Effects of International Sanctions on Age-Specific Mortality: A Cross-National Panel Data Analysis

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Summary

Background: Prior research has documented a correlation between the imposition of sanctions and worsening health conditions in target countries. However, the direction of causality in this relationship remains unclear. No study has yet examined the effects of sanctions on age-specific mortality rates in cross-country panel data using methods designed to address causal identification in observational data.

Methods: In this cross-national panel data analysis, we analysed the effect on health of sanctions using a panel dataset of age-specific mortality rates and sanctions episodes for 152 countries between 1971 and 2021. We apply a range of methods designed to address causal questions using observational data, including entropy balancing, Granger causality, event-study representations, and instrumental variables.

Findings: Our findings showed a significant causal association between sanctions and increased mortality. We found the strongest effects for unilateral, economic, and US sanctions, whereas we found no statistical evidence of an effect for UN sanctions. Mortality effects ranged from 8·4 log points (95% CI 3·9–13·0) for children younger than 5 years to 2·4 log points (0·9–4·0) for individuals aged 60–80 years. We estimated that unilateral sanctions were associated with an annual toll of 564 258 deaths (95% CI 367 838–760677), similar to the global mortality burden associated with armed conflict.

Interpretation: Sanctions have substantial adverse effects on public health, with a death toll similar to that of wars. Our findings underscore the need to rethink sanctions as a foreign-policy tool, highlighting the importance of exercising restraint in their use and seriously considering efforts to reform their design.

Funding: The Center for Economic and Policy Research.

Research in Context

Evidence Before This Study

We identified 31 quantitative studies that use econometric or calibration techniques to assess the link between sanctions and indicators of social and economic development through searches on Google, Google Scholar, and JSTOR, carried out between Aug 12 and Oct 18, 2022. The searches combined terms characterising quantitative methodologies (econometrics and calibration), the explanatory variable of interest (economic sanctions), and terms describing the wellbeing indicator of interest (eg, life expectancy, mortality, and health). Four studies dealt directly with the effect of sanctions on mortality: one considered under-5 mortality, one considered life expectancy, one considered children's weight, and one considered HIV infection and death rates. None of the studies identified in our search had systematically examined the effects of sanctions on age-specific mortality in cross-country data using methods designed to address causal questions using observational data.

Added Value of This Study

This study provides the first estimates of the effect of economic sanctions on age-specific mortality derived from the use of methods designed to address causal identification on observational data. These methods allow us to address concerns over endogeneity and confounding that have limited previous research and to derive quantitative estimates of deaths associated with sanctions at a global level. Our findings reveal that unilateral and economic sanctions, particularly those imposed by the USA, lead to substantial increases in mortality, disproportionately affecting children younger than 5 years.

Implications of All the Available Evidence

Sanctions have substantial adverse effects on health conditions in target countries, effects similar in magnitude to those of armed conflict. These effects are particularly strong for unilateral, economic, and USA sanctions. In light of this evidence, policy makers should rethink the use of sanctions as a foreign policy tool and consider initiatives to substantially restrain their use and reform their design to reduce adverse humanitarian consequences.

Introduction

International sanctions are restrictions on international transactions imposed by governments in pursuit of foreign policy objectives. Whether sanctions affect health conditions in target countries and whether these impacts are strong enough to cause a substantial number of deaths are among the most contentious issues in contemporary thinking on economic statecraft.

Discussions in the 1990s on the effects on child mortality of sanctions on Iraq strongly influenced policy debates and were one of the main drivers of the subsequent redesign of sanctions on the Government of Saddam Hussein.[1,2]

Sanctions can lead to reductions in the quantity and quality of public health provision driven by sanctions induced declines in public revenues;[3] decreased availability of essential imports, resulting from sanctions induced reductions in foreign exchange earnings, which limit access to medical supplies, food, and other crucial goods;[4] and constraints on humanitarian organisations, through real or perceived sanctions-induced barriers that hinder their ability to operate effectively in target countries.[5] Concern with the humanitarian effect of conventional cross-cutting sanctions regimes has prompted numerous reform initiatives over the years.[6,7]

Despite these initiatives, the use of economic sanctions has grown substantially in recent decades. According to calculations made using the Global Sanctions Database (GSDB), 25% of all countries were subject to some type of sanctions by either the USA, the EU, or the UN in the 2010–22 period, by contrast with an average of only 8% in the 1960s.[8,9] This increase is driven by the growth of sanctions that have the claimed aim to end wars, protect human rights, or promote democracy.[10]

We aimed to investigate the impact of sanctions on mortality in target countries using a cross-national panel dataset of age-specific mortality rates and sanctions events for 152 countries between 1971 and 2021.

