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The Cuban revolution and infant mortality: A synthetic control approach

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ABSTRACT

The Cuban government often boasts that the country's infant mortality rate has been low and falling since Fidel Castro's revolution in 1959. However, because many Latin American countries have experienced similar decreases, and because Cuba historically enjoyed lower infant mortality rates than the rest of Latin America, it is unclear whether the government should get credit. We use the fact that Cuba underwent momentous and unique political changes to consider the effect of Castro's regime on infant mortality. We employ a synthetic control method to ascertain how much of the reduction, if any, can be attributed to the regime. We find that in the first decade of the regime, infant mortality increased relative to the counterfactual, but that—after the introduction of Soviet subsidies—infant mortality partially reverted to trend. To measure the effect of the subsidies, we run a second synthetic control test concerning the collapse of the Soviet Union and the accompanying end of the subsidies. This control suggests that the subsidies played no important role.

1. Introduction

With the ongoing political changes in Cuba following the resignation and subsequent death of Fidel Castro, there is a need to assess the long-run impact of his regime. One salient legacy is that Cuba has one of the lowest levels of infant mortality in all of the Americas in spite of its low income per person. In fact, Cuba's infant mortality rate is roughly equal to levels observed in industrialized countries (World Bank, 2018). This appears to bear witness to the regime's efficacy in providing health care (Borowy, 2011; Campion and Morrissey, 2013; Cooper et al., 2006; Keck and Reed, 2012; Spiegel and Yassi, 2004; Wenham and Kittelsen, 2020).

However, the available assessments concentrate only on Cuba's health performance relative to other countries today. There are no attempts to ascertain the regime's effect on health outcomes by asking what the outcomes would have been without the 1959 revolution. In other words, no one has attempted to create a counterfactual Cuba to assess the impact of the regime on health outcomes.

There are two reasons to create a counterfactual. The first is that numerous scholars question whether the early years of the regime were marked by improvements. Some point to considerable government efforts to improve health outcomes (Danielson, 1979; Guttmacher and Danielson, 1977; Valdés, 1971). Others are more pessimistic and note that there was either stagnation or deterioration—a view shared by people with favorable (Dominguez, 1978) and unfavorable (Eberstadt, 1988) judgments of the regime. The lack of a counterfactual to define what could have been expected without the regime is an important hindrance. The second reason is that Cuba's strong health outcomes pre-date Castro's ascent to power (Devereux, 2019; McGuire and Frankel, 2005;

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Ward and Devereux, 2012). These facts led economic historians Marianne Ward and John Devereux to assert that "we have to compare current outcomes to the counterfactual of what would have occurred had the revolution failed", adding that they suspected that "overall healthcare outcomes would not have been much different given the remarkably low levels of infant mortality" prior to the revolution (Ward and Devereux, 2012, p. 127). However, they left that particular challenge to future researchers and concentrated on economic outcomes.

Recent developments in causal-inference methods, such as synthetic controls, allow us to create this needed counterfactual (Abadie et al., 2010; 2015; Abadie and Gardeazabal, 2003; Grier and Maynard, 2016). The synthetic control method has recently been used by Jales et al. (2018) to evaluate the effect of Fidel Castro's accession to power on income per capita and found large negative effects. From this, it could be concluded that the Cuban revolution was highly detrimental to the country. But, if the paradox of Cuban society is the combination of relative poverty with strong health outcomes, then focusing solely on income misses the point made by scholars regarding the country's low rate of infant mortality. Scholars who have measured the causal effect of Castro's rise on GDP per capita agree, arguing that "estimating the difference between the actual and the counterfactual GDP per capita of Cuba is necessary but not sufficient to provide a comprehensive assessment of the revolution" (Jales et al., 2018, p. 2244). To develop this more comprehensive assessment, we use a synthetic control approach to estimate the revolution's effect on infant mortality. To construct the synthetic controls, we rely on two donor pools. The first is based on Latin American countries who shared the same pre-revolutionary trend of infant mortality rates. The second is based on Western countries whose levels of infant mortality were closer to those of Cuba before the revolution. The use of both donor pools allows us to assess the robustness of our results. However, we only report tables and figures for the results based on the Latin American donor pool in this article. To keep the article short, we mention our results based on the Western countries donor pool, but relegate the detailed results to Appendix A (available as an online supplement).

