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How U.S. Travel Restrictions on China Affected the Spread of COVID-19 in the United States*

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Abstract

Early in the COVID-19 pandemic, President Trump imposed travel restrictions on the People's Republic of China (PRC) to slow its spread to the United States. We use the synthetic control method (SCM) under sixteen different specifications to see whether the travel restrictions slowed the domestic spread of COVID-19. The travel restrictions had no effect on the number of COVID-19 cases in the United States. Regardless of the intervention date or how the spread of COVID-19 is measured, we find that the travel restrictions did not delay the prevalence of COVID-19 in the United States.

JEL Codes: I10, I18, J15

Key Words: Travel bans, immigration, COVID-19, SARS nCoV-19

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1 Introduction

On February 2, 2020, President Donald Trump banned the entry of all aliens who were physically present within the People's Republic of China (PRC) during the 14-day period preceding their entry or attempted entry into the United States, with some exceptions for U.S. lawful permanent residents and those closely related to American citizens (White House, 2020). The U.S. travel restriction was the earliest domestic nonpharmaceutical intervention to limit the spread of SARS-CoV-2 (COVID-19) in the United States. Peer-reviewed papers on the effect of international travel bans on the spread of COVID-19 find that they delay the spread by a few days up to 2-3 weeks. However, those papers rely entirely on epidemiological models of emigration restrictions from the epicenter of the outbreak in Hubei (Chinazzi et al., 2020; Wells et al., 2020), focus on travel restrictions imposed by other countries like Japan (Anzai et al., 2020), or on how domestic travel restrictions in the PRC affected the spread of COVID-19 among Chinese cities (Fang et al., 2020).

The U.S. travel restriction on people who had been in the PRC in the two weeks prior to their attempted entry, which is a de facto ban on the entry of all Chinese residents, allows us to empirically estimate the extent to which the restriction affected the spread of COVID-19 in the United States. Historically, travel restrictions to prevent the spread of pandemic influenzas have been ineffective at halting or significantly delaying the spread (WHO Writing Group, 2006). This is the first paper to examine how U.S. travel restrictions affected the spread of COVID-19 in the United States.

2 Data and Empirical Strategy

This paper uses the synthetic control method (SCM) to estimate a counterfactual number of COVID-19 cases for the United States in the absence of the February 2, 2020 travel restriction (Abadie, 2019; Abadie et al., 2010, 2015; Abadie et al., 2003; McClelland et al., 2017). We use four different outcome variables to measure number of COVID-19 cases: the cumulative number of new COVID-19 cases, the cumulative number of COVID-19 cases per million, the number of new cases, and the number of new cases per million. The predictor variables are those that influence the number of COVID-19 cases.

The SCM is used outside of laboratory settings to create a more comparable control group when such a control group does not exist. The SCM is particularly useful when examining how policy interventions affect countries. This method mitigates endogeneity by creating a counterfactual Synthetic United States based on the same pre-treatment predictor variables that affect the number of COVID-19 cases. The only difference between the Real United States and the Synthetic United States is the PRC travel restriction.

This new Synthetic United States is estimated using a weighted average of predictor variables in similar countries that did not institute a PRC travel restriction during the time studied. The weighted average of predictor variables is determined by matching countries that share similar observable characteristics with the United States on the predictor variables that influence the number of COVID-19 cases before the travel ban. Given a set of weights, the SCM estimates the impact of the travel restriction as the difference between the number of COVID-19 cases in the Real United States and the number of COVID-19 cases in the Synthetic United States after the travel ban was enacted.

To outline this procedure, let Y_i be the sample mean of an outcome of interest for country i. The estimated treatment effect τ_1 for the United States ($i = 1$) is estimated as a weighted average of $N + 1$ donor countries in the form:

$$\tau_1 = Y_1 - \sum_{i=2}^{N+1} w_i Y_i. \tag{1}$$

This procedure considers the weighting vector $W = [w_2, \ldots, w_{N+1}]'$ which assigns a weight w_i to control countries subject to non-negativity ($\{w_i \in [0, 1]; i = 2, \ldots, N + 1\}$) and additive ($w_2 + \cdots + w_{N+1} = 1$) constraints (Nowrasteh et al., 2020).

The intervention period is February 2, 2020. The pre-treatment period begins on January 22, 2020 and runs to February 1, 2020. The post-intervention period begins on February 3, 2020 and runs through March 9, 2020, right before other countries in the sample began to impose similar travel bans on China. The weighted average of the country-predictor variables in the pre-treatment period is the basis for the construction of the Synthetic United States. The average weight of the predictor variables for the Synthetic United States in the pre-treatment period is then drawn out into the post-treatment period. The values for the average weights of the predictor variables in the countries in the post-treatment period continue to construct the Synthetic United States.

To test the robustness of our results, we also analyze specifications that use reasonable alternative options for the intervention period and the start of the pre-treatment period. First, we used specification in which we changed the intervention period to February 16, 2020 to account for the 14-day length of the travel ban. Second, we tested specifications in which we normalized the data for all countries such that the first day of the pre-treatment period was the first day when there was one case of COVID-19 in each country in the donor pool. This second change does not affect the SCM's validity as no other countries in the donor pool had a PRC travel ban.

A Synthetic United States must be estimated from comparable countries to avoid interpolation bias. Since the number of COVID-19 cases after the U.S. travel ban is the outcome of interest, we select a donor pool of countries with similar levels of economic development (OECD, 2020), that are in the Northern Hemisphere (Luo et al., 2020), and that did not impose a travel ban on China until after the end of the post-treatment period (IATA, 2020). Most countries in the donor pool imposed a limited travel ban on Chinese citizens from Hubei province in the PRC (Chinazzi et al., 2020). Those travel bans on Hubei do not contaminate our donor pool because the Chinese government already instituted emigration bans from Hubei, making travel restrictions on the entry of people from Hubei redundant. This leaves 13 countries in our donor pool: Austria, Belgium, Canada, France, Germany, Ireland, Japan, South Korea, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom

The outcome variable for the SCM specifications 1-4 is the cumulative number of COVID-19 cases. The outcome variable for SCM specifications 5-8 is the rate of cumulative COVID-19 cases per million American residents. The outcome variable for specifications 9-12 is the number of new cases. The outcome variable for specification 13-16 is the rate of new cases per million American residents. In total, we ran sixteen SCM specifications.

The predictor variables for each specification are the immigrant population, the total population, population density, the percent of the population that is elderly, the share of the population that is urban, the median age, real GDP per capita (PPP), the absolute latitude or distance from the equator, the number of immigrants from China, and the number of airports with direct flights to China. We remove total population as a predictor variable from specifications 5-8 and 13-16 because population is already controlled for by the outcome variable. These predictor variables are similar to those in other SCM research on the effect of state-level social distancing policy on the spread of COVID-19 (Friedson et al., 2020). We do not include lags of the outcome variables as predictor variables in any specification to avoid biasing our results (Kaul et al., 2018).

