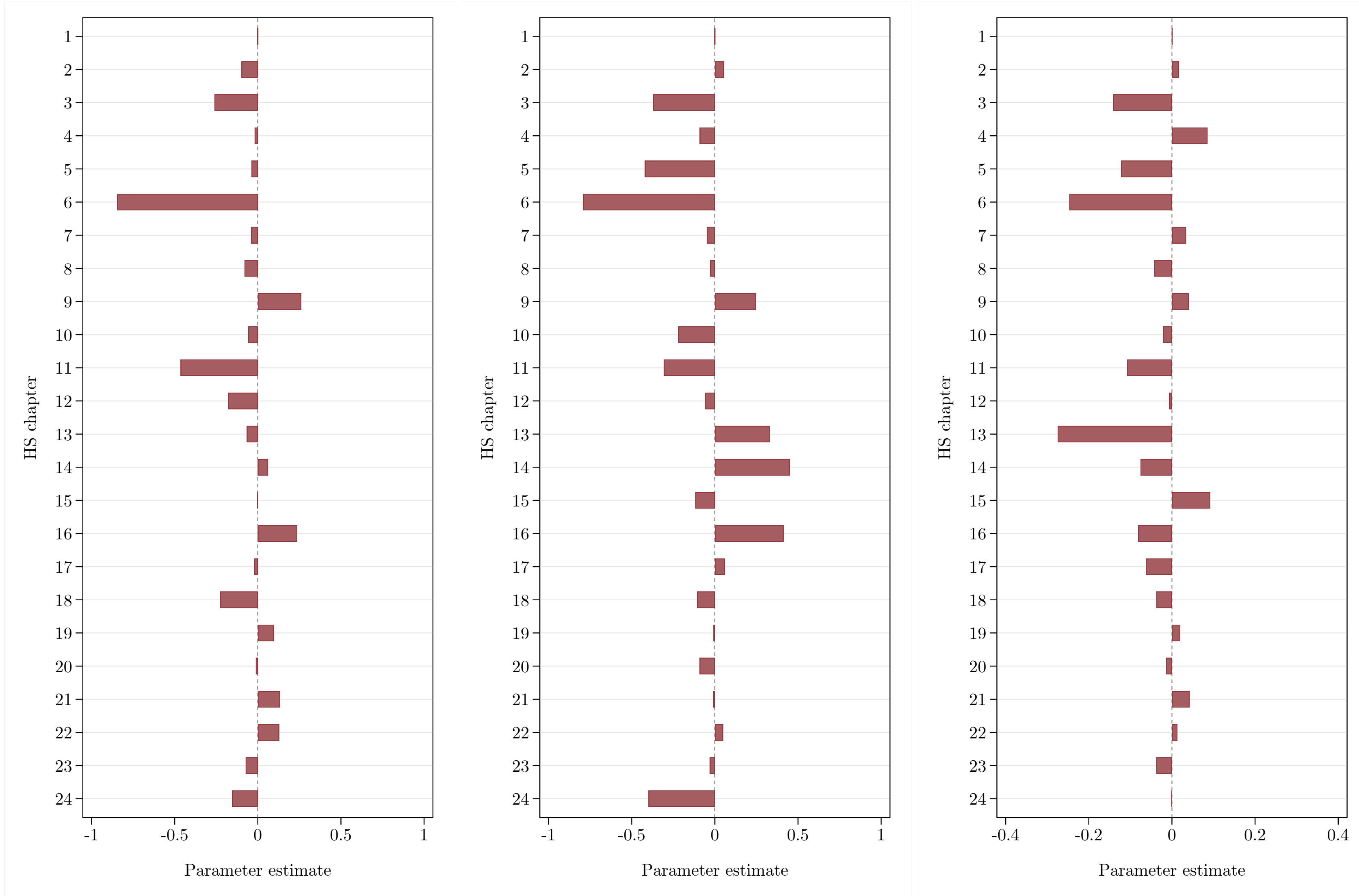
(e) Quantity with Subtracted Trend.



(f) Unit Value with Subtracted Trend.

Figure 5: Robustness to Linear Pre-Trends.

Note. The figure shows pre-trend adjusted event studies for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports. We overlaid the predicted linear pre-trends in panels (a) to (c) and subtracted them from the estimated net treatment effects in panels (d) to (f) following the approach outlined by Dobkin et al. (2018) and Freyaldenhoven et al. (2021). All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The standard errors are adjusted for within-cluster correlation at the port-destination-good level. We plot the dynamic treatment parameters and 95 percent confidence intervals for the event-time coefficients. We report Wald tests for the linear pre-trends, the average post-event treatment effects, the pseudo/adjusted R-squared, and the panel size in the subfigure notes. The event time is measured in months relative to February 2022.



