An investigation of relationship between global economic sanction and life expectancy: do financial and institutional system matter?1

Le Thanh Ha and Pham Xuan Nam
Faculty of Economics, National Economics University, Hanoi, Viet Nam

ABSTRACT
This article examines the impact of cross-border economic sanctions (CES) on the quality of national health – proxied by life expectancy. Structural gravity models are employed for a sample of 148 sanctioned countries (108 developing countries and 40 developed countries) during the 1995–2018 period. We consider various forms of sanction, including arms, military, trade, finance and travel. The results reveal that the imposition of sanctions, especially arm, financial, travel and other sanctions, has a significant negative effect on the national health of the targeted countries. The effects are largely heterogeneous across sanctioned countries in terms of their economic development. Furthermore, financial market development and institutional quality of the sanctioned countries critically affect the relationship between CES and national health. Particularly, more developed financial markets, the higher degree of financial openness and central bank independence, as well as higher institutional quality, help targeted countries alleviate the consequences of CES on national health. These empirical findings are expected to provide insightful lessons for economists and policymakers in the targeted countries facing the risk of economic degradation.

1. Introduction
Nowadays, wars and military conflicts are usually no longer suitable options for resolving cross-border conflicts. Nations around the world tend to employ economic sanctions as an alternative measure when participating in international politics. Economic sanctions can be applied when a country violates international law, human rights or just simply the national interests of other nations (Gutmann, Neuenkirch, and Neumeier 2021). The impact of sanctions are often severe. For example, Neuenkirch and Neumeier (2015) assert that countries sanctioned by the United States experienced a 13% reduction in their gross domestic product. The impact is even more significant, up to 25%, when the sanction is utilized by the United Nations. Sanctions have a direct economic impact on the targeted countries. Hatipoglu and Peksen (2018) argue that sanctions influence the economic elites more severely, even triggering a financial crisis, although the adverse effect is also common on the income of vulnerable individuals of society. In addition to direct economic influences, sanctions also increase poverty and deepen income inequality in the targeted state, as found by (Afesorgbor and Mahadevan 2016; Choi and Luo 2013; Neuenkirch and Neumeier 2016).

Additionally, it is widely affirmed that sanctions cause social costs other than economic damage (Gutmann, Neuenkirch, and Neumeier 2021). Research on the impact of sanctions on all aspects of human well-being, therefore, is essential. Recognizing this, since 1990, the United Nations (2015) has promoted human development instead of economic growth. To measure this development, the United Nations has issued the Human Development Index, which takes the income, life expectancy and education level of the population in each country into account. Following that practice, among various social aspects, we expect that economic sanctions to have effects on the life expectation of the population in a country.

Recently, scholars have been focusing on the effects of sanctions on health, especially on finding more empirically evidence. For example, Peksen (2011) first addresses this issue with an international sample utilizing child mortality as a proxy for health. However, Peksen’s model still causes concerns regarding endogeneity that might bias the estimation results. Kim (2019) employs HIV infection in children and their AIDS-related mortality to represent the health when...
studying this link, but the author does not pay adequate attention to the issue of identification. For the effect on life expectancy, the exclusive literature is that of Allen and Lektzian (2013). Although Allen and Lektzian (2013) applied the Heckman selection model to resolve the endogeneity problem, their instrumental variables could not satisfy the exclusion constraint since sanctions are indicators for military conflict. Notably, the authors have experimentally demonstrated that military conflict has a direct influence on life expectancy. The uniformity of sanctions can lead to errors in estimates, resulting incorrect conclusions.

Other studies like Parker, Foltz, and Elsea (2016) analyze the effect of sanctions on companies operating in specific areas of the Democratic Republic of Congo under section 1502 of the United States Dodd-Frank Act (Stoop et al. 2018). The paper study this link by concentrating on a single-country case. The authors find that the infant mortality rate is high (140%) when local warlords boycotted mineral purchases to disrupt the finances of villages near the targeted mines. Empirical evidence suggests this action considerably decreases mothers’ consumption of infant health care goods and services. The impact assessment strategy of this paper is very attractive, but it cannot be generalized and applicable to the diversity of sanctions as well as to different countries.