3 Results

3.1 Main Results

Table 1 Panel A shows the results and goodness of fit measures for SCM specifications 1-4 where the outcome variable is the cumulative number of COVID-19 cases per day. The different specifications are identified in columns 1 through 4. Row 1 shows the average estimated effect of the U.S. travel ban on the cumulative number of confirmed COVID-19 cases. In brackets below, we present the placebo-based p-values for each specification. These p-values represent the share of placebos with an estimated treatment effect greater than the Synthetic United States. The Root Mean Square Predicted Error (RMSPE) measures the distance between the Real United States and the Synthetic United States during the pre-treatment period. For all specifications, the RMSPEs are low and show a good pre-treatment fit. Additionally, we report the proportion of pre-treatment placebo RMSPEs that are at least as large as that of the Synthetic United States. These large p-values indicate that the pre-treatment fit for the United States is better than most other countries in the donor pool. Panel A of Tables 2, 3, and 4 describe the country donor weights, predictor variable weights, and predictor variable balance for the Synthetic United States for specifications 1-4.

Specifications 1-4 show a statistically insignificant difference in the number of COVID-19 cases between the Synthetic United States and the Real United States after the travel restrictions were imposed (Figure 1). Table 1 shows the average p-values during the post treatment period for each specification and they are all far too high to be statistically significant. The p-values measure the fraction of gaps from an in-place placebo test that is larger than the gap between Real United States and Synthetic United States (Figure 2). Pooling these placebo effects together estimates the distribution of observed treatment effects in the sample. The p-value denotes the probability that the estimated treatment effect for the United States is larger than all other placebo effects for the other countries in the donor pool. The p-values are presented for each day and there are no days in any specification where there is a statistically significant gap.

The figures for specifications 1 and 3 appear to show a statistically significant divergence beginning around day 30, long after the intervention date in specification 1 and shortly after for specification 3 (Figure 1). However, both apparent divergences for the Synthetic United States are insignificantly different from the Real United States because there is substantial variation in the number of COVID-19 cases among the donor pool countries at that time. Figure 2 shows that there was no statistically significant divergence in specifications 1 or 3. There is no statistically significant difference in the number of COVID-19 cases in the Real United States with a travel ban compared to the Synthetic United States without a travel ban.

Table 1 Panel B shows the results and goodness of fit measures for SCM specifications 5-8 where the outcome variable is the number of COVID-19 cases per million residents. Each specification reveals statistically insignificant gaps in the post-treatment period. While results in Figure 3 appears to show significant departures in the COVID-19 case rate per million, placebo tests reveal that the gaps are insignificant compared to other donor countries (Figure 4). This result is echoed by insignificant average effects (Table 1 Panel B). Panel B of Tables 2, 3, and 4 describe the country donor weights, predictor variable weights, and predictor variable balance for the Synthetic United States for specifications 5-8.

Taken together, we find no statistical evidence to suggest that the U.S.-China travel ban impacted the spread of COVID-19 in the United States relative to other comparable countries. Our SCM results hold both for the cumulative number of COVID-19 cases and the rate of cumulative cases per million American residents.

3.2 Travel Restrictions and the Disease Growth Curve

Travel restrictions may also impact the spread of COVID-19 by flattening the disease growth curve. For instance, restricting the number of potential disease carriers who can enter the United States may slow the spread of the epidemic by reducing the number of international transmissions. Banholzer et al. (2020) find a distinct, non-zero effect of border closures on the spread of COVID-19 cases but these effects are more likely to appear in the short run following the border restrictions.

We test this channel by running SCM specifications 9-16 using the number of new cases as the outcome variable to measure the disease curve for each country in our sample. We re-run each of our main specifications, replacing the response variable with the first-difference in

COVID-19 cases: $\Delta Y_{it} = Y_{it} - Y_{it-1}$, where Y_{it} is either the number of new COVID-19 cases or new cases per million. This outcome variable lets us examine whether the U.S. travel restrictions on the PRC impacted the growth of COVID-19 infections in the United States compared to countries in the donor pool.

The goodness of fit measures and results for specifications 9-12 and specifications 13-16 are in Table 5. The RMSPEs are low so there is a good pre-treatment fit between the Real and Synthetic United States. Tables 6, 7, and 8 describe the country donor weights, predictor variable weights, and predictor variable balance for the Synthetic United States for specifications 9-16.

Again, we find no statistically significant association between the U.S. imposition of travel restrictions on the PRC and the number of new cases or the new case rate per million. Additionally, there is no significant effect of the travel ban on the number of new cases or the rate of new cases per million in the long-run, shown by large p-values on average for each specification (Table 5). This means that the estimated gaps between the Real and Synthetic United States were relatively small compared to those of other placebo countries (Figures 6 and 7). The U.S. travel restriction on the PRC had no discernible effect on flattening the disease growth curve.

4 Discussion

If a U.S. restriction on travel from the original COVID-19 hotspot in the PRC were to have a significant effect in delaying the spread of the disease domestically, we would expect to see it in every specification that we ran. Thus, our findings imply that travel restrictions in response to COVID-19 were ineffective at containing its spread. Each specification reveals no statistically significant divergence in the number of COVID-19 cases or case rate per million between the Real United States with a ban on travel from China and the Synthetic United States without a ban on travel from China.

5 Conclusion

In the sixteen SCM specifications that we ran, the U.S. ban on travel from the PRC had no effect on the spread of COVID-19 in the United States compared to a donor pool of comparable rich nations in the Northern Hemisphere without such a policy. These results are robust under an in-place placebo test. The empirical evidence suggests that the U.S.-imposed travel ban on the PRC had no statistically significant effect on the timing, number, or rate of COVID-19 cases in the United States. Similarly, we find no empirical evidence to suggest that the U.S.-PRC travel restrictions helped flatten the disease growth curve in the United States. Regardless of how we define the intervention date and regardless of whether the spread of COVID-19 is measured by the cumulative number of cases, the cumulative number of cases per million residents, the number of new cases, or the rate of new cases per capita, we find that the travel ban did not curtail the spread of COVID-19 in the United States. President Trump's February 2, 2020 ban on travel from the PRC did nothing to slow the spread of COVID-19 in the United States.

References

Abadie, A. (2019). Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects. *Journal of Economic Literature (forthcoming)*. http://economics.mit.edu/files/17847

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, *105*(490), 493–505. https://doi.org/10.1198/jasa.2009.ap08746

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, *59*(2), 495–510. https://doi.org/10.1111/ajps.12116

Abadie, A., & J., G. (2003). The economic costs of conflict: A case study of the Basque country. *American Economic Review*, *93*(1), 113–132. https://doi.org/10.1257/000282803321455188

Anzai, A., Kobayashi, T., Linton, N., Kinoshita, R., Hayashi, K., Suzuki, A., Yang, Y., Jung, S., Miyama, T., Akhmetzhanov, A., & Nishiura, H. (2020). Assessing the impact of reduced travel on exportation dynamics of novel coronavirus infection (COVID-19). *Journal of Clinical Medicine*, *9*(2), 601. https://doi.org/10.3390/jcm9020601

Banholzer, N., van Weenen, E., Kratzwald, B., Seeliger, A., Tschernutter, D., Bottrighi, P., Cenedese, A., Salles, J. P., Vach, W., & Feuerriegel, S. (2020). Impact of non-pharmaceutical interventions on documented cases of covid-19. *medRxiv*. https://doi.org/10.1101/2020.04.16.20062141