Methods

Data Sources

Our sanctions indicators come from the GSDB, the most comprehensive and updated global dataset on sanctions compiled to date. We focus on sanctions imposed by three countries or organisations that can be expected to have substantial effects: the USA, the EU, and the UN. We expect European and US sanctions to have substantial effects given the size of their economies and the fact that most world trade and financial transactions are carried out using the US dollar or the euro.[11] We distinguish between economic sanctions, which are those that restrict trade or financial transactions, and non-economic sanctions, which are those that deal with arms trade, military assistance, travel, or other issues. We also distinguish between sanctions that are imposed unilaterally by the USA or the EU, and those imposed concurrently with a multilateral UN sanctions regime on the same target.

Our dependent variables were mortality rates for newborns (0–27 days), infants (0–1 year), children younger than 5 years (hereafter referred to as under-5; 0–5 years), children (5–9 years), adolescents (10–14 years), adults (15–60 years),

and older people (60–80 years). Estimates for the first three of these groups are constructed by the UN Inter-agency Group for Child Mortality Estimation using data on vital registration systems and direct or indirect estimates based on sample surveys and censuses. Adult mortality rates are constructed by the World Bank using data from the UN Population Division (UNPD) and the Human Mortality Database. We construct mortality rates for children, adolescents, and older groups directly from the age-specific mortality rates published by the UNPD. We combined male and female adult mortality rate estimates from the World Development Indicators database with population shares by sex from the UNPD to constrict our adult mortality rate estimate.

As measures of economic development and modernisation, we used the logarithm of per capita income adjusted for differences in purchasing power parity from the Penn World Table, the ratio of dependents to the working-age population, and the proportion of the population living in rural areas constructed by the World Bank using UNPD data. We used data from the UN Development Programme and UNESCO to construct an indicator of expected years of female schooling, defined as the years of schooling that an average female would attain in her life given the current age-specific female school enrolment rates. We also used a measure of democracy from the Polity5 Project and an indicator of whether the country was involved in either a civil or international war from the Department of Peace and Conflict Research at Uppsala University and the Centre for the Study of Civil War at the Peace Research Institute Oslo.

Panel Fixed-Effects Regressions

We estimated panel fixed-effects regressions in which the dependent variables were measures of age-specific mortality rates and the explanatory variables consisted of an indicator for whether the country was subject to international sanctions and a set of controls capturing the target country's demographic, economic, and institutional characteristics. All regressions include country and year effects, which capture, respectively, the effect of country-specific time-invariant factors such as geography, culture, and religion, and of time-varying factors affecting all countries, such as changes in health technologies. Our baseline specification was thus:

$$m_{it}^{k} = \gamma^{k} S_{it} + \beta^{k} X_{it}^{k} + \eta_{i}^{k} + \delta_{t}^{k} + \varepsilon_{it}$$

Where m_{it}^{k} is the natural logarithm of mortality rates for age group *k* in country *i* at time *t*, S_{it} is a vector of sanctions indicators, X_{it}^{k} is a vector of control variables, η_{i}^{k} is a country-specific effect, δ_{t}^{k} is a time-specific effect, and the subscripts *i* and *t* and superscript *k* denote respectively, the country, year, and

age subgroup of each observation. Because our sanctions indicators S_{it} are dichotomous variables, the two-way fixed-effects (TWFE) specification uses information from both the sanctions period and the periods before and after sanctions to identify the effects of sanctions on mortality.

Nested Specifications Analysis

Our baseline specification estimates the effects of each sanctions indicator through separate regressions. In addition, we provide a set of nested specifications in which several sanctions indicators are included simultaneously in a single regression, making k a vector of length greater than 1. These nested models allow us to evaluate the impact of specific sanction types conditional on the presence of others and help address potential omitted variable bias when several types of sanctions each have effects. The models can thus help us to more precisely assess whether some sanctions have greater explanatory power than others in determining changes in mortality. We used this approach to assess the relative effects of unilateral versus multilateral UN sanctions, economic versus non-economic sanctions, and sanctions by different sender countries.

Econometric Analyses

We used four main econometric methods to address causal identification in observational data: entropy balancing[12] (the use of reweighting to replicate the observable characteristics of experimental control groups), event-study representations (the evolution of post-intervention effects over time), Granger causality tests (the analysis of temporal precedence), and instrumental variables (the use of exogenous sources of variations as natural experiments). Table 1 outlines the specification, key assumptions, and limitations of these methods.

For the event-study specification estimates, we calculated point estimates and 95% CIs from estimates of the following equation

$$m_{it}^{k} = \theta^{k} P_{it} + \sum_{g=1}^{N} \gamma_{g}^{k} D_{it}^{g} + \beta^{k} X_{it} + \eta_{i}^{k} + \delta_{t}^{k} + \varepsilon_{it}^{k}$$

where P_{it} is an indicator variable equal to 1 if period *t* falls within the 3-year interval before the imposition of sanctions and D_{it}^{g} is an indicator variable equal to 1 for g-th successive 3-year interval after the imposition of sanctions, with g=1 corresponding to years 1–3 after sanctions, g=2 to years 4–6, and g=3 to years 7 and beyond. This analysis allows us to distinguish between short-term, medium-term, and longer-term effects of sanctions on mortality rates. All other variables are as defined in equation (1).