Our study, therefore, contributes to the extant literature by investigating the influences of different types of economic sanctions on life expectancy. Our contributions are twofold. First, to the best of our knowledge, we are the first to study the effects of global economic sanctions on the life expectancy of targeted countries. We also first to distinguish the heterogeneous impacts of various sanction types. Gutmann, Neuenkirch, and Neumeier (2021) also focus on this link, but they only consider the association between UN and US sanction and life expectancy. Their limited data also limit them to analyze this relationship only over the period 1977–2012. Employing the new and rich database of the Global Sanction DataBase introduced by (Felbermayr et al. 2020a; 2020b), we are able to obtain both empirical and policy implications for the 1995–2018 period. Furthermore, our study has also an empirical contribution by taking the endogeneity issue into account when investigating the effects of economic sanctions on life expectancy. Second, this paper gives further insights into the sanctions-life expectancy linkage by testing the moderating role of institutional quality and financial development of the targeted country.

To obtain these research objectives, we use a panel dataset including 148 targeted countries during the 1995–2018 period. Our estimation results consistently indicate that the imposition of sanctions significantly deteriorates the life expectancy of the sanctioned states. However, this consequence could be partly mitigated if the targeted country has high-quality institutions and a well-developed financial sector. The findings of this research are important in the views of policymakers in both the sender and the target. For the sanctioning state or international organizations, this study provides implications about the problematic value of sanctions in protecting the people as mostly claimed. On the other hand, given the crucial roles of life expectancy improvement for sustainable development and the threat of sanctions during deep economic integration, this research suggests strategic initiatives for the ‘vulnerable’ countries to protect the individuals’ life expectancy of society.

The rest of the paper proceeds as follows. Section 2 reviews relevant literature and develops hypotheses. Section 3 introduces the model, data, and estimation method. Section 4 reports empirical results and discussion. Section 5 concludes the paper.

2. Literature review and hypothesis development

2.1. Sanctions and life expectancy

Many studies claim that the negative effect of economic sanctions on life expectancy can be explained by several key reasons. First, import limitations, which entail restriction on the provision of final consumer products and inputs for the production, including those that are for medical utilization such as medicines, ambulances, hospitals, medical machinery, cause significant damage to the health infrastructure of the targeted countries. Garfield (1997) analyzes the health dimension and reports that adverse consequences for health infrastructure may occur even when healthcare goods are excluded from the sanctions bracket. This indirect effect is through an increase in the overall cost of trading goods and inputs. The second reason is related to government spending on health services. Because government spending is based on tax revenue, a decrease in tax revenue, as well as the overall income of the economy, constrains government resources and forces governments to reduce spending on public health services. The third reason is related to import costs and increased production costs. Private health services continue to be provided but at a higher price, leading to the restriction of a part of the population to access health care. These excluded people are often low-income and more vulnerable people. According to Garfield (1997), women and children are the groups
that are most vulnerable to the negative effects of economic sanctions on life expectancy. The fourth reason is that the deterioration of public infrastructure, especially the sanitation system, may lead to the spread of infectious diseases. Fifth, a lower-income creates incentive for workers to engage in jobs that have harsh or unsafe working conditions. In general, sanctions impact health due to the influences on citizens’ incomes. Burke, Gong, and Jones (2015) demonstrate that adverse income shocks explain up to 20% of differences in HIV prevalence across African countries. Kim (2019) also examines the association between sanctions and increased HIV infection rates among women. As income decreases, so does spending on food and clean water, which clearly has a direct impact on health. In short, economic sanctions differentially affect different social groups, and most severe impacts are to the more vulnerable members of society, including the poor, women, children, and the elderly (Allen and Lektzian 2013; Peksen 2011).

Based on our discussion, we propose that:

**H1:** Economic sanctions harm life expectancy.

### 2.2. The moderating effect of institutional quality

In this study, we give another focus on the moderating roles of institutional quality in influencing the impacts of international sanctions on life expectancy. Specifically, we argue that institution's quality, in many aspects including policymaking, law enforcement, control of corruption as well as political stability, could influence both the economic and social condition of a nation, hence, may alter the extent to which the sanctions could influence life expectancy. Given the existing good institutional quality before the imposition of sanctions, the targeted country has built its democratic norms that lead to a common culture that promotes the willingness to bargain instead of rebellion and violence. This culture is rooted in the targeted society and political regime and hence, not easily changed even when the sanctions are imposed. Facing economic hardships caused by the sanctions, effective institutions help the target countries continue to maintain a favorable business environment and encourage economic activities by providing stable political environment, a well-protected regulatory system and efficient law and order enforcement (Coe, Helpman, and Hoffmaister 2009; Mansoor and Quillin 2006). A targeted country with good institutional quality, therefore, may be more resilient under the imposition of economic sanctions and mitigate the negative consequences of the sanctions on the economy. This contributes to economic growth and avoids the reduction of income levels. Consequently, the government could maintain its sufficient spending for public services and decrease the probability that the sanctions lead to poverty, inequality and unemployment issues. Moreover, given the relatively stable economic outlook and continuous governmental subsidies, citizens would continue to invest in schooling. The high educational attainment, thus, raises the opportunity costs of having more children. This helps stabilize the population size. Overall, the targeted country could maintain stability regardless of the imposed sanctions.