Chinazzi, M., Davis, J., Marco, A., Gioannini, C., Litvinova, M., Merler, S., Piontti, P., Mu, K., Rossi, L., Sun, K., Viboud, C., Xiong, X., Yu, H., Halloran, M., Longini Jr., I., & Vespignani, A. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. *Science*, *368*(6489), 395–400. https://doi.org/10.1126/science.aba9757

Fang, H., Wang, L., & Yang, Y. (2020, March). Human Mobility Restrictions and the Spread of the Novel Coronavirus (2019-nCoV) in China (Working Paper No. 26906). National Bureau of Economic Research. https://doi.org/10.3386/w26906

Friedson, A., McNichols, D., Sabia, J., & Dave, A. (2020, April). Did California's shelter-in-place order work? early coronavirus-related public health effects (Working Paper No. 26992). National Bureau of Economic Research. https://doi.org/10.3386/w26992

IATA. (2020). Coronavirus Outbreak – Update. Travel News. https://www.iatatravelcentre.com/international-travel-document-news/1580226297.htm

Kaul, A., Klößner, S., Pfeifer, G., & Schieler, M. (2018). Synthetic Control Methods: Never Use All Pre-Intervention Outcomes Together With Covariates (Working Paper No. 83790). Munich Personal RePEc Archive. https://mpra.ub.uni-muenchen.de/id/eprint/83790

Luo, W., Majumder, M. S., Liu, D., Poirier, C., Mandl, K. D., Lipsitch, M., & Santillana, M. (2020). The role of absolute humidity on transmission rates of the COVID-19 outbreak. *medRxiv*. https://doi.org/10.1101/2020.02.12.20022467

McClelland, R., & Gault, S. (2017). The synthetic control method as a tool to understand state policy. https://www.urban.org/research/publication/synthetic-control-method-tool-understand-state-policy

Nowrasteh, A., Forrester, A. C., & Blondin, C. (2020). How mass immigration affects countries with weak economic institutions: a natural experiment in Jordan. *The World Bank Economic Review*, *34*(2), 533–549. https://doi.org/10.1093/wber/lhy032

OECD. (2020). List of OECD Member Countries. https://www.oecd.org/about/document/list-oecd-member-countries.htm

Wells, C., Sah, P., Moghadas, S., Pandey, A., Shoukat, A., Wang, Y., Wang, Z., Meyers, L., Singer, B., & Galvani, A. (2020). Impact of international travel and border control measures on the global spread of the novel 2019 coronavirus outbreak. *Proceedings of the National Academy of Science*, *117*(13), 7504–7509. https://doi.org/10.1073/pnas.2002616117

White House. (2020). Proclamation on Suspension of Entry as Immigrants and Nonimmigrants of Persons Who Pose A Risk of Transmitting 2019 Novel Coronavirus. https://www.whitehouse.gov/presidential-actions/proclamation-suspension-entry-immigrants-nonimmigrants-persons-pose-risk-transmitting-2019-novel-coronavirus/

WHO Writing Group. (2006). Nonpharmaceutical Interventions for Pandemic Influenza, International Measures. *Emerging Infectious Diseases*, *12*(1), 81–87. https://doi.org/10.3201/eid1201.051370

6 Figures

Figure 1. Main SCM Results for Specifications 1-4

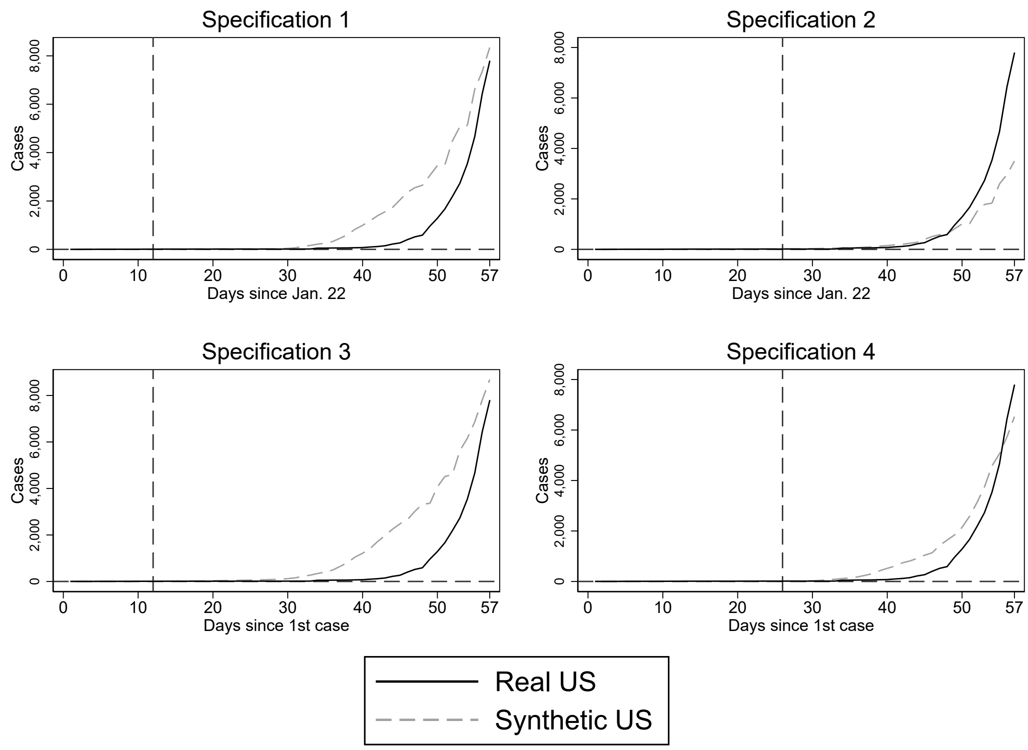

Figure shows the daily number of COVID-19 cases in the Real United States and Synthetic United States for each specification before and after the travel restriction was imposed. The Real United States is represented by the dark line and the Synthetic United States by the dashed gray line. The intervention date is the vertical dashed line.