For the Granger causality tests, we separately test for the significance of lags, leads, and contemporaneous effects of the treatment variable in the panel regressions. This approach is premised on the idea that temporal precedence can be interpreted as evidence in favour of causality, and that the absence of temporal precedence can be interpreted as evidence against the hypothesis of reverse causality.

For the instrumental variables analysis, we used a set of measures of similarity of foreign policy positions between the target country and potential sanctioning countries as instruments for unilateral sanctions. We built these measures from the indices of foreign policy preferences developed by Bailey, Strezhnev, and Voeten,[13] who used a dynamic ordinal spatial latent variable model applied to UN General Assembly votes from 1946 to 2022 to estimate country-specific and time-specific ideal points characterising the foreign policy preferences of UN members. Concretely, our instrument for US and EU unilateral sanctions is the absolute distance between the ideal points of each country and the potential sanctioning countries. Our identification approach is based on the idea that the USA and Europe are less likely to seek to impose unilateral sanctions on countries that hold foreign policy positions that are very similar to theirs. In other words, they are unlikely to be inclined to sanction their own allies; if they do so, it will be when a great level of consensus has emerged that the target country has done something egregious enough so as to merit multilateral condemnation, in which case sanctions will also be imposed by the UN and by definition not be unilateral.

Table 1: Summary of Methods Used in This Study

	Specification	Key Assumptions	Limitations
Entropy balancing	Regression weights chosen to achieve covariate balance	Covariates capture all relevant confounders; treatment assignment and outcomes are independent; weighting achieves balance across treatment and control groups.	Results hinge on accuracy of included covariates and success in rebalancing; cannot address unobserved confounders.
Event-study representations	Dynamic regression including pre and post-sanctions effects	Correct identification of treatment timing and absence of pre-treatment trends; treatment assignment and outcomes are independent.	Sensitivity to event windows, confounding events, and anticipatory effects.
Granger Causality	Joint tests of predictive causality of leads of explanatory variable	Temporal precedence is treated as evidence of causality.	Not valid under anticipatory effects or omission of confounders correlated with regressor and dependent variable.
Instrumental variables	Two-stage least squares estimation with UN General Assembly votes as instruments	Instrument is correlated with sanctions and uncorrelated with other unobserved determinants of mortality.	Can lead to biased and inconsistent estimates if instruments are weak or exclusion restriction fails; produces estimates that are valid only locally for sanctions events associated with changes in the instrument.

Estimates of the Annual Number of Deaths Caused by Sanctions

We used the coefficient estimates for the effect of global, economic, and unilateral sanctions on age-specific mortality rates to estimate the annual number of deaths in the world associated with the imposition of sanctions for the 1971–2021 period. Formally, let D_{it} represent the total number of deaths observed in country *i* at time *t* and $\hat{D}_{it}$ number of deaths that the country would have experienced in the absence of sanctions. Then the total number of deaths worldwide attributable to sanctions will be given by:

$$D_t^S = \sum_{i=1}^{N} (D_{it} - \widehat{D}_{it})$$

The UNPD provides annual country-year data for total deaths since 1960, allowing us to calculate D_{it}. To estimate $\hat{D}_{it}$, we combine our estimate of age-specific mortality rates inclusive of the estimated effect of sanctions with the UNPD age-specific population estimates.

Role of the Funding Source

At the time most of the research for this study was done, SR and FR were visiting researchers at the Center for Economic and Policy Research (CEPR). However, the manuscript was written and finalised after their paid affiliation with CEPR had ended. The CEPR did not have any direct role in the writing of the manuscript or the decision to submit it for publication.

Results

The baseline global sanctions indicator, weighted using entropy-balancing, was significantly associated with increased mortality at conventional levels for all seven age groups (six of them at $p < 0{\cdot}01$, one at $p < 0{\cdot}05$; table 2). Economic, unilateral, and unilateral economic sanctions were significantly associated with increased mortality for at least six of the seven age groups (the exception being adolescents). Non-economic and unilateral noneconomic sanctions were significant for four age subgroups, whereas weapons sanctions were significant for two age subgroups. None of the 14 coefficients on the UN sanctions variables, by contrast, were significant, and six of them have a negative sign.