Both donor pools produce the same result: relative to the counterfactual, the Castro regime *increased* infant mortality by somewhere between 41,000 and 53,000 deaths. Our results are robust to alternative specifications (see Appendixes B and C online). We also find that the full US trade embargo in 1962 does not explain the divergence from the counterfactual. Our results suggest that during the first decade of the regime, there was no paradox of improving health outcomes and falling GDP: the fall in income per capita relative to the counterfactual (documented by Jales et al., 2018) was accompanied by an increase in the infant mortality rate relative to the counterfactual.

A decade after the revolution, Cuba's infant mortality rate began to return to the counterfactuals.[2] This late return toward the counterfactual coincides with increases in Soviet foreign aid (mainly through subsidies for sugar exports). To assess the relevance of Soviet foreign aid, we conduct a second set of tests related to the loss of the subsidies in 1989. We run the synthetic control method backward by making the post-1989 period (when no one received Soviet aid) the pretreatment period that we use to create the synthetic Cuba before 1989 (when Cuba was the only one to receive Soviet aid). We find no statistically significant effects of Soviet subsidies regardless of the donor pool used.

We interpret our results as follows. First, the combined effect of the Castro regime, the US trade embargo, and the Soviet subsidies was negative to 1975. Second, the trade embargo does not appear to affect Cuba's health performance. Third, the first decades of the regime suggest no paradox of improving health outcomes and rising poverty. Cuba was already a healthy country, and it performed poorly compared to the counterfactual Cuba in both economic (Jales et al., 2018) and health outcomes. Fourth, in the period leading up to the end of the Soviet foreign aid, the combined effect of Castro's regime and the US trade embargo was negative net of the effects of Soviet subsidies. Combined, our results suggest that the revolution cannot be credited for the improvements since 1959.

2. Cuban health care

When Fidel Castro took power in January 1959, Cuba was 80 percent richer than the rest of Latin America (Ward and Devereux, 2012, p. 115). Infant mortality rate was less than a third of the rate in the rest of Latin America (Ward and Devereux, 2012, p. 115). Since then, a paradox emerged: income per capita fell relative to other Latin American countries while infant mortality rates improved substantially: Cuba's per capita income is now 58 percent of the Latin American average (Bolt et al., 2018) while infant mortality is 28 percent of the Latin American average (World Bank, 2018).[3] The initially low level of infant mortality, which means that efforts at further reducing it faced decreasing marginal returns, and the relative deterioration in incomes make this relative improvement in health outcomes quite impressive.

The paradox is explained in the literature as a result of the regime's health policies. After taking power, Castro initiated a wide range of health care reforms concentrating largely on primary care, prevention, epidemiological control, and the training of a sizable share of the population as physicians (Swanson et al., 1995; Whiteford and Branch, 2007; World Health Organization, 2008). The regime also increased health spending as a share of GDP from 5.5 percent to 11.7 percent by 1976 (Danielson, 1979, p. 233). The Cuban health system's centerpiece is the network of regional polyclinics and neighborhood clinics that provide primary care. Given the country's poverty, primary care is believed to be the most cost-effective tool (Campion and Morrissey, 2013; Spiegel and Yassi, 2004). Physicians are expected to visit patients in their residences once every year to provide follow-ups and track basic health

[2] Relative to the synthetic control based on other Latin American countries, Cuba fully returned to the counterfactual by 1975. Relative to the synthetic control based on Western countries, Cuba managed to halve the difference by 1975. In Appendix B, we also cautiously extend the counterfactual to 1980 and observe that Cuba's infant mortality rate appears to fall below that in the counterfactual based on Latin American countries and further close the gap with Western countries. However, in the same appendix, we explain that this extension to 1980 needs to be taken with a grain of salt for econometric reasons.

[3] Income per capita is probably less than that if we accept the revised GDP figures of Devereux (2019).

conditions (Campion and Morrissey, 2013, 297). The Cuban government expects physicians to meet health-outcome targets that it sets, or face penalties for not doing so (Berdine et al., 2018; Hirschfeld, 2006).