Figure 2. Placebo in Place Robustness Check for Specifications 1-4

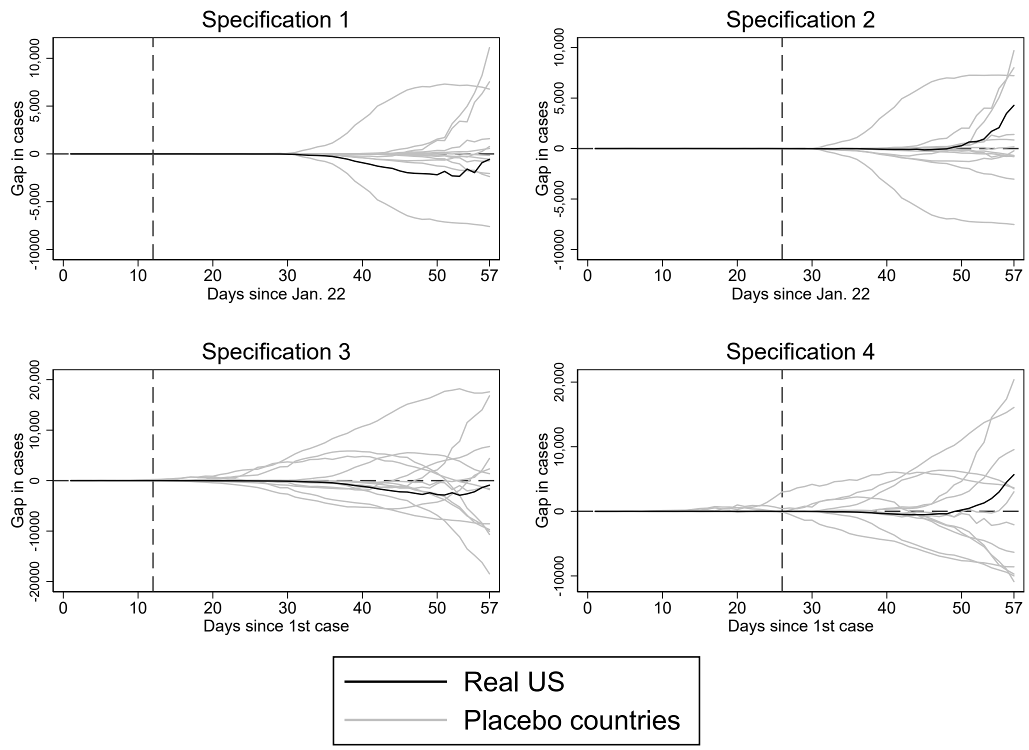

Figure shows a graphical representation of the p-values showing that there is no statistically significant gap in the number of COVID-19 cases after the intervention date compared to the other countries in the donor pool for each specification. The Real United States is represented by the dark line and the donor pool countries by the light gray lines. The intervention date is the vertical dashed line.

Figure 3. Main SCM Results for Specifications 5-8

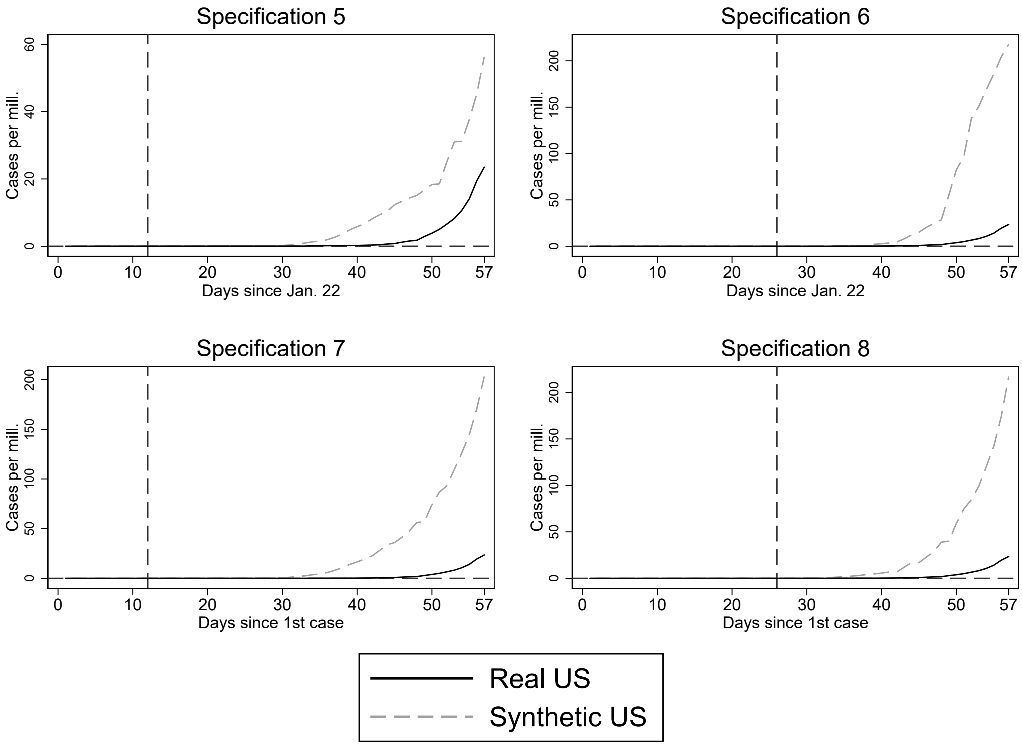

Figure shows the daily number of COVID-19 cases per million in the Real United States and Synthetic United States for each specification before and after the travel restriction was imposed. The Real United States is represented by the dark line and the Synthetic United States by the dashed gray line. The intervention date is the vertical dashed line.

Figure 4. Placebo in Place Robustness Check for Specifications 5-8

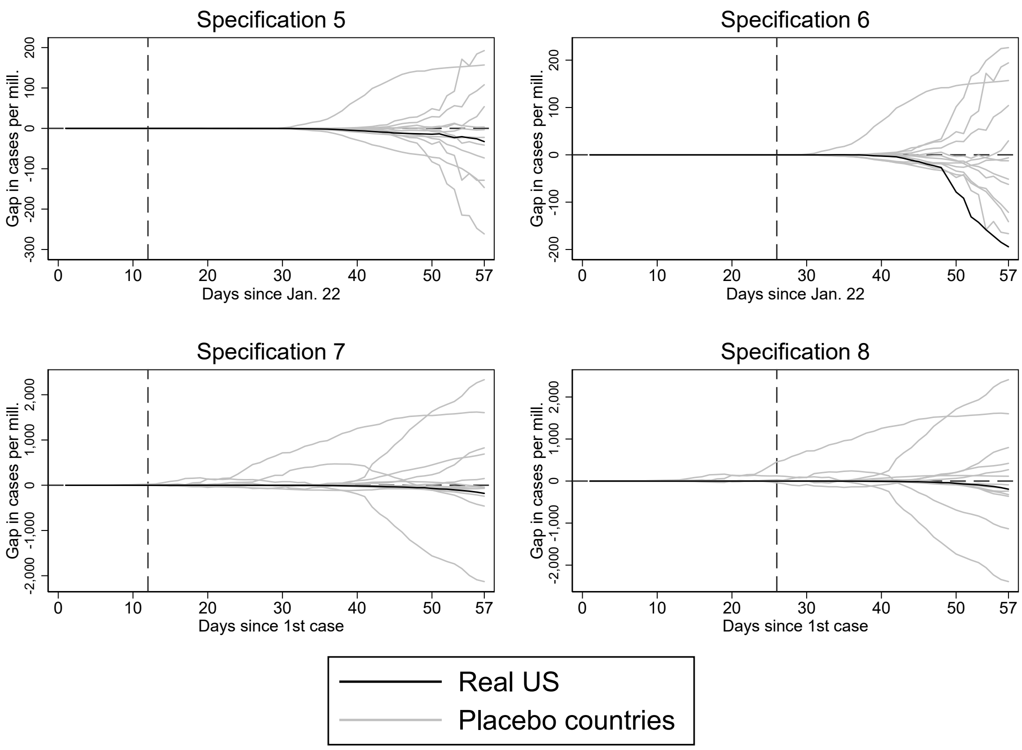

Figure shows a graphical representation of the p-values showing that there is no statistically significant gap in the number of COVID-19 cases per million after the intervention date compared to the other countries in the donor pool for each specification. The Real United States is represented by the dark line and the donor pool countries by the light gray lines. The intervention date is the vertical dashed line.