**H2:** The negative effects of global economic sanctions on the life expectancy level become less significant if the sanctioned country has a well-developed institutional system.

### 2.3. The moderating effect of financial development

The literature on determinants of life expectancy shares the common idea that the root of shortened life expectancy is from the lack of capital and inefficient resource allocation. Specifically, as income decreases, so does spending on food and clean water, which clearly has a direct negative impact on health (Allen and Lektzian 2013; Peksen 2011). On the other hand, when firms do not have enough financial capability for R&D and marketing activities, they lose competitiveness and seek the ‘criminal route’ if they are properly incentivized for survival (Drezner 2011). This, in turn, worsens corruption issues. Alternatively, those firms may have poor business performance. The poor business environment will, inevitably, lead to a high unemployment rate. At the same time, isolation from international markets and foreign aids, as usually followed by the sanctions, could make the government lack funds for subsidizing firms and individuals. As a result, the above socioeconomic issues will further trigger social conflicts and hence, endanger people’s lives (McBride, Milante, and Skaperdas 2011; Quinn, Mason, and Gurses 2007). Furthermore, when international sanctions are imposed, they disrupt both the trade and the capital flows to and from the targeted country. This acts as an economic shock that reduces national income, deteriorates the business environment, causes unemployment and poverty (Qadir 2015; Walentek et al. 2021). Both individuals and firms in the sanctioned state will face financial hardship while the targeted government lacks funds for maintaining social welfare and resolving the socioeconomic consequences of the sanctions. Access to public health
services would then by heavily limited. In addition, trade sanctions adversely influence the health infrastructure of a target country (Garfield 1997). This will threaten life expectancy in the targeted country. However, we argue that the negative impacts of sanctions on life expectancy could be partly negated if the sanctioned state has a well-functioning financial system that could mobilize diverse financial sources to mitigate the economic hardships caused by the sanctions.

For individuals, especially the poor, the development of various financial institutions will increase their accessibility to different forms of credit lines. When the financing of education and investment becomes easier, the schooling rate will increase (Hartog 2000). This will help resolve poverty, narrow income inequality, and ensure human capital for the economy in general (Weychert 2020). Also, developed financial intermediaries facilitate the target firms’ access to a larger pool of credits to finance their machinery and equipment investment, employ more labors and conduct more R&D activities (Boutabba 2014; Bui 2020; Sadorsky 2010). This boosts technological innovation and creates more employment (King and Levine 1993). In addition, a well-developed financial market could attract savings from the economy and foreign capital inflows while channelizing them to profitable investments (Herwartz and Walle 2014; Zhang, Wang, and Wang 2012). Consequently, the financial sector could facilitate more efficient resource allocation and reduce financial costs, hence, foster the accumulation of physical capital and improve economic efficiency (Durusu-Ciftci, Isip, and Yetkiner 2017; Pradhan et al. 2016; Uddin, Sjö, and Shahbaz 2013). Given the strong human and physical capital as well as technological innovation, the economy becomes more resilient from the hardships caused by the sanctions while the government could maintain sufficient spending for social needs such as unemployment, poverty, inequality and access to public health services. The life expectancy of the target country is, therefore, reserved and less affected by the sanctions.

H3: The negative effects of global economic sanctions on life expectancy become less significant if the sanctioned country has a better financial development.

3. Methodology

To examine the nexus of economic sanctions and life expectancy, we use the following model specification:

\[ LE_{it} = \beta_0 + \beta_1 ES_{it} + \beta_2 \text{CONTROL}_{it} + \theta_i + \delta_t + \epsilon_{it}, \]  

where \( i \) and \( t \) indicate the sanctioned country and year, respectively. \( \theta_i \) and \( \delta_t \) are incorporated to control for the time and country-fixed effects, while \( \epsilon_{it} \) denotes the error terms. The dependent variable, \( LE_{it} \), is the life expectancy at birth of country \( i \) in year \( t \). It demonstrates the number of years a typical newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. This variable is sourced from the World Development Indicator (WDI). Regarding the independent variables, the key variable, \( ES_{it} \), is taken from Felbermayr et al. (2020b), which is a dummy receiving the value of 1 if there is any type of sanction imposed on the country \( i \) in year \( t \). The sanction types include arm sanctions (\( ES_{Arm} \)), military sanctions (\( ES_{Military} \)), trade sanctions (\( ES_{Trade} \)), financial sanctions (\( ES_{Finance} \)) and other sanctions (\( ES_{Other} \)). The influence of sanction type is also investigated in this study.