However, there are downsides in the form of the heavy-handed methods used to achieve the centrally set objectives. Upon taking power, the Castro regime proceeded with the "militarization of clinical medicine," whereby physicians were made members of the army and were expected to report on local activities and the "political integration" of local families (Hirschfeld, 2006, pp. 215216). Accordingly, doctors are the first line of defense for the regime (Geloso et al., 2020). It is not surprising that there is no right to privacy for patients. Patients cannot refuse treatments and can be interned if they refuse (Hirschfeld, 2006, p. 215). Some patients were also forcibly segregated, most notably homosexuals afflicted with HIV-AIDS (Gómez Dantés, 2018). This heavy-handedness could have induced behavioral responses in favor of concealing certain conditions from physicians. Moreover, institutions that rely on such heavy-handed methods may be unable to generate sustained economic growth (Troesken, 2015), which deprives the population of the long-run palliative effects of growth (Geloso et al., 2020; Preston, 1975; Troesken, 2015). These downsides could help explain why, "contrary to widespread belief, the performance of the Cuban health-care system was mixed throughout the 1960s and improved only in the 1970s" (Dominguez, 1978, p. 221).[4]

The US trade embargo and Soviet foreign aid make it harder to assess the net effect of Castro's health care reforms. The strengthening of the US trade embargo in 1962 is argued to have increased infant mortality rates (Garfield and Santana, 1997) while Soviet foreign aid until 1989 is argued to have reduced them (National Intelligence Council, 1991).[5] One has to net out the positive effect of Soviet aid from the adverse effect of the US trade embargo in 1962. Jales et al. (2018) provide a partial solution to this issue. They find that the loss of these subsidies in 1989 caused a significant economic downturn for Cuba. This, they argue, allows them to net out the effect of Soviet aid from the combined effects of the embargo and the revolution.

This is a unique mix of considerable reallocation of resources to health care, heavy-handed methods, relative poverty, and foreign aid. The effects of each ingredient in this mix conflict with those of the others, which makes it hard to determine the net effect of the revolution on health outcomes. The present paper serves to fill this gap in the literature.

3. Data and methodology

Using infant mortality data provided by Mitchell (2003), we utilize the synthetic control method to create counterfactual scenarios of the evolution of infant mortality without the revolution (which we will refer to as the treatment).[6] These counterfactuals, which illustrate a hypothetical Cuba without the 1959 revolution, are built using a weighted average of countries similar to Cuba (Abadie et al., 2010; 2015; Abadie and Gardeazabal, 2003; Athey and Imbens, 2017). Our weights are non-negative and sum to one.[7] Accordingly, our counterfactual is a convex combination of similar countries and does not rely on extrapolation. The differences between the actual observations and the proposed counterfactual scenarios are taken to be the effect of the revolution.

The counterfactuals are constructed from two sets of donor pool countries that were not directly affected by the treatment. Donor countries must share characteristics with (and have similar economic processes as) Cuba prior the treatment in order to be viable donors. Our main donor pool is based on Latin American countries as they shared similar trends in infant mortality before 1959.[8] These shared trends are why we use indices of infant mortality (where 1959 is the base year see the first row of Table 1).[9] From 1946 to 1958 (the pretreatment period), no other country in that donor pool became subject to a communist dictatorship, which makes Cuba unique. We also assembled a second donor pool based on Western countries.[10] This is because while Cuba shared infant mortality trends with Latin America prior to 1959, it did not share similar *levels* (see the second row of Table 1). The country's rate of infant mortality was more in line with those of Western countries. The downside of that second pool is that while both levels and trends of infant mortality are shared prior to the revolution, their economies share fewer similarities (as can be seen in the last rows of Table 1). Each donor pool is thus imperfect, but we can declare the results robust if both donor pools yield similar results (which they do, as we will see below).[11] However, we will only report the results from the Latin American donor pool, and while we will mention the Western countries donor pool results, the details are relegated to Appendix A.

The selection of weights for donor pool countries is made from a group of predictor variables for the pretreatment period: GDP per capita, education, and urbanization. These predictor variables are averaged using all available data over our entire pretreatment

[4] Moreover, improvements were not generalized. The case rates for acute diarrhea, acute respiratory diseases, chicken pox, measles, syphilis, and hepatitis increased in the first two decades of the regime while those for typhoid fever, diphtheria, and tetanus receded (Sixto, 2002).

[5] Soviet subsidies took the form of the Soviet Union paying prices for sugar that were above the world price. They increased in importance until they were cut in 1989 (Hernández-Catá, 2000; Pérez-López, 1991; 1988; Radell, 1983; Walters, 1966).