Figure 5. Placebo in Place Robustness Check for Specifications 9-12

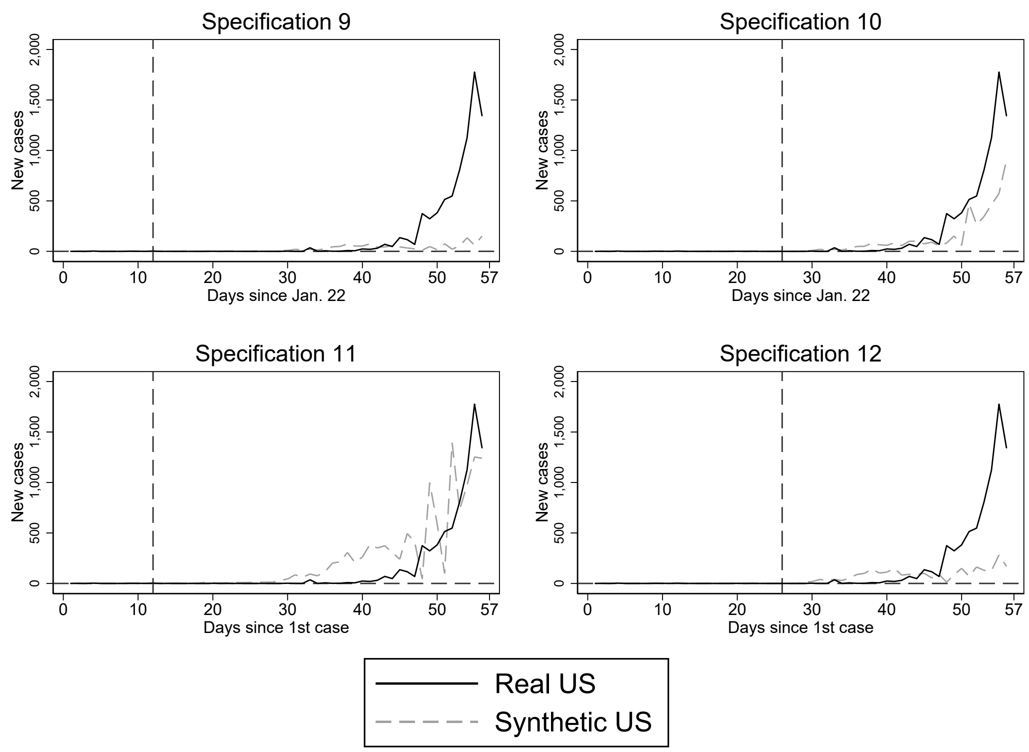

Figure shows the daily number of new COVID-19 cases in the Real United States and Synthetic United States for each specification before and after the travel restriction was imposed. The Real United States is represented by the dark line and the Synthetic United States by the dashed gray line. The intervention date is the vertical dashed line.

Figure 6. Placebo in Place Robustness Check for Specifications 9-12

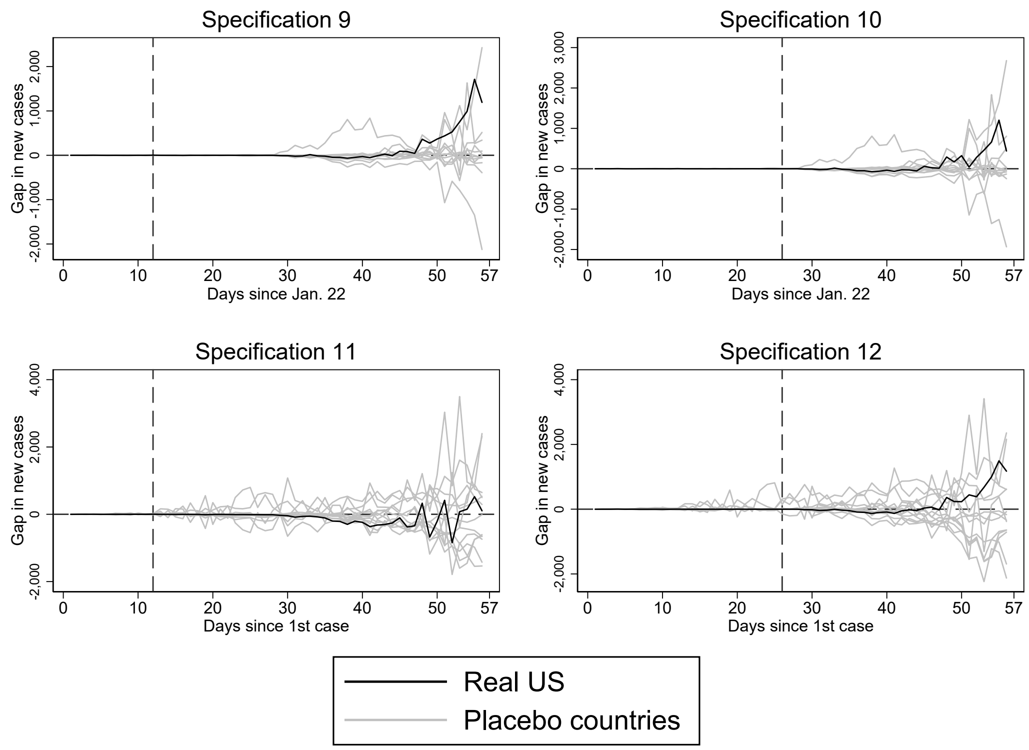

Figure shows a graphical representation of the p-values showing that there is no statistically significant gap in the number of new COVID-19 cases after the intervention date compared to the other countries in the donor pool for each specification. The Real United States is represented by the dark line and the donor pool countries by the light gray lines. The intervention date is the vertical dashed line.

