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### A synthetic control approach on Argentina's beef exports suspension

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#### Abstract

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## A Synthetic Control Approach on Argentina's Beef Exports Suspension

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Argentina, a major global beef producer, suspended beef exports in May 2021 to contain rising domestic prices amid high inflation. This paper estimates the short-term impact of the export ban on retail beef prices. Using the synthetic control method, we construct a counterfactual price for a mid-sized Argentine city and compare it to observed market outcomes. The ban temporarily slowed the growth of beef prices between July and October 2021, after which prices resumed their upward trend as restrictions were relaxed. Overall, the findings suggest that export restrictions can stabilize domestic prices temporarily but have limited lasting effects.

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# 1 Introduction

Argentina plays a significant role in the global beef market, accounting for 7.3% of world exports in 2020, while also being one of the world’s largest consumers, with a per-capita beef consumption of 52 kg, representing 74.6% of its domestic production (U.S. Department of Agriculture 2023). Since 2018, beef prices rose faster than inflation due to macroeconomic instability, leading the government to suspend<sup>1</sup> beef exports in May 2021 to stabilize domestic prices (Argentine Ministry of Agriculture, Livestock, and Fisheries 2021b).

This paper estimates the impact of the beef export suspension on retail beef prices in Argentina. Because nationwide Consumer Price Index (CPI) data are unavailable at the required class level<sup>2</sup>, our analysis centers on the city of Bahía Blanca<sup>3</sup>, which provides the necessary level of disaggregation. Our data consist of class-level average prices from the CPI provided by CREEBBA, a non-profit organization that monitors retail prices following INDEC standards. To estimate the effect of the ban, we apply the synthetic control method (Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2010), which constructs a comparison unit for beef prices as a weighted average of units that best match pre-policy price dynamics.

This paper contributes to the literature on export restrictions and their effects on domestic markets. Consistent with previous findings (Götz et al. 2016; Arague, Balié, and Morales-Opazo 2020; Akter 2022), our results indicate that export restrictions can temporarily lower domestic prices. The decline we observe is consistent with Hubbard and Philippidis (2001), who report a price decrease following the 1996 British beef export ban and a partial recovery afterward, while we find a full recovery, likely due to the shorter duration of the policy. Methodologically, this paper advances the existing literature by applying a quasi-experimental design, whereas prior studies have predominantly relied on time-series analyses (Götz et al. 2016; Rossini, Arancibia, and Guiguet 2017; Djuric, Götz, and Glauben 2015). Our work also relates to Garcia-Lembergman, Rossi, and Stucchi (2018), who employ the synthetic control method to study the 2008 beef export restrictions in Bolivia; however, we focus on short-run price effects using higher-frequency data rather than long-run production.

Evidence for Argentina remains limited despite its importance in global beef markets, making our results relevant for policymakers and for other major exporters considering similar interventions. Existing studies show that past export controls in Argentina (2006–2015) lowered retail beef prices in the short run but subsequently disrupted production and contributed to higher prices (Rossini, Arancibia, and Guiguet 2017; Nogués 2011).

## 2 The beef export ban

In April 2021, Joint Resolution 3/2021 (Argentine Ministry of Agriculture, Livestock, and Fisheries 2021a) introduced Meat Export Sworn Statements, requiring firms to register exports for ministerial approval. This register gave the government the ability to deny

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1. Throughout the paper, we use the terms “ban” and “suspension” interchangeably.

2. Class is a level in Argentina’s CPI hierarchy (Instituto Nacional de Estadística y Censos 2020).

3. Bahía Blanca is a mid-sized city in Buenos Aires Province, with a population of 336,557 (Instituto Nacional de Estadística y Censos 2023).

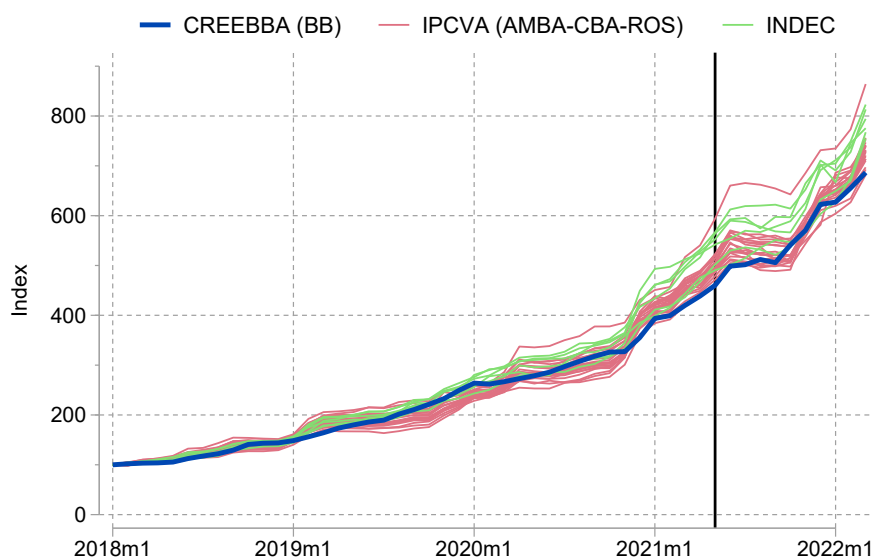
authorization, which it exercised in late May through Resolution 75/2021 to impose a 30-day ban on all beef exports, except those under tariff quotas (Argentine Ministry of Agriculture, Livestock, and Fisheries 2021b). Table 1 summarizes the four stages of the policy.