\( \text{CONTROL} \) consists of a set of control variables. The selection of these variables is based on prior works, such as Bayati, Akbarian, and Kavosi (2013), Gilligan and Skrepnek (2015), Gutmann, Neuenkirch, and Neumeier (2021) and Lin et al. (2012). These variables are categorized into three groups, namely economic factors, demographic factors and political factors. Regarding the economic factors, we include GDP, that is, the real GDP per capita (constant 2010 US dollars). Since Gutmann, Neuenkirch, and Neumeier (2021) demonstrate that the globalization level significantly influences a country’s life expectancy, we use the amount of trade flow and the net inflows of foreign trade investment which are available from the International Monetary Fund (IMF) and The World Bank’s WDI databases, respectively. We take the natural logarithm of trade flow (\( \text{LnTrade} \)) and foreign investment (\( \text{LnFDI} \)) before incorporating them into the model. The globalization level is also considered in the financial dimension by using the level of financial openness (\( \text{FO} \)) measure developed by Chinn and Ito (2006). Regarding the demographic factors, we employ the level of education attainment (\( \text{Educ} \)) proxied by the proportion of population enrolling in pre-primary, primary, secondary and tertiary education; the population (\( \text{Population} \)); the degree of industrialization (\( \text{Industry} \)) measured by the ratio of industrial value added to GDP; and the degree of urbanization (\( \text{Urbanization} \)) measured by the share of the urban population in total population. These variables are taken from the WDI. We base on the argument of Montez et al. (2020) and Gutmann, Neuenkirch, and Neumeier (2021) to take the political factors into account when investigating the determinants of life expectancy. In this regard, political factors consist of the index of democratization (\( \text{Polidemo} \)) and the prevalence of corruption in the economy (Corruption) captured by the political
corruption index. While PoliDemo is sourced from the Finnish Social Science Data Archive, we take data for Corruption from the Varieties of Democracy Projects (Coppedge et al., 2020).

In this paper, we use the fixed effects model controlling both the year and country-fixed effects to examine the association between sanction and life expectancy. For a robustness check, we also employ the score propensity matching model to mitigate biased estimations arising from the causal link between sanction and life expectancy. This paper contends that the ES–LE nexus varies with respect to the degree of financial market development (FD, t) and institutional quality (IQ, t).

To check our belief, we use the following specification:

\[
LE_t = \alpha_0 + \alpha_1 ES_t + \alpha_2 X_{it} + \alpha_3 X_{it}ES_t + \alpha_4 CONTROL_{it} + \theta_t + \delta_t + \epsilon_{it},
\]

where \(X_{it} = (FD_{it}, IQ_{it})\). The sign and magnitude of coefficient on an interaction between \(X_{it}\) and \(ES_{it}\) reflect the moderating effects of financial market development and institutional quality. Based on Donaubauer, Neumayer, and Nunnenkamp (2020), the Financial Development Index Database developed by the IMF is employed to illustrate the level of financial market development, including financial institutions (FI) and financial markets (FM) development. Further analyses are conducted by decomposing the FI and FM in terms of their depth, access and efficiency. Based on the International Country Risk Guide index (ICRG), institutional quality is measured through six dimensions: (i) Voice and Accountability (VA) consists of the military in politics and democratic accountability; (ii) Political Stability and Absence of Violence (PV) includes government stability, internal and external conflicts and ethnic tensions; (iii) Government Effectiveness (GE) reflects bureaucratic quality; (iv) Regulatory Quality (RQ) captures investment profile; (v) Rule of Law (RL) includes law and order; (vi) Control of Corruption (CC) reflects corruption.

4. Data and empirical results

4.1. Data description

Figure 1 displays the mean of life expectancy year (the line) and economic sanction (the dot) over time. Life expectancy tended to increase over the years, this phenomenon was experienced across all countries albeit with different speeds depending on the state of economic and social development. Usage of sanctions has increased for almost two decades and reached its peak in 2014. The sanction imposition decreased after that. The distribution of means of life expectancy year and economic sanction in the 148 target countries (108 developing countries and 40 developed countries) are portrayed in Figure 2. In general, countries with lower life expectancy encounter more sanctions than those with higher life expectancy.

Table 1 outlines the statistical description of included variables. In our sample, roughly 13% of countries face...
economic sanctions imposed by other countries. Among all types of sanctions, financial and arm sanctions are the most frequently used, followed by military sanctions.