Table 2: Entropy-balancing Estimates (non-nested specifications) of Mortality Effects of Sanctions by Age Group According to Sanction Type

	Neonatal mortality 0-27 days	Infant mortality 0-1 year	Under-five mortality 0-5 years	Child mortality 5-10 years	Adolescent mortality 10-15 years	Adult mortality 15-60 years	Mortality in older adults 60-80 years
Global sanctions	0·054 (0·021)***	0·081 (0·022)***	0·084 (0·023)***	0·076 (0·028)***	0·052 (0·024)**	0·037 (0·014)***	0·024 (0·008)***
Economic sanctions	0·047 (0·020)**	0·074 (0·023)***	0·075 (0·025)***	0·075 (0·032)**	0·055 (0·027)**	0·041 (0·016)**	0·025 (0·009)***
Non-economic sanctions	0·041 (0·022)*	0·080 (0·024)***	0·084 (0·025)***	0·067 (0·035)*	0·038 (0·030)	0·035 (0·016)**	0·029 (0·008)***
Unilateral sanctions	0·049 (0·020)**	0·064 (0·019)***	0·069 (0·020)***	0·056 (0·025)**	0·031 (0·022)	0·052 (0·015)***	0·021 (0·007)***
UN sanctions	0·018 (0·032)	0·019 (0·046)	0·002 (0·056)	0·059 (0·084)	0·071 (0·074)	0·005 (0·036)	0·002 (0·012)
Unilateral economic sanctions	0·044 (0·019)**	0·069 (0·021)***	0·071 (0·023)***	0·065 (0·032)**	0·046 (0·027)*	0·047 (0·017)***	0·024 (0·008)***
UN economic sanctions	0·023 (0·023)	-0·025 (0·042)	-0·062 (0·056)	-0·091 (0·099)	-0·065 (0·080)	-0·071 (0·046)	-0·015 (0·012)
Unilateral non-economic sanctions	0·030 (0·022)	0·059 (0·022)***	0·066 (0·024)***	0·050 (0·034)	0·015 (0·028)	0·048 (0·016)***	0·026 (0·008)***
Weapons sanctions	0·038 (0·033)	0·083 (0·040)**	0·080 (0·043)*	0·081 (0·055)	0·067 (0·048)	0·036 (0·020)*	0·038 (0·012)***

Data are standard regression coefficients (SE, clustered by country). All estimations include country and time-specific effects. Observations are weighted using entropy-balanced weights obtained by balancing on the sanctions indicator whose treatment is being estimated. ***p<0·01. **p<0·05. *p<0·1.

The result of alternative nested specifications in which we included several sanction indicators as explanatory variables at the same time are presented in table 3. Specification 1 showed that unilateral sanctions clearly dominate UN sanctions; when both are included in the equation, unilateral sanctions are significant for all age groups, whereas UN sanctions were never significant, and in one specification, they have the wrong sign (negative rather than the expected positive). Specification 2, by contrast, showed that although economic sanctions sometimes have stronger effects than non-economic sanctions when both are included in the equation, there is one age group (aged 60–80 years) in which non-economic sanctions have a significant effect, and another two in which they have borderline significant effects (p values between 0·05 and 0·10). Specifications 3–5, in turn, showed that US sanctions appear to be driving the adverse mortality effects. In specification 4, for example, US unilateral sanctions were significant for six age groups, whereas EU unilateral sanctions were not significant in any of the age groups. When we included the six sanctions indicators in the regressions in specification 5 (USA-based, EU-based, and UN-based unilateral and economic sanctions), we continued to find

that US sanctions deliver the most significant effects. Similarly, non-weapons sanctions dominate weapons sanctions when they are included jointly (specification 6).

Table 3: Entropy-balancing Estimates (nested specifications) of Mortality Effects of Sanctions by Age Group According to Specification and Sanction Type