Table 1: Cronology of the suspension

| Stages     | Date     | Event                                                                                                                         |
|------------|----------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>I</b>   | 20/05/21 | Resolution 75/2021 suspended the approvals of Meat Export Sworn Statements for 30 days.                                       |
| <b>II</b>  | 23/06/21 | Export of certain cuts is allowed with an export quota of 50% of the monthly average exported in the second semester of 2020. |
| <b>III</b> | 12/10/21 | Export of cows in categories E and D is allowed.                                                                              |
| <b>IV</b>  | 01/01/22 | Seven of the suspended cuts are included in the "Cortes Cuidados" program. For the remaining goods, the export ban is lifted. |

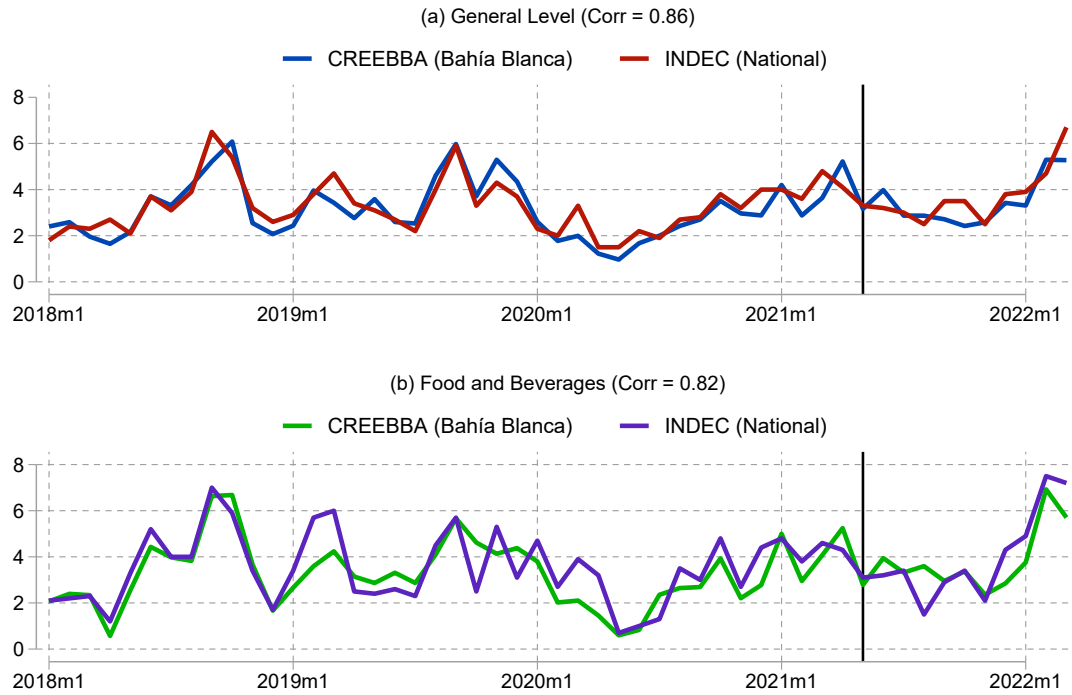
While our analysis focuses on a single city, the conclusions likely extend beyond. Beef prices in other Argentine regions mirrors the patterns seen in Bahía Blanca (Figure 1), consistent with the evidence in Daruich and Kozłowski (2023), who document that grocery chains in Argentina maintain uniform pricing across regions, exhibiting minimal within-chain variation and limited response to local conditions. At a more aggregate level, Figure 2 shows that CPI data from Bahía Blanca closely track national inflation rates, both for the general level and for the "Food and Beverages" division. Therefore, we consider that prices from Bahía Blanca provide a reliable proxy for national dynamics, allowing the effects to be generalized countrywide.