Figure 7. Placebo in Place Robustness Check for Specifications 13-16

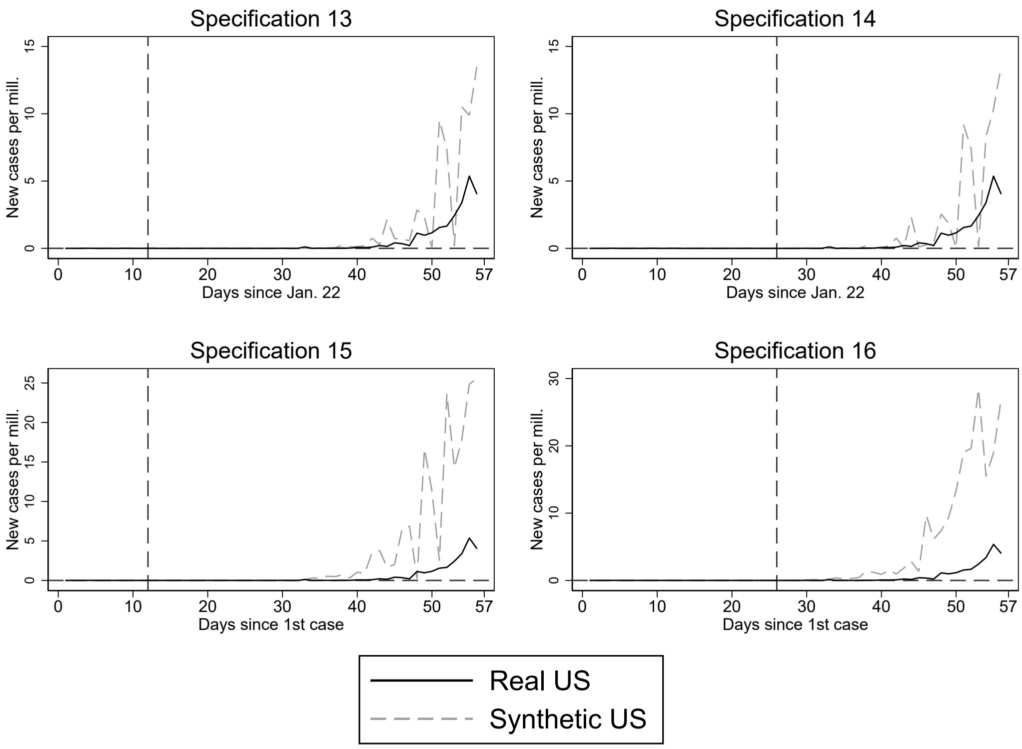

Figure shows the daily number of new COVID-19 cases per million in the Real United States and Synthetic United States for each specification before and after the travel restriction was imposed. The Real United States is represented by the dark line and the Synthetic United States by the dashed gray line. The intervention date is the vertical dashed line.

Figure 8. Placebo in Place Robustness Check for Specifications 13-16

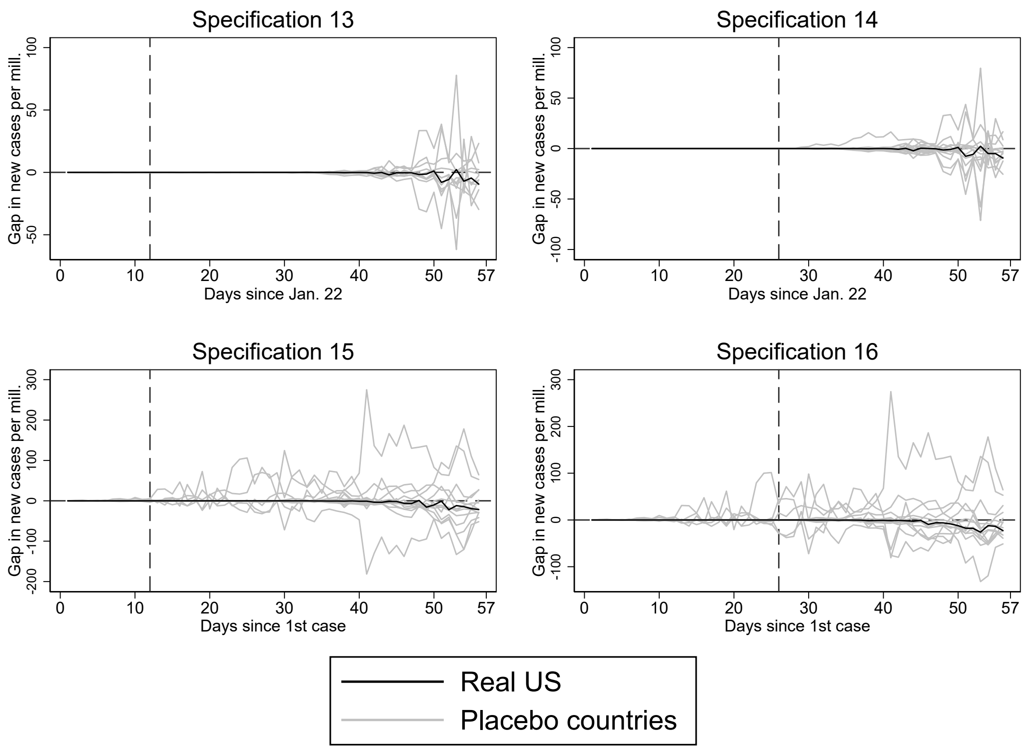

Figure shows a graphical representation of the p-values showing that there is no statistically significant gap in the number of new COVID-19 cases per million after the intervention date compared to the other countries in the donor pool for each specification. The Real United States is represented by the dark line and the donor pool countries by the light gray lines. The intervention date is the vertical dashed line.

7 Tables

Table 1. Goodness of Fit and Results for SCM Specifications 1-8

Table presents synthetic control method (SCM) results for the effect of the US-China travel ban on the cumulative confirmed COVID-19 cases and rates per million. In each panel, rows 1 and 2 show the average gap between the Real and Synthetic US and its associated permutation-based p-value. Row 3 reports the Root Mean Square Predicted Error (RMSPE) measures the distance between the Real United States and the Synthetic United States during the pre-treatment period. Row 4 reports the proportion of placebos with a pre-treatment RMSPE greater than the Synthetic US. Specification numbers are listed in parentheses in each column header.

	Panel A: Cases			
	(1)	(2)	(3)	(4)
Effect	-707.360	413.866	-926.909	398.293
	[0.250]	[0.516]	[0.656]	[0.758]
RMSPE	0.889	1.542	0.661	0.688
Pre-RMSPE $>$ US	0.250	0.250	0.846	0.750
N Donor Countries	13	13	13	13
Pre-Travel Ban Days	11	25	11	25
N	798	798	798	798

	Panel B: Cases per million			
	(5)	(6)	(7)	(8)
Effect	-6.343	-41.239	-28.709	-33.860
	[0.453]	[0.490]	[0.694]	[0.844]
RMSPE	0.008	0.006	0.048	0.080
Pre-RMSPE $>$ US	0.500	0.750	0.462	0.385
N Donor Countries	13	13	13	13
Pre-Travel Ban Days	11	25	11	25
N	798	798	798	798

Table 2. Country Donor Weights for Synthetic Control Specifications 1-8

Table presents estimated country donor weights for each synthetic control specification. The outcome variable for each specification is the cumulative number of COVID-19 cases or the cumulative number of COVID-19 cases per million. Each specification does not allow extrapolation, such that $w_i \in [0, 1]$ and $\sum_i w_i = 1$. Specification numbers are listed in parentheses in each column header.

	Panel A: Cases				*Panel B: Cases per million*			
Country	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Austria	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Belgium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Canada	0.000	0.465	0.284	0.673	0.000	0.210	0.000	0.000
France	0.689	0.319	0.439	0.000	0.000	0.000	0.224	0.000
Germany	0.000	0.000	0.000	0.160	0.000	0.000	0.000	0.000
Ireland	0.000	0.000	0.033	0.000	0.395	0.052	0.000	0.000
Japan	0.074	0.204	0.000	0.068	0.000	0.000	0.000	0.000
Korea, Republic of	0.237	0.012	0.244	0.099	0.075	0.000	0.170	0.000
Netherlands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Norway	0.000	0.000	0.000	0.000	0.000	0.738	0.000	0.000
Sweden	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Switzerland	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
United Kingdom	0.000	0.000	0.000	0.000	0.529	0.000	0.606	1.000

Table 3. Predictor Variable Weights for Synthetic Control Specifications 1-8

Table presents variables weights used to construct the Synthetic United States. The full donor pool consists of Austria, Belgium, Canada, France, Germany, Ireland, Japan, South Korea, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Specification numbers are listed in parentheses in each column header.