[6] Our data, in both intermediate and final forms, and our codes are available for replication through ICPSR (Geloso and Bologna Pavlik, 2020) (DOI: https://doi.org/10.3886/E121691V4).

[7] While Doudchenko and Imbens (2016) suggest an alternative estimator that allows negative weights, it is an experimental alternative and the non-negative weights approach remains the norm (Abadie and Gardeazabal, 2003; Absher et al., 2020; Grier and Maynard, 2016; Peri and Yasenov, 2019).

[8] These countries also share a common institutional framework stemming from the Spanish Empire, or are island economies of the Caribbean.

[9] In Appendix B, we also highlight other reasons why indices are superior. Our use of indices has shortcomings, but they are addressed below and in Appendix A by the use of the Western countries donor pool.

[10] The use of multiple donor pools is a commonly-used approach to assess robustness – see Grier and Maynard (2016) for an example.

[11] It is worth pointing out that the raw data make clear that Cuba probably performed differently after the revolution. This can be seen in the third row of Table 1, in which we use the raw data to compute the average annual rate of change in the infant mortality rate between 1959 and 1975. It fell faster in both donor pools on average in the post-treatment period.

Table 1
Comparing donor pools for the effect of Castro's rise to power.

Variable	Period	Cuba	Latin American Donor Pool	Western Countries Donor Pool
Infant Mortality (1959=1)	1946–58	1.16	1.18	1.37
Infant Mortality (deaths per 1,000 live births)	1946–58	37.26	85.62	43.79
Infant Mortality (average annual rate of change)	1959–75	0.82%	2.38%	3.71%
GDP per capita	1946–58	$ 3870	$ 3859	$ 7877
Mean Years of Education	1950	3.53	3.22	7.12
Urbanization Rate	1950–58	57.27%	41.72%	59.96%

Notes: The indexed values for Western countries are heavily affected by postwar years when infant mortality were exceptionally high (but rapidly falling) in countries such as Italy, Belgium, the Netherlands, Austria, and Germany. If we compare only the 1950s, the mean index value for Western countries is 1.23 compare to 1.13 in Cuba. **Sources:** GDP per capita data are taken from the Maddison Project at the University of Groningen (Bolt et al., 2018). Urbanization data come from the 2018 revision to the *World Urbanization Prospects* report produced by the United Nations (2018). And schooling-rate data (enrollment of relevant age group) are taken from the database of Human Development Indices assembled by Prados de la Escosura (2015). We obtain our infant mortality data from *International Historical Statistics* for the Americas and Europe (Mitchell, 1998; 2003). We could not find other health indicators such as life expectancy for the period from 1946 to 1975 to use in assembling the donor pool.

Table 2
The Latin American donor pool, resulting country weights, and RMSPEs.

Latin American Countries Donor Pool		
Countries	Fidel Castro Regime	(Loss of) Soviet Subsidies
Argentina	0	0
Barbados	–	0
Bolivia	–	0
Brazil	–	0
Chile	0	0.506
Colombia	0	0
Costa Rica	0.171	0
Dominican Republic	–	0
Ecuador	–	0
El Salvador	0.274	0.355
Guatemala	0	0
Haiti	–	0
Honduras	0	0
Jamaica	0	0
Mexico	0	0
Nicaragua	–	0
Panama	–	0
Paraguay	–	0
Peru	0.507	0
Puerto Rico	0	0
Trinidad and Tobago	0.049	0
Uruguay	0	0.139
Venezuela	0	0
RMSPE	**0.069**	**0.020**

period (1946–58). Our primary specification uses pre-intervention outcomes at four different points in time, along with long-run averages of all other controls. These long-run averages ensure that we are focusing on the constant trend of each variable within each country. We match on four different pre-intervention infant mortality outcomes largely because this variable exhibits a generally decreasing trend that we want to be sure to capture in our matching. The selected weights minimize the difference between the predictor variables in Cuba and synthetic Cuba.