Figure 1: Evolution of beef prices by region (jan-2018 = 100)



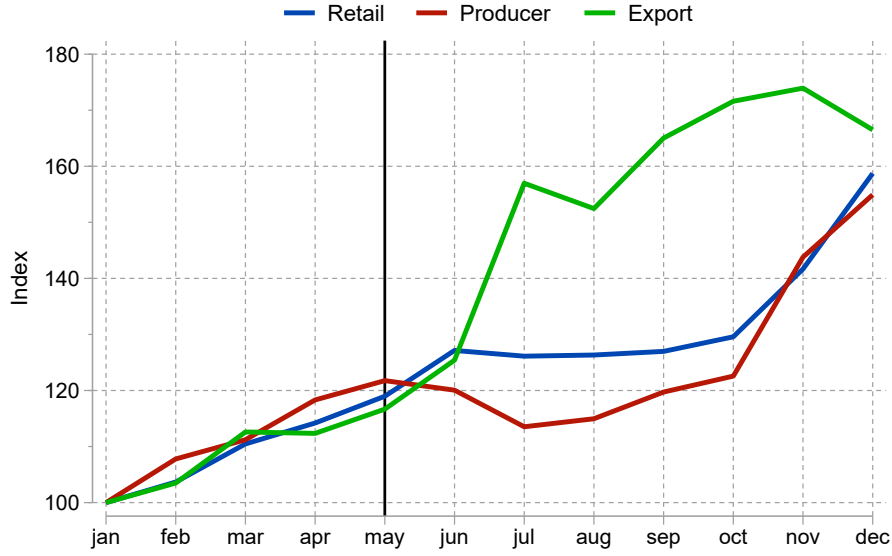
**Note:** IPCVA series are the prices of different cuts averaged between the Greater Buenos Aires, Cordoba, and Rosario cities. INDEC series are the prices of ground beef, for the six regions of Argentina.

Figure 2: Inflation dynamics (Bahía Blanca vs. Argentina)



The expected effect of the export ban in the short run is to increase domestic beef supply, generating a surplus in the market that puts downward pressure on prices. In contrast, in the long run, the policy may discourage production, eventually leading to higher prices (Garcia-Lembergman, Rossi, and Stucchi 2018; Nogués 2011). Consistent with this short-run mechanism, Figure 3 shows that following the implementation of the export ban, retail prices remained stable for several months, while the price received by producers declined. Concurrently, export prices continued to rise, further diverging from domestic price trends.

Figure 3: Evolution of beef prices in 2021



**Note:** Retail prices is the average price of Fresh Beef from CREEBBA. Producer and export prices are from the Ministry of Agriculture, Livestock, and Fisheries. The solid black line marks the policy implementation date.

### 3 Data and methodology

The data consist of monthly average CPI prices by class, obtained from CREEBBA, covering the period from January 2018 to March 2022. The time series are deseasonalized using the X13-ARIMA-SEATS. The unit subject to treatment is the class “Fresh Beef”.

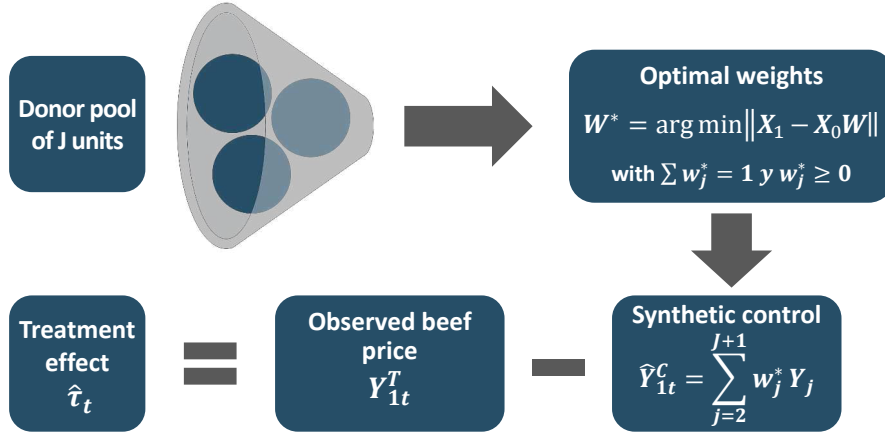
As only a single unit is treated, approaches such as difference-in-differences are unsuitable due to the lack of variation in the treatment group. In addition, there is no clear control group, as beef prices in Argentina for the same period without intervention are not observed. Therefore, we employ the synthetic control method (Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2010), which constructs a synthetic unit from a donor pool that closely matches the pre-treatment trajectory of the treated unit. Under the assumption that both would have evolved similarly absent the intervention, in standard applications, any post-treatment divergence is attributed to the treatment. In our specific context, this divergence isolates the relative effect on beef prices against the shared macroeconomic dynamics captured by the synthetic control. An advantage of this method is that it allows for time-varying unobserved components, such as market-specific shocks, unlike difference-in-differences, which relies on the parallel trends assumption and thus requires such effects to remain constant (Abadie, Diamond, and Hainmueller 2010).