	Neonatal mortality 0-27 days	Infant mortality 0-1 year	Under-five mortality 0-5 years	Child mortality 5-10 years	Adolescent mortality 10-15 years	Adult mortality 15-60 years	Old age mortality 60-80 years
Specification 1							
Unilateral sanctions	0·055 (0·020)***	0·080 (0·020)***	0·085 (0·022)***	0·072 (0·026)***	0·046 (0·022)**	0·050 (0·014)***	0·025 (0·008)***
UN sanctions	0·046 (0·050)	0·090 (0·051)*	0·080 (0·055)	0·099 (0·089)	0·089 (0·082)	-0·045 (0·059)	0·018 (0·019)
Specification 2							
Economic sanctions	0·028 (0·022)	0·049 (0·022)**	0·052 (0·024)**	0·057 (0·031)*	0·047 (0·027)*	0·037 (0·017)**	0·017 (0·008)**
Non-economic sanctions	0·030 (0·025)	0·043 (0·023)*	0·045 (0·024)*	0·033 (0·034)	0·009 (0·030)	0·006 (0·020)	0·020 (0·009)**
Specification 3							
US sanctions	0·042 (0·021)**	0·050 (0·021)**	0·051 (0·022)**	0·024 (0·030)	0·006 (0·026)	0·032 (0·017)*	0·016 (0·008)**
EU sanctions	-0·016 (0·030)	0·018 (0·031)	0·024 (0·034)	0·051 (0·048)	0·035 (0·043)	-0·004 (0·027)	0·008 (0·011)
UN sanctions	0·014 (0·048)	0·031 (0·050)	0·016 (0·055)	0·037 (0·084)	0·049 (0·076)	-0·076 (0·057)	-0·001 (0·018)
Specification 4							
US unilateral sanctions	0·059 (0·021)***	0·076 (0·019)***	0·079 (0·020)***	0·054 (0·027)**	0·032 (0·023)	0·045 (0·018)**	0·023 (0·008)***
EU unilateral sanctions	-0·022 (0·032)	0·016 (0·032)	0·023 (0·034)	0·052 (0·043)	0·033 (0·037)	0·018 (0·024)	0·008 (0·011)
UN sanctions	0·039 (0·049)	0·087 (0·050)*	0·078 (0·055)	0·099 (0·088)	0·087 (0·081)	-0·046 (0·059)	0·017 (0·019)
Specification 5							
US unilateral sanctions	0·089 (0·025)***	0·087 (0·025)***	0·082 (0·026)***	0·052 (0·038)	0·030 (0·035)	0·036 (0·024)	0·019 (0·010)*
EU unilateral sanctions	0·002 (0·045)	0·023 (0·047)	0·027 (0·051)	0·024 (0·097)	0·015 (0·089)	0·048 (0·056)	0·000 (0·020)
UN sanctions	-0·007 (0·064)	0·093 (0·071)	0·102 (0·080)	0·121 (0·126)	0·114 (0·115)	-0·025 (0·083)	0·005 (0·026)
US economic sanctions	-0·041 (0·026)	-0·015 (0·025)	-0·004 (0·025)	0·002 (0·036)	0·001 (0·035)	0·014 (0·022)	0·004 (0·010)
EU economic sanctions	-0·023 (0·050)	-0·009 (0·054)	-0·006 (0·061)	0·034 (0·121)	0·021 (0·112)	-0·041 (0·072)	0·010 (0·023)
UN economic sanctions	0·129 (0·064)**	0·008 (0·075)	-0·032 (0·084)	-0·063 (0·134)	-0·060 (0·127)	-0·018 (0·097)	0·010 (0·030)
Specification 6							
Weapons sanctions	0·021 (0·034)	0·034 (0·032)	0·028 (0·035)	0·043 (0·048)	0·032 (0·041)	-0·003 (0·027)	0·024 (0·012)**
Non-weapons sanctions	0·041 (0·018)**	0·069 (0·018)***	0·074 (0·020)***	0·064 (0·025)**	0·046 (0·023)**	0·039 (0·017)**	0·017 (0·008)**

Data are standard regression coefficients (SE, clustered by country). All estimations include country and time-specific effects. Observations are weighted using entropy balanced weights obtained by balancing on the sanctions indicator whose treatment is being estimated. ***p<0·01. **p<0·05. *p<0·1.

The results of panel event-study specification estimates are shown in the figure. The figure shows the results for infants, children younger than 5 years, adults, and people who are older (results for additional age subgroups, and for yearly time intervals, are reported in the appendix (pp 21–22). These results illustrate how the effects of sanctions on mortality generally increase over time, with longer-lived sanctions episodes resulting in higher tolls on lives. For example, in the case of infant mortality, economic sanctions resulted in an increase of 5·9 log points (95% CI 1·6–10·2) in mortality during the first 3 years following their adoption, 8·3 log points (3·3–13·3) in the period between 4 years and 6 years

after adoption. In all cases, the effects were statistically indistinguishable from zero for the pre-sanctions period, yet significant for most or all the subperiods after sanctions, consistent with the hypothesis of a causal effect running from sanctions to mortality.

The results of Granger causality tests showed that lagged and contemporaneous treatment indicators were significantly associated with the dependent variable, whereas lead indicators were not (appendix p 20).

The results of our use of exogenous sources of variation (UN General Assembly votes on the use of sanctions) as instrumental variables to estimate causal effects of overall sanctions and those of unilateral and economic sanctions are shown in table 4. All three sanctions measures showed significant coefficient estimates at $p < 0{\cdot}05$ for neonatal and infant mortality. The general sanctions and economic sanctions indices also showed significant effects for under-5 mortality, whereas economic sanctions also showed a significant effect on mortality in older people.

We provide the results of several additional tests in the appendix. These tests include unweighted TWFE estimates (appendix pp 6–8); log-linear, linear, and Poisson specifications (appendix pp 12–16); systems of equations estimates (appendix pp 17–18); gender and time-specific effects (appendix pp 22–23, 31–32); staggered imputation methods (appendix pp 23–24); estimation of direct and indirect effects (appendix pp 24–25); robustness tests for alternative controls (appendix pp 25–26); removal of outliers and lagging of independent variables (appendix pp 26–29); use of alternative sanctions indicators (appendix pp 29–31); use of alternative child and adolescent mortality measures (appendix pp 31–32); non-linear interaction terms (appendix pp 32–33); weapons sanctions (appendix pp 41–42); measures of sanctions comprehensiveness (appendix pp 42–45); and crude mortality (appendix pp 45–47).