4.2. Baseline results

Table 2 reports the estimation results on the relationship between economic sanction (ES) and life expectancy (LE). In Column 1, ES is the dummy that takes the value of 1 if there is any sanction type imposed in the country and zero otherwise. Columns (2)–(6) give the focus on the effects of specific sanction types. Our estimation confirms hypothesis H1 that there is a negative association between economic sanction and the average life expectancy of a sanctioned country’s population. Our finding is consistent with Gutmann, Neuenkirch, and Neumeier (2021), which investigate the impact of UN and US economic sanctions on life expectancy. By contrast, Allen and Lektzian (2013) report no impact of sanctions on life expectancy. In our estimate, the coefficient of ES is −0.30 at the 1% significance level, implying that usage of sanctions reduces average life expectancy by 0.3. On the influence of a particular type of economic sanction, Table 2 reveals that only trade (ESTrade) and other (ESOther) sanctions’ coefficients are statistically significant, which respectively reduce average life expectancy by 0.21 and 0.30. To provide more insights on the sanction-life expectancy nexus, this paper regresses the data in the subsample of countries based on different levels of economic development (the developing and developed groups). The results are outlined in Table A.3 in the Appendix. The estimate suggests that the adverse effect of economic sanctions on life expectancy is only evident in the case of developing countries, while similar evidence cannot be found in developed markets. There could be several explanations for these results. First of all, it could be due to a limitation in the sample, where the majority

![Graph of life expectancy versus matched and unmatched data]

**Figure 2.** Distribution of average year of life expectation and cross-border economic sanctions target country. Note: The mean value of life expectation year is on the left-right scale, and the mean value of sanction is on the right-hand scale.
of targeted states are less developed and developing countries. There simply are not enough developed markets being sanctioned to get a concluding answer. Secondly, most developed economies have at their use a considerable number of resources. During periods of being sanctioned, while funding for other government purposes could be heavily cut, healthcare fundings, especially for essential services, should be prioritized and therefore less affected.

To provide more insights on our analysis, this paper sheds light on the sources of declines in life expectancy due to economic sanctions. To pursue this goal, we examine whether there are effects of economic sanctions on output growth (GDP); public services that are related to health, education and sanitation; measures related to policing, criminality, education provision, literacy, water and sanitation, infrastructure, quality healthcare, telephony, internet access, energy reliability, roads (source: Fund for Peace); the prevalence of corruption measured by the political corruption index (source: the Varieties of Democracy Project); the social protection measured by a social protection rating (source: World Bank Group); the environmental performance measured by the environmental performance index (EPI) that capture the countries’ performance on two setting environmental issues: human health’s protection and ecosystems’ protection (source: EPI Full reports); and the death rate (source: WDI). We report the results in Table 3. The results show that sanctions have a negative effect on GDP growth, which signifies the economic channels in which a country receives the punishment. Moreover, sanctions also dampen the environmental performance and make the country more corrupted. These findings suggest that the welfare and life quality of the population in the targeted country are severely affected by economic sanctions, declining their life expectancy. Our results also show that the death rate increases due to sanctions. While the common belief is that sanctions are the more humane type of international pressure, Garfield (1997) showed that effective sanctions result in consequences that are no different than armed conflicts, including suffering and death.

In the following sections, we concentrate on analyzing the impacts of other explanatory variables on life expectancy. In general, our estimates stay in line with prior studies in the literature. In particular, the globalization degree proxied by international trade flows (\(\text{LnTrade}\)), foreign investments (\(\text{LnFDI}\)) and financial openness (\(\text{FO}\)) is positively associated with life expectancy. Our empirical findings provide evidence to support the argument raised by Gutmann, Neuenkirch, and Neumeier (2021). The results also indicate the positive effects of Population, Industry and Urbanization on life expectancy. The findings are consistent with Bayati, Akbarian, and Kavosi (2013), Gilligan and Skrepnek (2015), Lin et al. (2012) and Shahbaz et al. (2016). Our study also advocates the discussion raised by Montez et al. (2020) pertaining to the effects of political factors on life expectancy by suggesting the positive relationship between the degree of democracy (\(\text{PolDemo}\)) and the negative relationship between the political corruption index (\(\text{Corruption}\)) and life expectancy.