The synthetic control method relies on several assumptions that must be satisfied, as discussed in Abadie (2021):

1. **Size of the effect relative to outcome volatility:** The intervention should generate an effect large enough to be distinguishable from noise within the observed post-treatment period.
2. **Availability of a comparison group:** The donor pool must include untreated units sufficiently similar to those of the treated unit.

3. **No interference/spillovers:** The treatment must not affect the outcomes of the units in the donor pool.
4. **No anticipation:** Agents should not adjust their behavior in anticipation of the intervention; any changes must occur only after treatment.
5. **Convex hull condition:** The treated unit must lie in the convex hull of the donor pool; that is, it should not be an outlier.

Figure 4: Illustration synthetic control method



The diagram in Figure 4 summarizes the synthetic control procedure. To estimate the treatment effect ( $\hat{\tau}_t$ ) we require an estimate of the counterfactual outcome that the treated unit ( $Y_{1t}^T$ ) would have exhibited in the absence of the intervention ( $Y_{1t}^C$ ). The synthetic control method constructs this counterfactual as a weighted average of the outcomes of units in the donor pool. These weights ( $W^*$ ) are chosen to minimize the distance between the treated unit and the synthetic control in terms of pre-treatment predictors ( $X_1$  and  $X_0$ , respectively), which can include lagged values of the outcome. The estimated treatment effect is computed as the difference between the observed outcome of the treated unit and that of the synthetic control.

We restrict the donor pool to the remaining 52 classes within the “Food and Beverages” division to ensure similarity with beef and to limit interpolation bias and overfitting, both of which increase with the size of the donor pool (Abadie, Diamond, and Hainmueller 2015). We do not impose further restrictions to avoid spillover effects that could violate the no-interference assumption and introduce bias (Abadie 2021), such as limiting the pool to only meat products.

This constitutes a non-canonical application of the method, as it is typically implemented using prices across regions or countries rather than across different food products. However, these prices reflect common price movements in the city over the period under identical macroeconomic conditions, including exchange rate pressures, demand factors, and government food policies. This allows us to isolate the effect of the intervention on beef prices from other shared dynamics. Accordingly, the synthetic control should be interpreted as a benchmark for common price movements, rather than as a structural counterfactual for the evolution of beef prices. Nevertheless, common macroeconomic exposure does not imply comparable price-formation mechanisms across these goods, and

this heterogeneity is not fully addressed by this approach. The treatment estimates therefore capture the relative price effect on beef prices with respect to the combination of food prices that best replicates their pre-treatment evolution.

## 4 Results

Based on the data and empirical framework described above, this section implements the synthetic control procedure and evaluates the effect of the export suspension on beef prices. The synthetic beef price is constructed using pre-intervention annual average prices as predictors (semester averages are considered in a robustness check). Because our dataset contains only average prices by class, lagged beef prices are the only possible predictors. Despite this constraint, the synthetic control closely follows the evolution of beef prices throughout the pre-intervention period, as shown below. Since the policy was implemented in late May 2021, June 2021 is considered the first treatment period, leaving 41 months in the pre-treatment period.

Table 2 presents the fitting results, comparing the observed beef price with the synthetic counterpart, and reports the optimal synthetic control weights. The synthetic control exhibits a strong pre-treatment fit, closely tracking the actual beef price prior to the intervention. However, a good pre-treatment fit is a necessary but not sufficient condition for the validity of the synthetic control, and does not by itself rule out concerns about structural differences across goods (Abadie and Vives-i-Bastida 2026). The selection of the donor units is entirely data-driven, these goods receive positive weight because their convex combination best replicate the pre-treatment trajectory of beef prices. Their weak relationship to beef helps ensure that the analysis is not affected by potential spillover effects that could arise if other meat products were included in the synthetic control.