(a) Value. (b) Quantity. (c) Unit Value.

Figure 6: Treatment Heterogeneity across HS Chapters.

Note. The figure shows average post-event treatment effects for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports at HS chapter level. All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The standard errors are adjusted for within-cluster correlation at the port-destination-good level.

Appendix Tables and Figures

Table A.1: Descriptive Statistics.

	Sum	Mean	SD	Min.	Max.	Obs.	Zeros
Panel (a): Commodity Container Assistance Program ports							
Value (Pre)	$972,188$	90.44	504.85	< 1	$11,680$	$10,749$	82.9%
Value (Post)	$889,901$	90.36	443.76	< 1	$10,273$	$9,848$	84.6%
Quantity (Pre)	$440,378$	40.97	203.48	< 1	$6,640$	$10,749$	82.9%
Quantity (Post)	$397,109$	40.32	199.49	< 1	$5,868$	$9,848$	84.6%
Unit Value (Pre)	$9,742$	0.91	1.00	-3	7	$10,749$	< 0.1%
Unit Value (Post)	$9,726$	0.99	1.00	-3	8	$9,848$	< 0.1%
Panel (b): All other ports							
Value (Pre)	$2,036,537$	31.69	167.79	< 1	$15,924$	$64,255$	82.9%
Value (Post)	$2,158,309$	34.15	164.08	< 1	$8,272$	$63,206$	84.2%
Quantity (Pre)	$1,364,629$	21.24	151.01	< 1	$8,226$	$64,255$	82.9%
Quantity (Post)	$1,321,370$	20.91	150.26	< 1	$8,530$	$63,206$	84.2%
Unit Value (Pre)	$69,831$	1.09	1.04	-4	9	$64,255$	< 0.1%
Unit Value (Post)	$72,762$	1.15	1.01	-5	7	$63,206$	< 0.1%

Note. The table provides the descriptive statistics for the pre- and post-event periods of the Commodity Container Assistance Program. The pre-event period covers September 2021 to February 2022, and the post-event period includes April to September 2022. We compare containerized agricultural exports from ports that participated in the Commodity Container Assistance Program in panel (a) with those that did not in panel (c). We scaled the export value by 1,000 $ and the export quantity by 1,000 kilograms. All descriptive trade statistics were calculated using positive observations. The zero share shows the proportion of zeros for each outcome in the balanced panel dataset.

Table A.2: Post-Event Treatment Effects for Different Fixed Effects.

	Value	Quantity	Unit Value
Panel (a): ijs#yr, ijs#mo			
Average post-event	-0.016	0.011	-0.008
	(0.040)	(0.042)	(0.009)
Observations	1,427,587	1,427,587	630,157
Pseudo/Adjusted R-squared	0.935	0.942	0.829
Panel (b): ijs, js#mo, is#mo, js#yr, is#yr			
Average post-event	-0.045	-0.037	-0.007
	(0.043)	(0.048)	(0.011)
Observations	5,274,700	5,273,822	1,085,583
Pseudo/Adjusted R-squared	0.870	0.895	0.737
Panel (c): ij#mo, is#mo, js#mo, ij#yr, is#yr, js#yr			
Average post-event	-0.056	-0.042	-0.004
	(0.043)	(0.048)	(0.011)
Observations	4,714,403	4,714,491	1,085,699
Pseudo/Adjusted R-squared	0.900	0.912	0.789
Panel (d): ij, i#mo, j#mo, s#mo, i#yr, j#yr, s#yr			
Average post-event	-0.046	-0.026	-0.014
	(0.038)	(0.039)	(0.010)
Observations	5,356,986	5,356,986	838,798
Pseudo/Adjusted R-squared	0.545	0.590	0.583

Note. The table shows average post-event treatment effects for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports using different fixed effect structures. The average post-event treatment effects were calculated following de Chaisemartin and D'Haultfœuille (2020). The standard errors are adjusted for within-cluster correlation at the port-destination-good level. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent confidence levels, respectively.