Our country weights in Table 2, which pertains to the Latin American donor pool, are chosen to minimize the difference between the predictor variables in Cuba and synthetic Cuba. The weights we choose depend, in part, on the importance of our predictors to infant mortality. We employ a nested-optimization procedure that searches all combinations of covariates and country weights

that minimize the pretreatment mean squared prediction error (MSPE).[12] This method also utilizes three different initial values of covariate weights: regression-based weights, equal weights, and weights resulting from a maximum likelihood search.[13] In Appendix A, we report the predictor balance for the pretreatment period.[14]

The last row of Table 2 reports the root mean square prediction error (RMSPE). To gauge the meaningfulness of our results, we use these reported RMSPE against those that emerge from placebo tests. These tests repeat the synthetic exercise for each country in our donor pools using 1959 as the treatment year. We then calculate the ratio of post-treatment RMSPE to pretreatment RMSPE and expecting it to be smaller for donor countries than for Cuba given that these other countries experience no treatment. If Cuba's ratio is average in comparison to these donor countries, this suggests that our results are driven by noise. Thus, we rank order the ratio of pre–post RMSPEs for all countries and calculate the *p*-value of our estimated effect as Cuba's rank divided by the total number of countries included.[15]

We repeat the same exercise for the period from 1975 to 2005 in order to assess the effect that Soviet subsidies may have had. As these subsidies helped the regime allocate more resources to health care, they must have had some effect on health outcomes.[16] Rather than extend our synthetic too far ahead of the treatment date of 1959 and risk a loss of relevance from our counterfactuals, we use the end of the subsidies in 1989 (Hernández-Catá, 2000, p. 25) as a second test.[17] The period from 1989 to 2005 acts as the pretreatment period in order to construct a synthetic control that predicts the era when Cuba was receiving Soviet support (1975 to 1989). In other words, we run the synthetic control method backward in order to tease out the effects of subsidies. The last row of Table 2 reports the donor weights for this exercise.[18]

In Appendixes B and C to the paper, we also run multiple robustness tests: moving back the treatment date, moving the treatment date forward to 1962 to see if the US embargo is having an effect, changing the combination of predictor variables, and the matching strategy. None of these tests alter our core findings that we discuss in the next section. In Appendix B, we also assess if our results are robust to changing data sources for Cuba. We replace the data provided by Mitchell (2003) by to those provided by McGuire and Frankel (2003); McGuire and Frankel (2005) in order to account for methodological differences in accounting for infant deaths in Cuba. Our results are robust to this change of data source.

Before we proceed with our results, we must preempt criticisms regarding the validity of post-revolutionary Cuban data. As pointed out above, Cuban physicians must meet infant mortality targets or face penalties. These penalties create an incentive to reclassify early neonatal deaths (within seven days of birth) as late fetal deaths (between twenty-two weeks of pregnancy and birth) since the latter type of death does not affect infant mortality rates (Gonzalez, 2015; Gonzalez and Gilleskie, 2017; Velkoff and Miller, 1995). The penalties also create an incentive to use pressured or coerced abortions in order to prevent riskier births (Berdine et al., 2018; Hirschfeld, 2006). These incentives affect the reliability of Cuban demographic statistics. However, corrections proposed by Gonzalez (2015); Gonzalez and Gilleskie (2017), and Berdine et al. (2018) are relatively small when compared with other Latin American countries. In fact, even the most extreme and implausible assumptions regarding data manipulations fail to knock Cuba from the top spots in rankings. And there is no evidence to believe that the bias varies over time (Eberstadt, 1986).[19] If the bias is small and consistent, it will skew our estimates of excess mortality downwards (see next section).

4. Results

4.1. The effects of the revolution

The top panels of Figure 1 show the results for the effect of the revolution with the Latin American donor pool. The left panel plots the actual and synthetic Cuba for our before and after periods. As can be seen, the counterfactual matches the pretreatment data on infant mortality for Cuba reasonably well until 1959. After Castro's accession to power in 1959, the infant mortality rate starts to increase and it deviates substantially from the counterfactual. At the end of the 1960s, the country begins a partial return to the counterfactual scenario. A partial reversal to the counterfactual is also observed for the results based on the donor pool of Western countries (see Appendix A).

Using both donor pools, we find that excess mortality was on average between 10.04 and 13.16 deaths per 1,000 live births. Converting those rates into raw numbers yields an excess level of infant mortality representing between 41,532 and 53,134 infant

[12] All countries included in our donor pool must be subjected to a placebo test. Because Barbados cannot be subjected to this test due to failed convergence, we drop it from the analysis for the 1946–75 period.