### 4.2.1. The mediating role of financial system development

Table 4 incorporates the interaction terms between the variable sanction and various measures of financial development index (the authors used three variables \(\text{FD}, \text{FI}\) and \(\text{FM}\) to represent the level of the overall level of financial development, financial institutions and financial markets, respectively). The question to be
| (1) | (2) | (3) | (4) | (5) | (6) |
|-----|-----|-----|-----|-----|-----|
| **ES Arm** | **Military** | **Trade** | **Financial** | **Other** |
| Variables | | | | | |
| LE | LE | LE | LE | LE | LE |
| Variables | | | | | |
| GDP | −0.26 | (0.221) | | | | |
| LnTrade | 0.03** | (0.013) | 0.03** | (0.013) | 0.03** | (0.013) | 0.03** | (0.013) | 0.03** | (0.013) | 0.03** | (0.013) |
| LnFDI | 0.10*** | (0.022) | 0.10*** | (0.022) | 0.10*** | (0.023) | 0.10*** | (0.023) | 0.10*** | (0.023) | 0.10*** | (0.023) |
| FO | 1.08*** | (0.170) | 1.07*** | (0.169) | 1.08*** | (0.172) | 1.08*** | (0.173) | 1.09*** | (0.174) | 1.07*** | (0.174) |
| EDUC | −0.00 | (0.025) | −0.00 | (0.025) | 0.00 | (0.025) | −0.00 | (0.025) | −0.00 | (0.025) | −0.00 | (0.025) |
| Population | 3.56*** | (0.577) | 3.60*** | (0.582) | 3.60*** | (0.580) | 3.56*** | (0.579) | 3.59*** | (0.578) | 3.58*** | (0.580) |
| Industry | 0.01* | (0.003) | 0.01** | (0.003) | 0.01** | (0.003) | 0.01** | (0.003) | 0.01* | (0.003) | 0.01** | (0.003) |
| PoliDemo | 0.10*** | (0.016) | 0.10*** | (0.016) | 0.10*** | (0.016) | 0.10*** | (0.016) | 0.10*** | (0.016) | 0.10*** | (0.016) |
| Urbanization | 1.61*** | (0.376) | 1.63*** | (0.374) | 1.69*** | (0.379) | 1.65*** | (0.375) | 1.68*** | (0.381) | 1.66*** | (0.383) |
| Corruption | −2.10*** | (0.618) | −2.09*** | (0.619) | −2.07*** | (0.618) | −2.07*** | (0.618) | −2.11*** | (0.614) | −2.09*** | (0.616) |
| Constant | 18.85*** | (5.575) | 18.39*** | (5.616) | 18.42*** | (5.604) | 18.74*** | (5.596) | 18.56*** | (5.579) | 18.54*** | (5.607) |
| Observations | 25,245 | 25,245 | 25,245 | 25,245 | 25,245 | 25,245 |
| Number of pair | 2,559 | 2,559 | 2,559 | 2,559 | 2,559 | 2,559 |

Note: Robust standard errors in parentheses.

*** p < .01, ** p < .05, * p < .1.

None: Robust standard errors in parentheses.
investigated here is whether having a more sophisticated financial system would ameliorate or worsen the negative effect of an economic sanction on the health of a country. In the reported estimations, the interaction terms in all three models did indeed have positive coefficients and are statistically significant at high levels. In other words, people in countries with a better financial system to support the running of the economy could be expected to suffer less detrimental health effects from cross-border economic sanctions Table 5.

To get further insights into the origin of the mediating role of financial market development, the authors rerun the models with the interaction terms between the variable sanction and several important aspects of the financial system. The results show that a higher level of credit information sharing and financial openness can help a country better overcome the consequences of an economic sanction. On the other hand, the higher the banking industry concentration ratio, the more severe the health effect of sanction would be. It is believed that a more concentrated, less competitive banking industry would lead to a decrease in the proportion of firms financed by screening contracts and increase the use of collateral by the financial institution; the effect would be a reduction in the mediating role of the financial markets. The level of central bank independence, although an important indicator of financial system development, does not have a significant influence on the effects of sanction in our model Table 6.

The impact of financial crises on a country’s economy is in several aspects similar to an armed conflict or a natural disaster. Nolan et al. describe the situation in Ireland after the 2008 financial crisis, which caused a followed sovereign debt crisis. The international loan agreements subjected the country to deep cuts in public sector spending, which include health services. It is through the same channels that the authors believe a cross-border economic sanction can affect national health. Following this chain of thoughts, the existence of a financial crisis (whether it is a banking, debt or currency crisis) in a sanctioned country could cause a double crisis that amplifies the detrimental effects on life expectancy. In the regressions, the interaction terms between sanction and the crisis variables are all negative and statistically significant at the 1% level. The results confirm our hypothesis that a financial crisis can make it worse for the health of people in sanctioned countries Table 7.