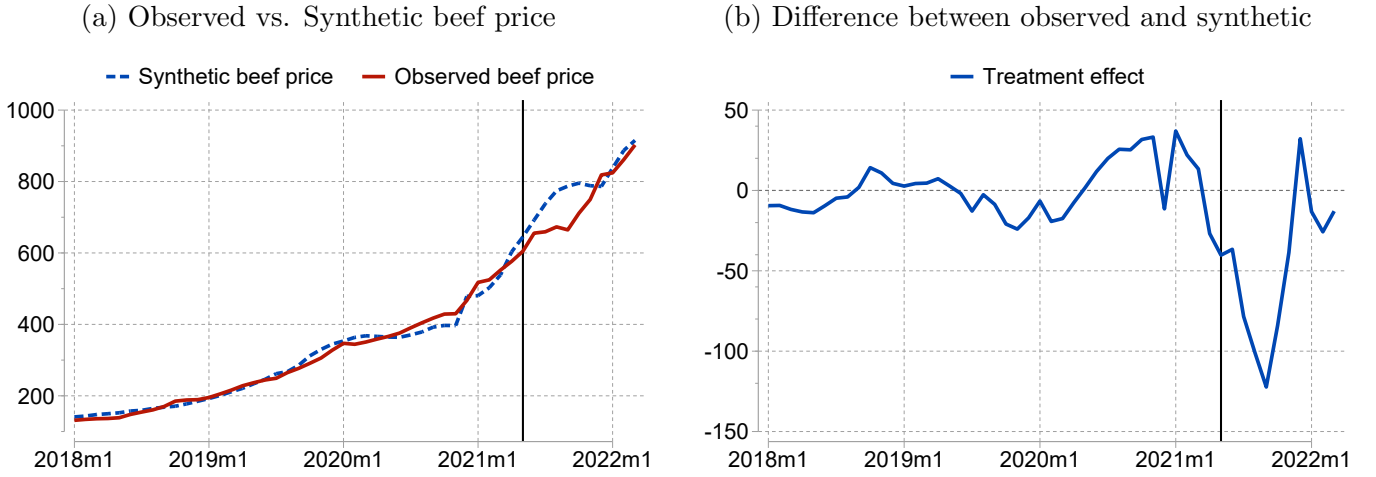
Table 2: Beef predictor means and optimal weights

| Periods                 | Weight | Observed   | Synthetic control |        | Optimal weights   |        |
|-------------------------|--------|------------|-------------------|--------|-------------------|--------|
|                         |        | Avg. (ARS) | Avg. (ARS)        | Bias   | Units             | Weight |
| <b>2018</b>             | 0.09   | 156.04     | 159.76            | 2.39%  | Beer              | 0.50   |
| <b>2019</b>             | 0.26   | 253.47     | 258.99            | 2.18%  | Semi-hard cheeses | 0.24   |
| <b>2020</b>             | 0.43   | 390.11     | 382.85            | -1.86% | Pastries          | 0.14   |
| <b>2021 (until May)</b> | 0.22   | 555.12     | 554.04            | -0.19% | Hard cheeses      | 0.12   |

**Note:**  $R^2=0.983$ . Averages expressed in Argentine pesos (ARS). Bias is the percentage deviation from the observed beef price average.

Figure 5 displays the actual beef price and the synthetic control, as well as the treatment effect, calculated as their difference. After the policy is implemented, the two series diverge markedly: the synthetic continues its upward trajectory, whereas the actual price stabilizes. This pattern indicates that the export ban slowed the evolution of beef prices, consistent with the short-run theoretical prediction that an excess supply generates downward pressure on prices.

Figure 5: Impact of the export ban on domestic beef prices



**Note:** Values expressed in Argentine pesos (ARS). Treatment effect is the difference between the observed price and the synthetic control.

Because standard large-sample inference is inappropriate for aggregate units (Abadie, Diamond, and Hainmueller 2010), we follow standard practice in the literature and assess significance using permutation tests, which generate “placebo” effects for each donor unit to evaluate how extreme the treated unit’s estimate is relative to the distribution of placebos. To verify the robustness of our findings, we also conduct temporal placebo tests, apply alternative donor pool restrictions, and estimate multiple synthetic control specifications.

Figure 6a presents the placebo estimates for each class, using a cutoff value of 5 as proposed by Abadie, Diamond, and Hainmueller (2010)<sup>4</sup>. This procedure allows us to compute p-values for each monthly treatment effect. Alternatively, Table 5 in Appendix A presents the post/pre-treatment MSPE ratios.