[13] We use Stata's *synth* command with the *nested* and *allopt* options.

[14] In Appendix B, we also provide results from the same tests without using the largest donors in order to assess robustness. Our results are similar. We thank an anonymous referee for this helpful suggestion regarding robustness.

[15] We repeat this in-space placebo exercise by excluding Cuba from the donor pool. Our calculated *p*-values are unchanged. We also repeat the same set of exercise for the Western Countries donor pool.

[16] The subsidies grew in importance starting in the 1970s (Pérez-López, 1991; 1988; Radell, 1983).

[17] Near the end of the 19591975 time window, authoritarianism rose in Latin America. This means that the donor countries suffer changes that reduce their viability as donors. Nevertheless, we do provide such an exercise (by extending the period to 1980) in Appendix B. Our results are unchanged.

[18] We used the World Bank (2018) data to construct infant mortality from 1975 to 2005. The predictor variables are the same as in Table 1.

[19] More importantly, the Batista regime, which preceded the Castro regime, also manipulated publicized data (Lewis-Beck, 1981)(however, there is no evidence that manipulation of health data changed from the Batista regime to the Castro regime).

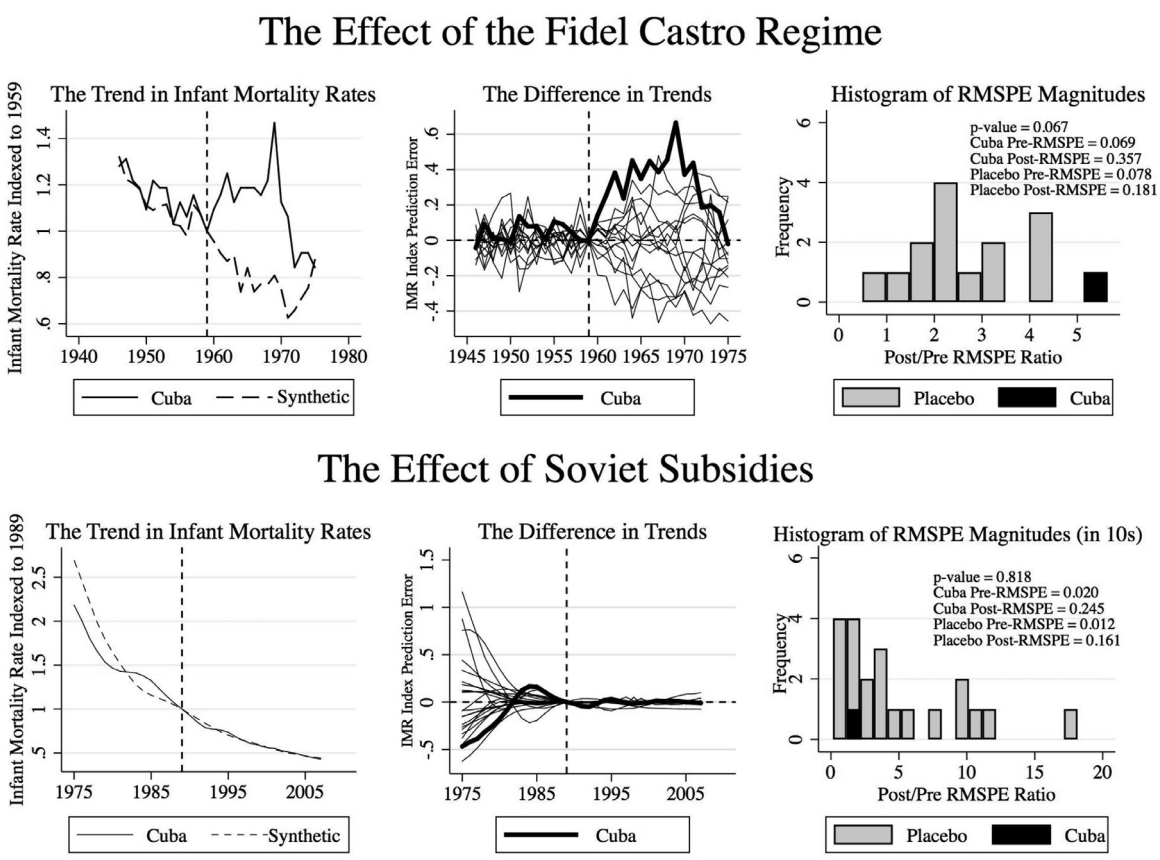

Fig. 1. IMR (indexed to 1959 on top panel and 1989 on bottom panel) in Cuba compared to synthetic Cuba (left), in-place placebo tests for all donor countries (center) and histogram of pre-post RMSPE ratios of all donor country placebos and Cuba (righ), based on Latin American donor pool **Note:** Barbados is not included in donor pool for the revolution's effect because it fails to achieve convergence in the in-place placebo analysis. It also has no weight when included as a donor for Cuba.