Table 4: Second-stage Instrumental Variable Estimates of Mortality Effects of Sanctions by Age Group According to Sanction Type

	Neonatal mortality 0-27 days	Infant mortality 0-1 year	Under-five mortality 0-5 years	Child mortality 5-10 years	Adolescent mortality 10-15 years	Adult mortality 15-60 years	Mortality in older adults 60-80 years
Global sanctions							
Coefficient estimate	0·39 (0·123)***	0·339 (0·128)***	0·26 (0·131)**	0·063 (0·144)	0·149 (0·149)	0·035 (0·129)	0·102 (0·055)*
Unilateral sanctions							
Coefficient estimate	0·355 (0·147)**	0·313 (0·153)**	0·228 (0·156)	0·046 (0·17)	0·15 (0·174)	0·015 (0·153)	0·101 (0·065)
Economic sanctions							
Coefficient estimate	0·624 (0·235)***	0·497 (0·190)***	0·385 (0·184)**	0·131 (0·188)	0·254 (0·186)	0·08 (0·19)	0·178 (0·067)***
Number of observations	5321	5591	5591	5599	5599	5579	5599

Data are standard regression coefficients (SE, clustered by country). All estimations include country and time-specific effects. Instruments include lags of the similarity of foreign policy positions between potential targets and the USA, the UK, and the six founding members of the European Economic Community. Specification tests are reported in the appendix (p 10). ***p<0·01. **p<0·05. *p<0·1.

We estimated the annual number of deaths caused by each type of sanction in the 2012–21 period (table 5). We presented estimates of deaths derived from the non-nested TWFE specification coefficients (table 2) for three sanction variables: global, economic, and unilateral variables (estimates obtained through various alternative specifications are presented in the appendix pp 38–39).

We estimate that unilateral sanctions over this period caused 564 258 (95% CI 367 838–760 677) deaths per year. This estimate corresponds to incremental annual deaths of 0·02% of the population (95% CI 0·01–0·03), which is equivalent to 3·6% (2·3–4·8) of total deaths observed in sanctioned countries. This estimate is higher than the average annual number of battle-related casualties during this period (106 000 deaths per year) and similar to some estimates of the total death toll of wars including civilian casualties (around half a million deaths per year).[14]

We also estimated the evolution of deaths caused by global sanctions for each age segment over time (appendix p 37). The largest incidence of global sanctions occurred in children younger than 1 year, followed by the 60–80 years age segment. Altogether, deaths of children younger than 5 years represented 51% of total deaths caused by sanctions over the 1970–2021 period. Note that most deaths (77% over the same period) were in the 0–15 years and 60–80 years age groups, implying that the bulk of the mortality effects falls on groups that are traditionally not in the labour force. Over time, deaths attributable to sanctions among younger age groups have decreased, whereas those for the older age groups have increased.

Table 5: Annual Deaths Caused by Different Sanctions by Age Range, 2012–21

	Global sanctions	Economic sanctions	Unilateral sanctions
Number of annual deaths caused by sanctions	776,610 (526,543–1,026,678)	628,860 (404,264–853,457)	564,258 (367,838–760,677)
Annual deaths caused by sanctions as percentage of population of sanctioned countries	0·02 (0·02–0·03)	0·03 (0·02–0·03)	0·02 (0·01–0·03)
Annual deaths caused by sanctions as percentage of all deaths in sanctioned countries	3·85 (2·61–5·10)	3·99 (2·56–5·41)	3·58 (2·33–4·82)

Data are model-based estimates of deaths (95% CI). Estimates obtained using coefficient estimates from the two-way fixed effects model of table 2 with CIs obtained through Monte Carlo simulations with N=1000 (see appendix p 38 for calculation details).

Discussion

Our study found a significant adverse effect of economic and unilateral sanctions on mortality rates in target countries. These results are consistent with those of previous research, which has also found significant negative effects of sanctions on various indicators of living conditions in targeted countries, including economic growth and health outcomes.

Our contribution advances existing research in several dimensions. First, our use of matching, instrumental variables, event study, and Granger causality techniques provides a framework for identifying a causal relationship from sanctions to mortality with greater confidence than the primarily correlational findings of previous studies. Second, we directly identify the effect of sanctions regimes on death rates of different subpopulations, going beyond the aggregate summary measure used previously. Third, we are able to distinguish the effects of different types of sanctions, including those imposed as part of multilateral efforts, those imposed unilaterally, and those that directly target economic conditions. Gibson and colleagues[15] found that aid suspensions caused significant increases in maternal and infant mortality. Our study focuses on a distinct phenomenon, which is the adoption of restrictions on economic interactions between nationals of two countries in pursuit of a foreign policy goal. Although aid suspensions are typically considered an element of economic statecraft, they are not included in the operational definition of sanctions that we use for our analysis.