Table 3: Export suspension effects

| Period  | Treatment effect (ARS) | p-value |
|---------|------------------------|---------|
| June-21 | -36.62                 | 0.060   |
| July-21 | -78.43                 | 0.040   |
| Aug-21  | -100.94                | 0.020   |
| Sept-21 | -122.28                | 0.020   |
| Oct-21  | -84.12                 | 0.040   |
| Nov-21  | -38.60                 | 0.140   |
| Dec-21  | 32.16                  | 0.200   |
| Jan-22  | -13.17                 | 0.580   |
| Feb-22  | -25.73                 | 0.360   |
| Mar-22  | -12.89                 | 0.660   |

4. Units with pre-treatment MSPE values exceeding five times that of beef were excluded.

Table 3 reports the treatment effects and their statistical significance. The estimates for July through October are statistically significant: during this period, prices were on average 96.4 ARS lower due to the ban, corresponding to a 25.1% reduction relative to the expected price of beef given the prevailing inflationary environment. The largest effect is observed in September, when prices were 122.3 ARS lower, corresponding to prices being 18.4% higher in the synthetic control. Toward the end of 2021, the effect dissipates and becomes statistically insignificant, as the gradual relaxation of restrictions led beef prices to rise, suggesting that the market rapidly adjusted to the policy reversal.