	Panel A. Cases			
	(1)	(2)	(3)	(4)
Populations 000s	0.099	0.058	0.022	0.000
Pop. Density	0.049	0.078	0.060	0.026
Pct. Pop. 65+	0.079	0.014	0.040	0.032
Pct. Urban	0.194	0.561	0.468	0.735
Median Age	0.026	0.049	0.071	0.002
Migrant Stock 000s	0.107	0.057	0.056	0.052
Migrant Stock, China 000s	0.030	0.052	0.041	0.006
Airport Connects. to China	0.169	0.051	0.092	0.116
Per Capita GDP (2011 $)	0.001	0.022	0.050	0.031
Abs. Latitude	0.247	0.058	0.100	0.000

	Panel B. Cases per million			
	(5)	(6)	(7)	(8)
Pop. Density	0.021	0.005	0.025	0.026
Pct. Pop. 65+	0.099	0.050	0.135	0.168
Pct. Urban	0.073	0.244	0.492	0.050
Median Age	0.267	0.065	0.049	0.206
Migrant Stock 000s	0.048	0.002	0.127	0.273
Migrant Stock, China 000s	0.049	0.007	0.024	0.083
Airport Connects. to China	0.008	0.009	0.037	0.051
Per Capita GDP (2011 $)	0.365	0.618	0.020	0.038
Abs. Latitude	0.069	0.000	0.091	0.105

Table 4. Predictor Variable Balance for Synthetic Control Specifications 1-8

Table presents summary statistics for pre-treatment predictor variables for the Real United States, their corresponding pre-treatment sample means, and the weighted averages used to construct the Synthetic United States. The full donor pool consists of Austria, Belgium, Canada, France, Germany, Ireland, Japan, South Korea, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Specification numbers are listed in parentheses in each column header.

		Panel A: Cases			
	Real US	(1)	(2)	(3)	(4)
Population 000s	331002.6	66483.5	64788.78	52046.47	52481.95
Pop. Density	36.185	232.7777	117.0595	184.5374	117.0465
Pct. Pop. 65+	16.63093	20.14298	21.02141	18.58646	19.14854
Pct. Urban	82.664	81.87876	83.45785	80.6772	81.58487
Median Age	38.308	43.11433	43.01832	42.19881	42.6135
Migrant Stock 000s	50661.15	6203.433	6884.268	6231.276	7743.792
Migrant Stock, China 000s	2899.267	288.5699	527.7314	401.3889	599.2001
Airport Connects. to China	58	53.274	39.154	44.886	35.684
Per Capita GDP (2011 $)	61391.37	43744.48	46073.82	46211.71	48130.83
Abs. Latitude	38	43.127	50.362	48.011	54.651

		Panel B. Cases per million			
		Days Since 1/22		*Days Since 1st Case*	
	Real US	(5)	(6)	(7)	(8)
Pop. Density	36.185	216.2982	15.5521	286.3883	280.602
Pct. Pop. 65+	16.63093	16.81025	17.49461	18.63716	18.65335
Pct. Urban	82.664	75.63367	81.67279	82.824	83.903
Median Age	38.308	39.79426	40.0238	41.44149	40.467
Migrant Stock 000s	50661.15	5469.598	2355.494	7853.412	9552.11
Migrant Stock, China 000s	2899.267	171.2508	155.1234	269.176	225.385
Airport Connects. to China	58	17.219	2.52	34.746	11
Per Capita GDP (2011 $)	61391.37	60441.62	61325.3	44977.35	46330.34
Abs. Latitude	38	52.276	61.112	49.318	54

Table 5. Goodness of Fit and Results for SCM Specifications 9-16

Table presents synthetic control method (SCM) results for the effect of the US-China travel ban on new confirmed COVID-19 cases and rates per million. In each panel, rows 1 and 2 show the average gap between the Real and Synthetic US and its associated permutation-based p-value. Row 3 reports the Root Mean Square Predicted Error (RMSPE) measures the distance between the Real United States and the Synthetic United States during the pre-treatment period. Row 4 reports the proportion of placebos with a pre-treatment RMSPE greater than the Synthetic US. Specification numbers are listed in parentheses in each column header.

	Panel A: New Cases			
	(9)	(10)	(11)	(12)
Effect	141.010	108.465	-85.320	160.932
	[0.304]	[0.411]	[0.530]	[0.666]
RMSPE	0.799	0.882	0.781	0.802
Pre-RMSPE > US	0.250	0.417	0.692	0.769
N Donor Countries	13	13	13	13
Pre-Travel Ban Days	10	24	10	24
N	798	798	798	798

	Panel B: New Cases per million			
	(13)	(14)	(15)	(16)
Effect	-0.840	-1.066	-3.104	-5.146
	[0.700]	[0.793]	[0.895]	[0.837]
RMSPE	0.003	0.003	0.009	0.011
Pre-RMSPE > US	0.455	0.692	0.769	0.846
N Donor Countries	13	13	13	13
Pre-Travel Ban Days	10	24	10	24
N	798	798	798	798

Table 6. Country Donor Weights for Synthetic Control Specifications 9-16

Table presents estimated country donor weights for each synthetic control specification. The outcome variable for each specification is the cumulative number of new COVID-19 cases or the number of new COVID-19 cases per million. Each specification does not allow extrapolation, such that $w_i \in [0, 1]$ and $\sum_i w_i = 1$. Specification numbers are listed in parentheses in each column header.

	New Cases				*New Cases per million*			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Austria	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Belgium	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Canada	0.774	0.313	0.000	0.799	0.068	0.069	0.211	0.338
France	0.000	0.000	0.608	0.000	0.125	0.019	0.607	0.000
Germany	0.000	0.266	0.000	0.000	0.000	0.000	0.000	0.502
Ireland	0.057	0.335	0.042	0.000	0.597	0.902	0.000	0.000
Japan	0.087	0.000	0.000	0.030	0.000	0.000	0.000	0.160
Korea, Republic of	0.082	0.086	0.312	0.170	0.000	0.000	0.000	0.000
Netherlands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Norway	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sweden	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Switzerland	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
United Kingdom	0.000	0.000	0.037	0.000	0.210	0.010	0.182	0.000

Table 7. Predictor Variable Weights for Synthetic Control Specifications 9-16

Table presents variables weights used to construct the Synthetic United States. The full donor pool consists of Austria, Belgium, Canada, France, Germany, Ireland, Japan, South Korea, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Specification numbers are listed in parentheses in each column header.