Figure 1: Event-study Representations of the Effect of Sanctions on Mortality, Selected Age Groups

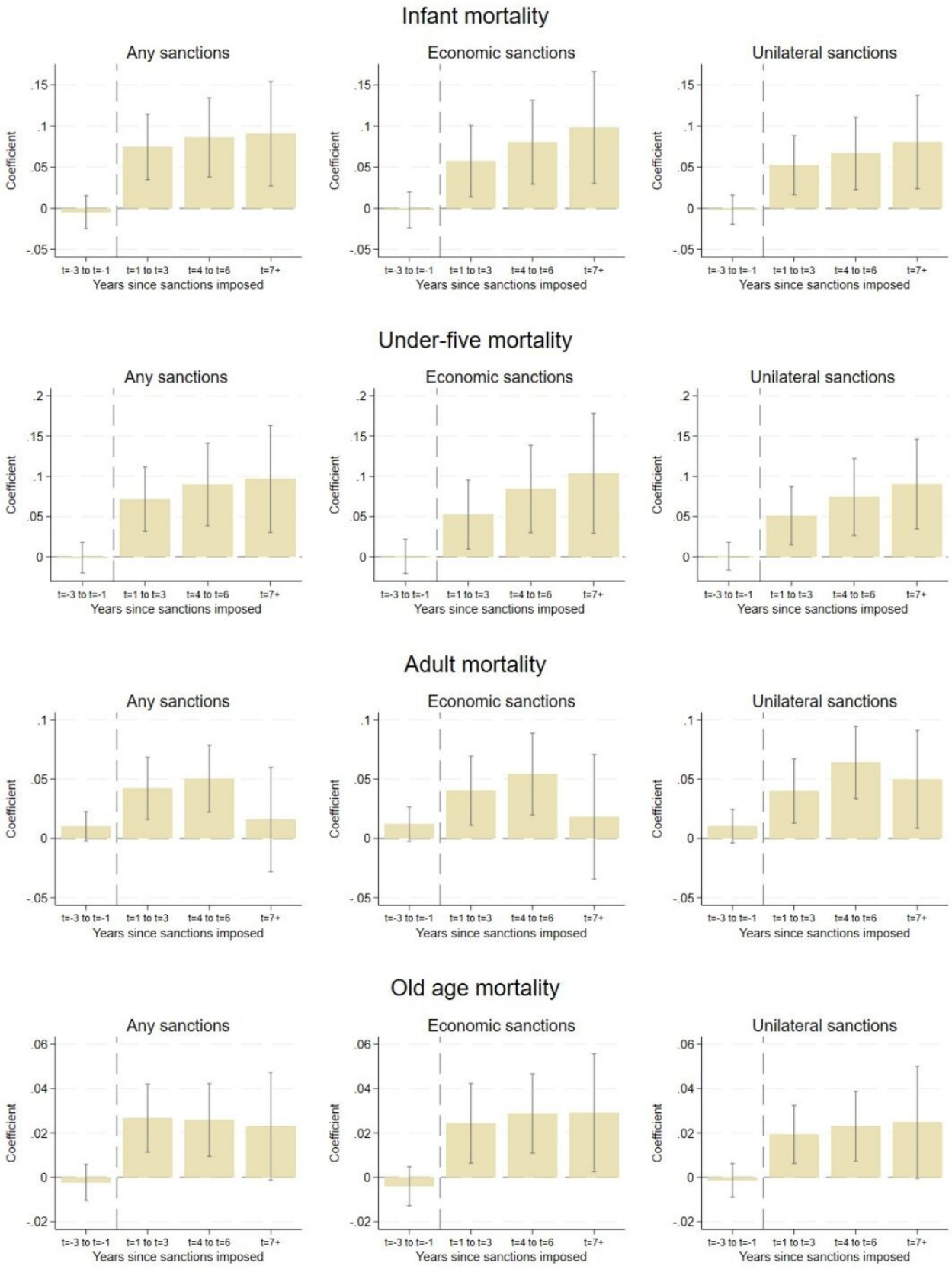

Figure represents event plots of estimates of equation (2). Confidence bands correspond to 95% CIs constructed using standard errors clustered by country. Observations are weighted using entropy balanced weights obtained by balancing on the sanctions indicator whose treatment is being estimated. Vertical dashed lines represent the reference period (t=0) marking the start of the sanctions episode.

These findings raise an important question for policy debates—what role, if any, should economic and unilateral sanctions have in the foreign policies of the countries or organisations imposing them? This question is particularly pertinent given the substantial increase over time in the use of these sanctions. The fraction of the world's economy subject to unilateral sanctions, for example, has grown from 5·4% in the 1960s to 24·7% in the 2010–22 period.