Figure 6: Robustness analysis

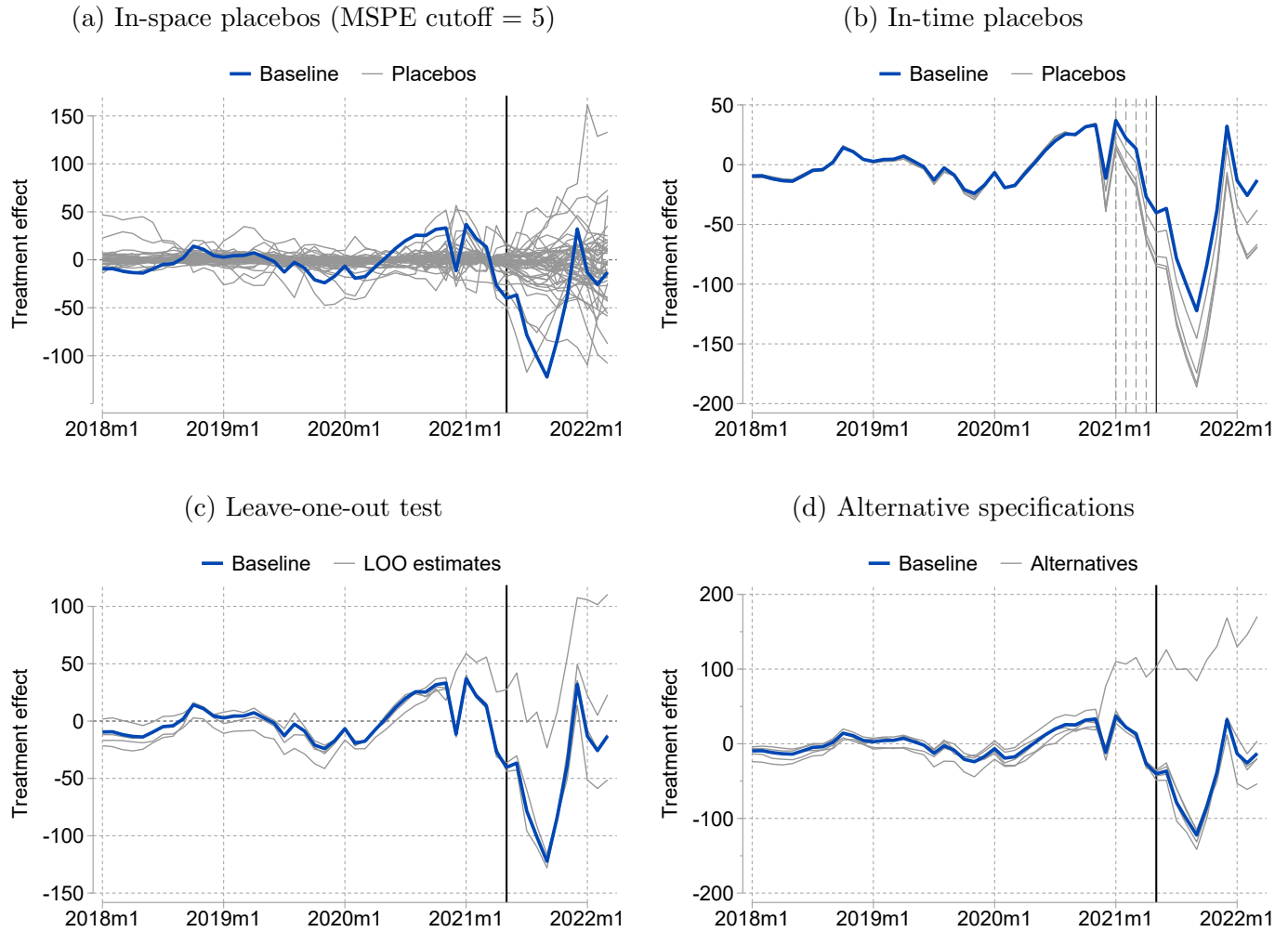


Figure 6b presents the estimates of the in-time placebos, in which the treatment date is sequentially moved backward until February. This helps detect anticipation effects that may occur before the official implementation. For example, the creation of the Meat Export Sworn Statements in April could have influenced the behavior of beef prices in advance. The results show that the placebos align with the baseline estimates. The only notable exception is a significant treatment effect observed in May, which was expected since the policy was implemented at the third week of that month. No significant effects are detected for any other months preceding the treatment date. This pattern suggests that the registration requirement alone may not have been interpreted as a commitment to suspend exports.

The leave-one-out test is presented in Figure 6c. This robustness check restricts the donor pool by individually removing the units with positive weight. Three of the four LOO estimates display a pattern similar to the baseline result. In the remaining case, the class “Beer” is removed, and the estimated impact of the export ban declines across all months, with only September exhibiting a negative effect. However, this estimate should be interpreted cautiously given the weaker pre-treatment fit. The substantial weight assigned to beer therefore warrants discussion. Rather than reflecting a theoretical relationship with beef markets, it suggests that beer prices tracked the same macroeconomic conditions during the pre-treatment period. Consistent with this interpretation, the leave-one-out analysis in Figure 6c shows that excluding beer from the donor pool markedly worsens the fit, highlighting its role in capturing common inflationary trends.

Finally, Figure 6d presents alternative specifications by changing the predictor means used. The first four models remove one of the years used for fitting the synthetic control, while the fifth model uses semester averages instead of annual. All estimates present a trajectory similar to the baseline scenario, except the one that removed the first five months of 2021, which diverges from the other estimates. This may reflect the surge in inflation during those months, which makes the treated unit difficult to follow without matching that period. Notably, the specification using semester averages produces estimates very similar to the baseline, suggesting that the results are not sensitive to whether the algorithm matches annual or semester-level pre-treatment dynamics.

The similar evolution of beef prices in Bahía Blanca and the rest of the country suggests that the observed effect extends beyond our case study. To assess its aggregate magnitude, we perform a back-of-the-envelope calculation extrapolating our estimates to the national level. This extrapolation should be interpreted with caution: the quantities used are endogenous to the policy and likely differ from those that would have prevailed without the suspension; we assume the effect estimated for Bahía Blanca applies uniformly across the country, ignoring potential heterogeneity; and we do not account for general equilibrium effects. Thus, the estimate reflects the difference that would have arisen had the same quantity of beef consumed been sold at the synthetic control price.

To compute this effect, we use the absolute values of significant treatment effects from Table 3, apparent consumption (domestic production plus imports minus exports) from the Ministry of Agriculture, Livestock, and Fisheries, and the average exchange rate from the Central Bank of Argentina. The treatment effect, measured in ARS per kilogram, is scaled to the national level by multiplying by monthly consumption and then converted to US dollars using the exchange rate. This illustrative estimate presented in Table 4 amounts to up to \$786 M. For comparison, this amount represents 29.1% of total beef exports in 2020, valued at \$2,699 M.

Table 4: Back-of-the-envelope calculation

| Period       | Treatment effect<br>(ARS/kg.) | Apparent consumption<br>(tn.) | Avg. exchange rate<br>(ARS/USD) | Total<br>(M. USD) |
|--------------|-------------------------------|-------------------------------|---------------------------------|-------------------|
| July-21      | 78.43                         | 206,858                       | 96.24                           | 169               |
| Aug-21       | 100.94                        | 208,667                       | 97.21                           | 217               |
| Sept-21      | 122.28                        | 186,870                       | 98.29                           | 232               |
| Oct-21       | 84.12                         | 197,993                       | 99.25                           | 168               |
| <b>Total</b> |                               |                               |                                 | <b>786</b>        |

## 5 Conclusions

Using the synthetic control method, we find that Argentina’s May 2021 beef export suspension temporarily slowed domestic beef price growth between July and October 2021, with the effect dissipating as restrictions were eased. These findings suggest that while temporary export restrictions can moderate prices in the short run, their effects are transitory.

Policymakers should weigh these policies carefully, considering also their long term effects on production and market stability. Existing evidence for Argentina (Nogués 2011; Rossini, Arancibia, and Guiguet 2017) and Bolivia (Garcia-Lembergman, Rossi, and Stucchi 2018) suggests that prolonged export restrictions can discourage investment in livestock production, reduce the cattle stock over time, and ultimately generate upward pressure on prices in the medium run. This evidence highlights the trade-offs inherent in export restrictions.