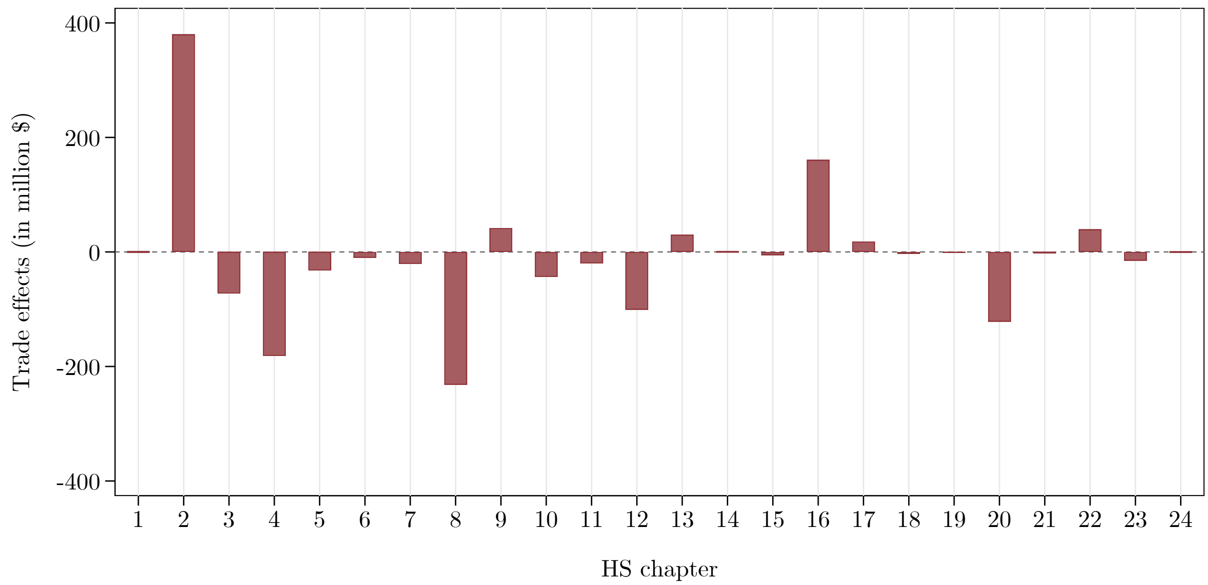
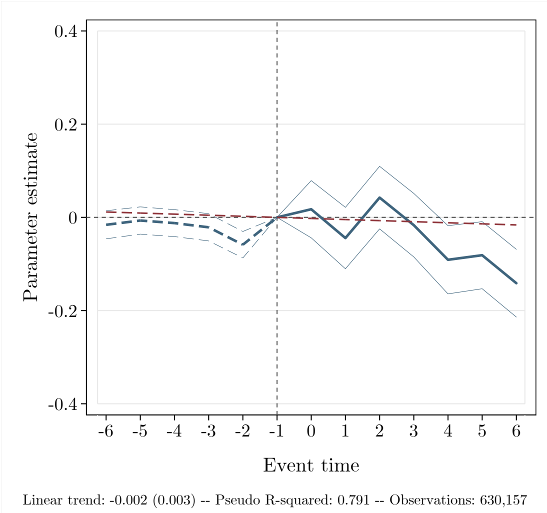
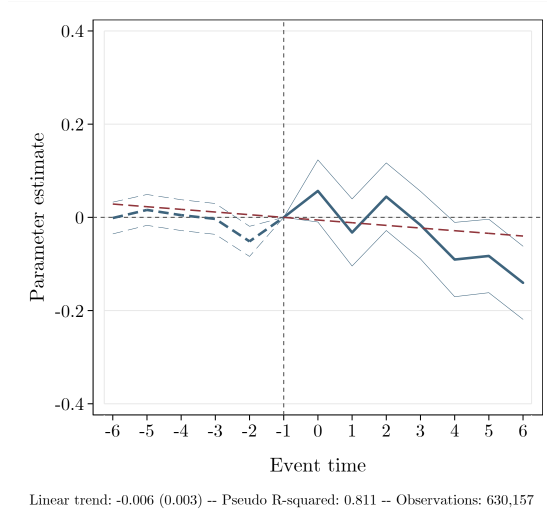


Figure A.1: Estimated Trade Effects between March and September 2022.

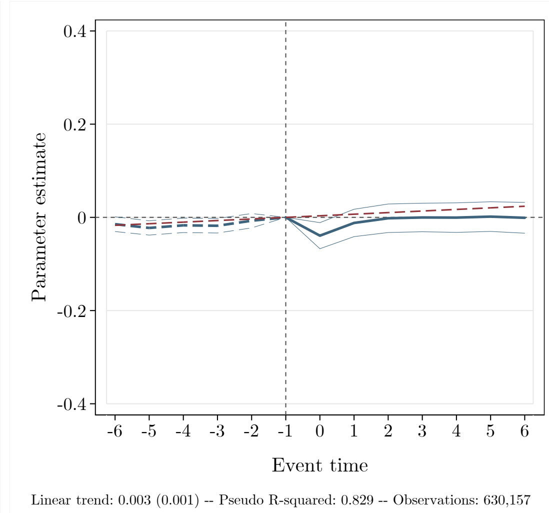
Note. The figure shows the estimated trade effects of the Commodity Container Assistance Program on U.S. containerized agricultural exports. The trade effects were calculated based on constant unit values for February 2022.