	Panel A. New Cases			
	(9)	(10)	(11)	(12)
Populations 000s	0.080	0.001	0.133	0.017
Pop. Density	0.101	0.062	0.075	0.065
Pct. Pop. 65+	0.089	0.277	0.144	0.002
Pct. Urban	0.267	0.003	0.145	0.255
Median Age	0.086	0.013	0.077	0.117
Migrant Stock 000s	0.081	0.088	0.042	0.182
Migrant Stock, China 000s	0.091	0.000	0.054	0.137
Airport Connects. to China	0.058	0.074	0.085	0.134
Per Capita GDP (2011 $)	0.097	0.466	0.039	0.010
Abs. Latitude	0.050	0.016	0.206	0.081

	Panel B. New Cases per million			
	(13)	(14)	(15)	(16)
Pop. Density	0.050	0.154	0.113	0.038
Pct. Pop. 65+	0.683	0.001	0.006	0.013
Pct. Urban	0.008	0.001	0.146	0.104
Median Age	0.218	0.798	0.145	0.005
Migrant Stock 000s	0.001	0.012	0.296	0.262
Migrant Stock, China 000s	0.006	0.000	0.120	0.132
Airport Connects. to China	0.007	0.009	0.000	0.368
Per Capita GDP (2011 $)	0.013	0.011	0.004	0.062
Abs. Latitude	0.013	0.015	0.170	0.017

Table 8. Predictor Variable Balance for Synthetic Control Specifications 9-16

Table presents summary statistics for pre-treatment predictor variables for the Real United States, their corresponding pre-treatment sample means, and the weighted averages used to construct the Synthetic United States. The full donor pool (used in Specifications 9-16) consists of Austria, Belgium, Canada, France, Germany, Ireland, Japan, South Korea, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Specification numbers are listed in parentheses in each column header.

		Panel A: New Cases			
	Real US	(9)	(10)	(11)	(12)
Populations 000s	331002.6	44701.41	40163.14	58401.45	42666.04
Pop. Density	36.185	80.71938	134.5973	250.3888	103.3645
Pct. Pop. 65+	16.63093	18.60913	17.67717	18.84732	18.00175
Pct. Urban	82.664	81.41819	74.45676	80.41181	81.76188
Median Age	38.308	41.80333	41.61325	42.49012	41.7436
Migrant Stock 000s	50661.15	6521.885	6364.155	5819.102	6633.353
Migrant Stock, China 000s	2899.267	655.1447	306.1247	276.1287	681.4928
Airport Connects. to China	58	33.932	21.882	53.911	39.628
Per Capita GDP (2011 $)	61391.37	49342.07	60902.85	45193.29	46930.49
Abs. Latitude	38	55.627	53.283	43.736	55.31

		Panel B. New Cases per million			
	Real US	(13)	(14)	(15)	(16)
Pop. Density	36.185	116.9009	70.01	124.3051	177.5789
Pct. Pop. 65+	16.63093	16.44555	14.97941	19.81228	21.54993
Pct. Urban	82.664	71.28856	65.42034	81.63175	81.13448
Median Age	38.308	39.41961	38.54454	41.74132	44.60068
Migrant Stock 000s	50661.15	4086.765	1555.044	8477.452	9682.862
Migrant Stock, China 000s	2899.267	117.8112	64.82831	260.4757	419.07
Airport Connects. to China	58	4.376	1.128	10.604	35.994
Per Capita GDP (2011 $)	61391.37	68563.88	79984.32	46332.36	50020.19
Abs. Latitude	38	52.811	53.36	50.41	51.642

Online Appendix for: How U.S. Travel Restrictions on China Affected the Spread of COVID-19 in the United States

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A Data Appendix

This section provides a brief description of the data we use in our analyses, including sources and definitions. Table A1 provides a listing of the variables and their descriptions, sources, and summary statistics.

A.1 Data Sources

A.1.1 COVID-19 Cases

Data on confirmed COVID-19 cases are from the COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. These data are compiled from a variety of sources, such as the World Health Organization (WHO) and other public health and media sources. The data provide the cumulative number of confirmed COVID-19 cases, deaths, and recoveries by day starting on Jan. 22, 2020. The raw data are available on GitHub here.

A.1.2 United Nations

The United Nations (UN) is our primary data source for population data, including demographic structure, urbanicity, population density, and international migration. We use three main data collections from the UN. First, we collect data on countries' age structure from the *World Population Prospects 2019* data files. These data include annual estimates of a country's population, broken down by age and sex. We subset these data to the 2020 estimates. Using the 2020 estimates, we identify the share of a country's population above the age of 65. These data also contain measures of population density, measured as persons per square kilometer, and the population's median age. These data are available here.

Next, we collect data on a country's urban population from the UN *World Urbanization Prospects 2018*. The UN urbanization data provide quinquennial estimates of the share of a country's population living in urban agglomerations spanning 1950-2050. We specifically use the 2020 estimates for each country. The data are available here.

Finally, we collect data on a country's foreign-born population from the UN *International*

Migrant Stock 2019 data. These data provide estimates of the number of international migrants for 2019 broken down by age, sex, and country of origin. For our analyses, we take the estimates of the total foreign-born stock and the foreign-born stock originating from China. The data are available here.

A.1.3 World Bank

We collect data on per capita income from the World Bank. These data provide the per capita Gross Domestic Product (GDP) by country, expressed in purchasing power parity (PPP) adjusted constant 2011 dollars. We use the most recent year of data available for 2018. These data are available here.

A.1.4 OpenFlights

Information on the number of flight connections to China are from OpenFlights and are available here. Unfortunately, the most recent data on connecting flights is from June 2014, since their provider of connecting flight information stopped updating their data at that time.

B Additional Tables

Table A1. Variable Descriptions and Sources

Table provides a listing of the outcome and predictor variables used in our analyses, including brief descriptions, their respective sources, and summary statistics.

Variable	Description	Source	Mean	SD
	Outcome Variables			
`n_cases`	Cumulative confirmed COVID-19 cases	Johns Hopkins	455.9	1,442.6
`n_cases_mill`	Cumulative confirmed COVID-19 cases per million	Johns Hopkins	14.38	41.44
`n_cases_new`	New confirmed COVID-19 cases	Johns Hopkins	67.82	237.8
`n_cases_new_mill`	New confirmed COVID-19 cases per million	Johns Hopkins	2.284	7.159
	Predictor Variables			
`un_migrant`	Total foreign born stock as of 2019 (000s)	UN	7,544.8	12,538.3
`un_migrant_china`	Total foreign-born stock from China as of 2019 (000s	UN	404.3	741.3
`pop_total`	Total population as of 2020 (000s)	UN	59,305.6	83,290.5
`pop_density`	Population density per sq. km. as of 2020	UN	206.1	174.6
`pct_oldpop`	% of the Population age 65+ as of 2020	UN	19.29	3.152
`pct_urban`	% of the population living in urban areas as of 2020	UN	81.24	10.21
`un_medage`	Median age of the population as of 2020	UN	42.22	2.652
`gdppc2011`	Per capita GDP in constant 2011 PPP-adjusted dollars as of 2018	World Bank	54,876.7	11,217.0
`abslat`	Absolute value of latitude	Source	49.76	8.291
`n_connects`	Number of airport connections with China as of 2014	OpenFlights.org	30.29	49.41