4.2.2. The moderating roles of institutional quality

In Table 8, the authors explored the mediating role of institutional quality on the interesting relationship between international sanction and national health. A variety of variables are used to represent certain aspects of institutional quality. Our expectation is that economy with a strong institutional basis can better accommodate the set of shortcomings that come with an economic sanction, mostly by fostering the growth of the private sectors, maintaining the efficient running of the markets and government services, dealing with the problem of asymmetric information (Coe, Helpman, and Hoffmaister 2009). With these qualities, the system might even take advantage of the cut in public health spending to force itself to be more efficient: expanding the coverage of health insurance (to reduce medical payment while personal disposable income decreased) as well as reduce wasteful spending in medical and pharmaceutical supply. In the models, the interaction terms of sanction with government effectiveness (GE) and with regulatory quality (RQ) are positive and statistically significant, showing that these elements of institutional quality do indeed mitigate the consequences of sanction on national health. Other aspects of institutional quality, including voice and accountability (VA), political stability and absence of violence/terrorism (PV), rule of law (RL) and control of corruption (CC), do not appear to have a significant moderation effect in the sample.

4.3. Robustness checks: propensity score matching method

In the following analysis, we employ a matching approach to address the endogeneity issue, which arises from the causal nexus between economic sanctions and life expectancy in the sanctioned country. These causal links may stem from the fact that the imposition of sanctions is related to the social, political and economic conditions in the sanctioned country. These conditions are then directly associated with the health outcomes of a country (Gutmann, Neuenkirch, and Neu-meier 2021).
### Table 3. Transmission channels.

| Variables     | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  |
|---------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Sanction      | −0.60*** (0.089)     | −0.04 (0.023)        | −0.29*** (0.093)     | −0.01 (0.020)        | −0.42** (0.175)      | 0.21** (0.089)       |
| GDP           |                      | −0.01*** (0.004)     | 0.02 (0.023)         | 0.21*** (0.031)      | 0.08*** (0.030)      | −0.00 (0.013)        |
| LnTrade       | 0.02** (0.009)       | −0.00** (0.002)      | −0.00 (0.007)        | 0.00 (0.001)         | −0.05** (0.019)      | −0.01 (0.010)        |
| LnFDI         | −0.10*** (0.030)     | 0.03*** (0.006)      | 0.22*** (0.032)      | 0.03*** (0.004)      | −0.32*** (0.049)     | −0.07*** (0.018)     |
| Population    | −9.53*** (1.377)     | 1.24*** (0.204)      | −18.46*** (1.905)    | 0.97*** (0.167)      | −3.00*** (0.762)     | −5.33*** (0.545)     |
| Industry      | −0.00 (0.003)        | 0.00 (0.001)         | 0.00 (0.002)         | 0.00 (0.000)         | −0.00 (0.005)        | −0.00** (0.002)      |
| Urbanization  | −0.18*** (0.028)     | 0.01 (0.008)         | 0.58*** (0.068)      | 0.01 (0.007)         | 0.01 (0.042)         | −0.04*** (0.012)     |
| Corruption    | 3.19*** (0.379)      | 0.14 (0.152)         | −5.08*** (1.927)     | −0.58*** (0.121)     | 0.38 (0.917)         | 1.39*** (0.423)      |
| Constant      | 100.75*** (12.944)   | −5.10*** (1.927)     | 189.80*** (18.200)   | −6.78*** (1.682)     | 68.30*** (7.929)     | 63.08*** (5.171)     |
| Observations  | 26,077               | 18,761               | 10,608               | 5,034                | 26,077               | 26,077               |
| Country FE    | YES                  | YES                  | YES                  | YES                  | YES                  | YES                  |
| Year FE       | YES                  | YES                  | YES                  | YES                  | YES                  | YES                  |

Note: Robust standard errors in parentheses.

*** p < .01, ** p < .05, * p < .1.
Table 4. Interaction between economic sanction and financial system development.

| Variables    | (1) Sanction | (2) Sanction + FD | (3) FD |
|--------------|--------------|-------------------|--------|
| Sanction     | −0.63*** (0.238) | −0.76*** (0.272) | −0.44** (0.175) |
| FD           | −1.93*** (0.611) | −0.52 (0.454)    | −1.28*** (0.355) |
| Sanction + FD| 1.20*** (0.511) | 1.31*** (0.499)  | 0.70* (0.409)    |
| GDP          | −0.01 (0.013)   | −0.01 (0.014)    | −0.01 (0.014)    |
| LnTrade      | 0.03* (0.014)   | 0.02* (0.014)    | 0.02* (0.014)    |
| LnFDI        | 0.09*** (0.023) | 0.09*** (0.022)  | 0.09*** (0.023)  |
| FO           | 1.11*** (0.167) | 1.06*** (0.165)  | 1.09*** (0.165)  |
| Population   | 3.64*** (0.379) | 3.78*** (0.587)  | 3.71*** (0.581)  |
| Industry     | 0.01* (0.003)   | 0.01* (0.003)    | 0.01* (0.003)    |
| Corruption   | −2.38*** (0.620) | −2.36*** (0.622) | 2.37*** (0.622)  |
| Constant     | 18.10*** (5.606) | 16.84*** (5.685) | 17.19*** (5.646) |