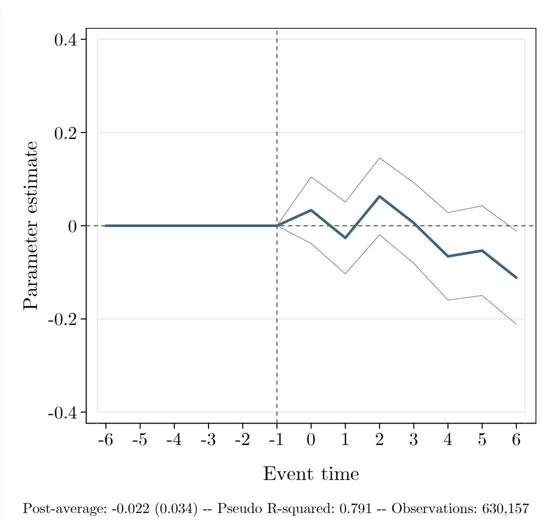
(a) Value with Overlaid Trend.



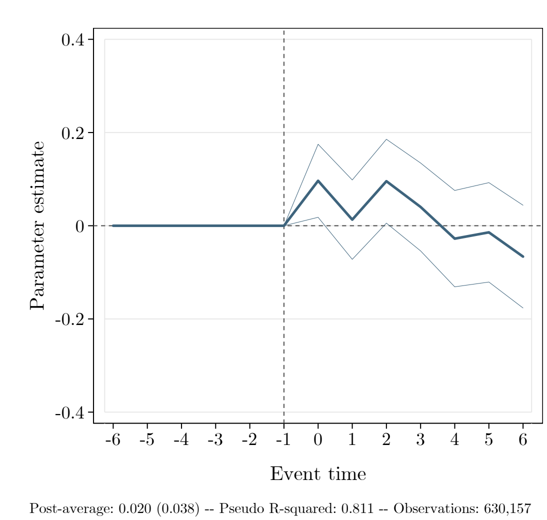
(b) Quantity with Overlaid Trend.



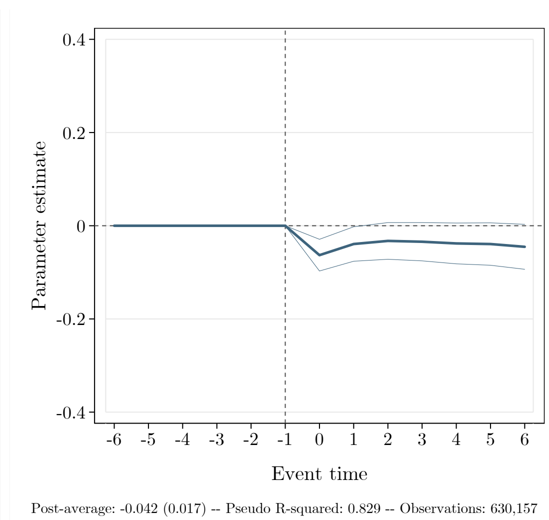
(c) Unit Value with Overlaid Trend.



(d) Value with Subtracted Trend.



(e) Quantity with Subtracted Trend.



(g) Unit Value with Subtracted Trend.

Figure A.2: Pre-Trend Adjusted Log-Linear Event Studies.

Note. The figure shows pre-trend adjusted event studies for the impact of the Commodity Container Assistance Program on U.S. containerized agricultural exports for the log-linear regression model. We overlaid the predicted linear pre-trends in panels (a) to (c) and subtracted them from the estimated net treatment effects in panels (d) to (f) following the approach outlined by Dobkin et al. (2018) and Freyaldenhoven et al. (2021). All regressions include port-destination-good-event-year and port-destination-good-event-month fixed effects. The standard errors are adjusted for within-cluster correlation at the port-destination-good level. We plot the dynamic treatment parameters and 95 percent confidence intervals for the event-time coefficients. We report Wald tests for the linear pre-trends, the average post-event treatment effects, the pseudo/adjusted R-squared, and the panel size in the subfigure notes. The event time is measured in months relative to February 2022.