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## A Appendix

Table 5: Ratios of post-treatment MSPE to pre-treatment MSPE

| Class                                  | Post/Pre<br>MSPE | Pre MSPE of Fake Unit/<br>Pre MSPE of Treated Unit |
|----------------------------------------|------------------|----------------------------------------------------|
| Fresh Bread                            | 4.2              | 0.1                                                |
| Packaged Bread                         | 10.9             | 0.0                                                |
| Pastries                               | 35.4             | 0.1                                                |
| Cookies                                | 24.1             | 0.0                                                |
| Salty Crackers                         | 48.9             | 0.0                                                |
| Bakery Products                        | 9.5              | 50.2*                                              |
| Rice                                   | 37.3             | 0.0                                                |
| Wheat Flour                            | 36.7             | 0.0                                                |
| Dry Pasta                              | 10.5             | 0.0                                                |
| Fresh Pasta                            | 26.3             | 0.0                                                |
| Pre-cooked Dough and Pastry Sheets     | 5.0              | 0.0                                                |
| <b>Fresh Beef</b>                      | <b>14.7</b>      | <b>1.0</b>                                         |
| Fresh Poultry                          | 4.9              | 0.2                                                |
| Fresh Fish and Seafood                 | 5.5              | 2.5                                                |
| Cold Cuts                              | 32.2             | 0.0                                                |
| Sausages, Canned and Prepared Meat     | 52.2             | 0.1                                                |
| Canned and Prepared Fish               | 2.5              | 0.1                                                |
| Blended Oil                            | 24.6             | 0.0                                                |
| Pure Oil                               | 18.5             | 0.2                                                |
| Margarine and Other Fats               | 40.2             | 0.0                                                |
| Fresh Milk                             | 8.6              | 0.0                                                |
| Powdered Milk                          | 13.0             | 0.4                                                |
| Soft and Spreadable Cheeses            | 6.6              | 0.1                                                |
| Semi-hard Cheeses                      | 25.1             | 1.0                                                |
| Hard Cheeses                           | 4.4              | 444.8*                                             |
| Butter and Cream                       | 11.7             | 0.0                                                |
| Yogurt and Dairy Desserts              | 6.9              | 0.0                                                |
| Eggs                                   | 9.6              | 0.2                                                |
| Fresh Fruits                           | 81.0             | 0.1                                                |
| Dried and Canned Fruits                | 3.1              | 0.1                                                |
| Vegetables, Tubers, and Legumes        | 57.4             | 0.1                                                |
| Canned Vegetables, Tubers, and Legumes | 3.9              | 0.0                                                |
| Sugar                                  | 8.4              | 0.0                                                |
| Jams                                   | 562.8            | 0.0                                                |
| Candies                                | 54.8             | 0.0                                                |
| Cocoa and Its Derivatives              | 100.7            | 0.0                                                |
| Coffee                                 | 30.9             | 0.1                                                |
| Tea                                    | 7.1              | 0.0                                                |
| Yerba Mate                             | 12.1             | 0.1                                                |
| Salt and Spices                        | 18.8             | 0.0                                                |
| Dressings                              | 12.6             | 0.0                                                |
| Broths and Concentrated Soups          | 89.3             | 0.0                                                |
| Dessert Powders                        | 50.2             | 0.0                                                |

Table 5: Ratios of post-treatment MSPE to pre-treatment MSPE (continued)

| <b>Class</b>                | <b>Post/Pre<br/>MSPE</b> | <b>Pre MSPE of Fake Unit/<br/>Pre MSPE of Treated Unit</b> |
|-----------------------------|--------------------------|------------------------------------------------------------|
| Prepared Meals              | 1.8                      | 0.8                                                        |
| Empanadas and Pizzas        | 2.2                      | 0.8                                                        |
| Ice Cream                   | 9.6                      | 2.1                                                        |
| Sodas                       | 78.4                     | 0.0                                                        |
| Juices and Refreshments     | 4.9                      | 0.4                                                        |
| Sparkling and Mineral Water | 96.1                     | 0.0                                                        |
| Wine                        | 34.4                     | 0.0                                                        |
| Beer                        | 9.1                      | 8.2*                                                       |
| Snacks                      | 10.1                     | 0.2                                                        |
| Lunch                       | 31.9                     | 0.3                                                        |

**Note:** \* indicate that the class is excluded from the p-value calculation for the cutoff value of 5.