How one should normatively assess the effect of sanctions depends on the ethical framework used to assess it.[16,17] Our results help inform this important discussion by providing a quantitative assessment of the human losses generated by the imposition of sanctions. From a rights-based perspective, evidence that sanctions lead to losses in lives should be sufficient reason to advocate for the suspension of their use. From a consequentialist perspective, this evidence should be considered alongside parallel evidence on the effectiveness of sanctions in reaching their stated goals.

Our evidence also contributes to the broader debate on efforts to overhaul sanctions design to mitigate or eliminate their adverse human consequences.[6,18,19] One finding of potential relevance for debates on sanctions reform is our result that, although unilateral and economic sanctions are positively associated with increases in mortality, UN sanctions are not. A possible interpretation of this finding is that this difference is a result of the greater public scrutiny that decisions of the UN, a deliberative body with participation of target countries, are naturally subject to.[20] Nevertheless, interpreting this finding with caution is important. In many of our estimations, the point estimates for the UN sanctions coefficient are positive, even if not statistically significantly different from zero. Thus, although the evidence does not allow us to reject the hypothesis that UN sanctions have no effect on mortality, it also does not allow us to reject the alternative hypothesis that they have a quantitatively significant adverse effect.

There are various reasons why UN sanctions could be expected to have effects that are more difficult to identify in cross-national data. One of them is that unilateral sanctions imposed by the USA or the EU might be designed in ways that have a greater negative effect on target populations. Most—although not all—UN sanctions regimes in recent decades have been framed as efforts to minimise their impact on civilian populations, although the extent to which they have achieved this goal remains debated.[21] US sanctions, in contrast, often aim to create conditions conducive to regime change or shifts in political behaviour, with the deterioration of living conditions in target countries in some cases being acknowledged by policy makers as part of the intended mechanism through which objectives are to be attained.[22,23] The USA—and, to a lesser extent, Europe—also has important mechanisms at its disposal that serve to amplify the economic and human effects of sanctions, including those

linked to the widespread use of the US dollar and the euro in international banking transactions and as global reserve currencies,[24] and the extraterritorial application of sanctions, particularly by the USA.[25,26]

The limitations of this study are those inherent to the use of non-experimental data to assess policy interventions. We summarised the specific limitations of each of our methods (table 1), including possible biases and inconsistency of estimates under unobserved confounders, weakness of instruments or failure of the exclusion restriction, and anticipatory effects in the case of methods that rely on time variation. Our instruments are plausibly exogenous determinants of unilateral sanctions while also being plausibly uncorrelated with non-sanctions determinants of mortality. There is no obvious channel of causation through which foreign policy positions affect domestic health conditions. While it is possible that a country's foreign policy position is correlated with poor public policy choices that also lead to increases in mortality, our sanctions coefficient estimate remains significant across most specifications when we control for measures of trade and macroeconomic policies (appendix pp 25–26). Our instruments also have strong explanatory power in the first-stage regressions, with the associated test statistics significantly exceeding under-identification and weak instrument test critical values (appendix p 10). The nature of sanctions interventions has varied over time, and the recent increase in the intensity of sanctions use highlights that the criteria for adopting sanctions may be substantially different in the present and near future from what they have been in recent decades. These structural changes in the motivations and intent of policy can pose a challenge for the external validity of our results when trying to make inferences about current or future sanctions interventions.

Woodrow Wilson[27] referred to sanctions as "something more tremendous than war". Our evidence suggests that he was right. Over the past decade, we estimate that unilateral sanctions caused around 560,000 annual deaths worldwide. It is hard to think of other policy interventions with such adverse effects on human life that continue to be pervasively used.

Contributors

FR contributed to the manuscript, including conceptualisation, data curation, formal analysis, investigation, methodology, supervision, validation, visualisation, and writing—both the original draft and reviewing and editing. MW contributed to the conceptualisation of the study as well as writing, review, and editing. SR contributed to the original draft writing, review, and editing, and data curation, formal analysis, and methodology. Both SR and FR directly accessed and verified the underlying data reported in the manuscript. All authors had full access to all the data in the study, and accept responsibility for submitting the manuscript for publication.

Declaration of Interests

FR is the owner of VenAnalytics, a for-profit consultancy, director of Oil for Venezuela, a non-profit organisation, and an expert witness in litigation involving Venezuela. SR and FR received financial support from the Center for Economic and Policy Research (CEPR) during the research phase.

Data Sharing

This study is based entirely on publicly available data, as cited in the Article. To facilitate further research, a compiled dataset including age-specific mortality rates, sanctions indicators, and other covariates used in the analysis has been deposited in the Harvard Dataverse repository. The dataset is available at https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/ZJSHU4.

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