deaths.[20] The literature on the drivers of infant mortality changes allows us to contextualize these results by expressing how much other drivers, such as income per capita, would have to change to generate the same effects we found (Kim and Saada, 2013; O'Hare et al., 2013; Schell et al., 2007). The meta-analysis of O'Hare et al. (2013) suggests an income elasticity of infant mortality of.33. This suggests that to get the average differences highlighted above, the equivalent income reduction would have had to be roughly between 9%and 12%

These findings suggest that, absent the revolution, infant mortality rates would have continued to fall. This amounts to saying that the revolution increased the number of infant deaths significantly. This is a provocative statement that requires robustness analysis in the form of a placebo test. The goal of such a test is to assess whether our initial findings are due to noise in the data. As mentioned in the previous section, our placebo analysis involves re-running the synthetic exercise for each donor country using 1959 as the treatment year. The top center and top right panels of Figure 1 show the resulting placebos and suggest that Cuba did receive a significant treatment. The histogram in the top right panel, which reports the pre–post RMSPE ratio of our placebos with that of Cuba, contains the most important information. Cuba's pretreatment RMSPE with the Latin American donor pool stands at 0.069 while the post-treatment RMSPE stands at 0.357. The placebo pretreatment RMSPEs is comparable to Cuba's while this is not the case for the post-treatment period. This suggests that the effect we find in Cuba is unique.[21] The histogram shows each placebo's pre–post RMSPE ratio in comparison to Cuba's. Notice that Cuba is represented by the bar farthest to the right (which is highlighted for clarity), suggesting low *p*-values and a significant effect of the treatment.

We also produced an additional robustness test to address the possibility of the US embargo acting as a foil to our results by shifting the treatment date to 1962 (when the US strengthened the embargo). This led to a breakdown of the pretreatment fit: the

[20] We transform the indexed values into rates in order to provide the amplitude of excess mortality. We use the crude birth rate reported by World Bank (2018) to calculate the excess number of infant deaths. The infant mortality rate is reported per 1,000 live births, but the raw number of births is not offered in Mitchell (2003). Thus, we use the crude birth rate (per 1,000 inhabitants) and the population reported by the World Bank to estimate the number of births. From there, we estimate excess mortality.

[21] Similar results are found when we use the Western countries donor pool in the appendix.

synthetic and the actual no longer matched (regardless of the donor pool used). This suggests that, as a treatment year, 1962 was not a crucial point and that the embargo was of minor relevance. We are unsurprised by this result given that the embargo made exceptions for unsubsidized sales of food and medicines (of relevance to Cuban health outcomes) and that numerous other countries continued to trade with Cuba.

4.2. The effects of Soviet subsidies

The reversion to the counterfactual during the 1970s coincides with the introduction of Soviet subsidies to Cuba which contributed to funding the regime's health policies. Starting on a small scale in the 1960s and then on a much larger scale during the 1970s (Radell, 1983, p. 379), the Soviet Union bought Cuban sugar at prices above those found in world markets (Pérez-López, 1988, p. 123). The subsidies, which began to be phased out in 1989, represented transfers of between $4.7 and $9 million per day to the Cuban government between 1976 and 1987 (Pérez-López, 1991, p. 171).

We cannot safely use the approach employed above to assess whether Soviet subsidies caused the partial reversal to the counterfactual. The subsidies increased significantly towards the end of our post-treatment period when regime changes in Latin America may have adversely affected the quality of our donor pool (see footnote 15). This limits our ability to assess whether the effects of Castro's rise to power were only transitory and whether Soviet subsidies helped the regime. To circumvent this limitation, we tweak the synthetic control method by running it backwards. The logic of the method relies on the idea that a unit receives a treatment that other units do not. There is no particular reason to believe that the treatment must run in any given temporal direction. Consider that a unit might lose a treatment that it was receiving. When it loses the treatment, it becomes like the untreated and we expect its outcomes to converge toward those of the untreated units. Thus, even if it comes later in time, the pretreatment period can be used to see the effect of the treatment. The same logic applies to Soviet subsidies. The pre-1989 period is the post-treatment period and the post-1989 period is the pretreatment period. This allows us to see whether Soviet assistance had an important effect on health outcomes before 1989.

The bottom panels of Figure 1 show the results for the effect of Soviet subsidies with the Latin American donor pool. The pre-treatment period (post-1989) shows that the synthetic performs very well. However, the post-treatment period (pre-1989) exhibits divergence both above and below the synthetic control, suggesting that the divergence may simply be noise. We replicated the placebo exercises in the bottom center and bottom right panels where we report the full set of RMSPE and their ratios in the histogram. The differences between the synthetic and the actual is not unique to Cuba and the *p*-values are much higher than those found in Section 4.1 regarding the effects of the 1959 revolution.

This suggests that Soviet subsidies played no significant role in affecting health outcomes.[22] In Appendix B, we verify this finding by using another measure of health outcomes. As reliable data on life expectancy at birth become available after 1960, we used these data as substitutes.[23] Relative to their counterfactual, both infant mortality rates and life expectancy at birth suggest the same story: there are no effects of Soviet subsidies on health outcomes. This reassures us of the quality of our results. Had subsidies played a positive and significant role, this would have entailed that a share of the reduction in infant mortality could not have been attributed to Castro's regime. In such a scenario, we would have been able to conclude that the revolution had a persistent effect in and of itself (that is, the subsidies would only have attenuated the revolution's effect). As this is not the case, we are unable to assess whether the revolution had a persistent effect. Consequently, we must confine ourselves to the immediate effects of the revolution and state that there was a negative effect of Castro's rise to power.

5. Conclusion

One of the most often-hailed legacies of Castro's rule over Cuba is the substantial decline in infant mortality. This improvement occurred while the country saw tepid economic growth. While many scholars and public health experts have emphasized these improvements in health outcomes, we found no attempts to assess the impact of Castro's accession to power on infant mortality. This gap in the literature is the key motivating factor for our use of the synthetic control method.

The story we document is a nuanced one. The early years of the regime were marked by rising infant mortality relative to the counterfactual scenarios and suggest excess mortality levels equal to between 41,532 or 53,134 infant deaths. This is an important result, as many have argued that Cuba represents a paradox of poverty and strong health outcomes (Borowy, 2011; Campion and Morrissey, 2013; Cooper et al., 2006). Our results suggest that this paradox did not become real until the later years of the regime. In the first decades of Castro's rule, changes in economic outcomes (Jales et al., 2018) went in the same direction as changes in health outcomes. We also observe a reversal to the counterfactual towards the end of our treatment period. We tested whether this reversal could be attributed to Soviet subsidies to Cuba and found that they had no statistically significant effect on health outcomes. While these results allow us to state that Soviet aid did not improve health outcomes, they do not allow us to assess whether the initial effects of Castro's seizure of power in 1959 continue to this day. Thus we cannot be certain whether the observed trend reversal was complete, or even whether the trend reversed again after 1975. Accordingly, our findings are constrained to the immediate aftermath of the revolution.

[22] This may be surprising given that the literature on Cuba's economy suggests that the end of the subsidies caused a prolonged economic contraction: a reduction of 35%of GDP (Benzing, 2005) relative to 1989. This proportion is more or less confirmed by Jales et al. (2018).

[23] We use the World Development Indicators database produced by the World Bank (2018).

This nuanced story opens the door to future research, especially on the role that the end of Russian subsidies played in creating a prolonged recession in Cuba. According to Borowy (2011), while "the degree of economic breakdown reached similar proportions in Cuba and Russia," the crisis "was barely visible in Cuban public health statistics" (p. 1489). If this assessment is correct, it suggests that by the time the USSR collapsed, the Castro regime had been able to improve its delivery of health services such that the quality of delivery was independent of foreign support. However, it does not exclude the possibility that Cuba failed to return to the counterfactual level of infant mortality. Future research should be geared toward identifying whether the effects we found persist to this day.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.eeh.2020.101376.

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