Note: Robust standard errors in parentheses.
*** p < .01, ** p < .05, * p < .1

We apply the propensity score matching (PSM) model to deal with this issue. Additionally, the PSM technique permits us to perform endogeneity tests arising from simultaneity between economic sanctions and life expectancy and unobserved variables. The PSM technique is employed to select a matching country for each targeted country to control for the non-random nature of a sanction imposition decision. Using the PSM method, we obtain the propensity scores (likelihood to receive the treatment) of all observations. Then each treated observation is matched with one or more untreated observations based on these propensity scores. Heckman and Navarro-Lozano argue that the included variables in the logit model used to estimate the propensity scores should also affect both the participation decision and the outcome variable. Based on the discussion, the model estimation is specified as follows:

\[ ES_{it} = \alpha_0 + \alpha_i \times CONTROL_{it} + \epsilon_{it}, \]  

To perform the PSM technique, we use the STATA command ‘psmatch2’ to drop any treated observations whose propensity score is either lower than the minimum score or higher than the maximum score of controls. We also use the k-nearest neighbor matching method to specify a matching sample of the controls (without economic sanction) with the treated sample (with sanction). Following this procedure, the results are summarized in Table A.1 in the Appendix. The balanced test of all controls and treated observations are also conducted and outline in Appendix A.2 and Figure A.1. The results suggest that all control variables pass the balance tests and our selected samples reveal no substantial distinction between the treated and control group. The definition of the average treatment effect on treated (ATT) is as follows:

\[ ATT = E(Y_1 - Y_0 | ES = 1) \]
\[ = E(Y_1 | ES = 1) - E(Y_0 | ES = 1), \]  

which is the difference between the life expectancy for those targeted countries facing economic sanctions (first term) and the life expectancy of the same countries not facing economic sanctions (second term). Rationally, we cannot observe the latter outcome, and therefore we base on a matching approach to create the missing counterfactual (Rosenbaum and Rubin 1983). The key assumption for the validity of the matching technique is the independence of treatment status and potential outcomes conditional on a set of observable characteristics. Based on these assumptions, we have:

\[ E(Y_1 | Control) = E(Y_1 | Control, ES = 1) \]
\[ = E(Y_1 | Control, ES = 0). \]  
\[ E(Y_0 | Control) = E(Y_0 | Control, ES = 0) \]
\[ = E(Y_0 | Control, ES = 1). \]  

The above equations refer that,

\[ ATT = E(Y_1 - Y_0 | Control, ES = 1) \]
\[ = (E(Y_1 | Control, ES = 1) - E(Y_0 | Control, ES = 0)) \]
\[ - (E(Y_0 | Control, ES = 1) - E(Y_0 | Control, ES = 0)) \]
\[ = E(Y_1 | Control, ES = 1) - E(Y_0 | Control, ES = 0), \]

where the second term in the equation reflects the selection bias, which is assumed to equal to zero conditional on Control. This technique leaves only the result of the causal effect. One potential problem is that the PSM diff-in-diff technique is unable to control for time-varying unobservable variables that may have a simultaneous influence on the decision to impose
Table 5. Interaction between economic sanction and financial market development.

| Variables  | (1) FID Health | (2) FIA Health | (3) FIE Health | (4) FMD Health | (5) FMA Health | (6) FME Health |
|------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Sanction   | −0.55*** (0.169) | −0.54*** (0.206) | −0.32 (0.347)  | −0.36** (0.161) | −0.44** (0.172) | −0.43*** (0.149) |
| FID        | −2.08*** (0.379) | 0.51** (0.215)  | −0.32 (0.377)  | −1.61*** (0.355) | −1.94*** (0.254) | −2.0*** (0.113)  |
| Sanction×FID | 1.38*** (0.403) | 0.83** (0.365)  | 0.03 (0.500)   | 0.21 (0.370)    | 0.79** (0.376)   | 0.74*** (0.247)   |
| GDP        | −0.01 (0.014)    | −0.01 (0.014)   | −0.01 (0.014)  | −0.01 (0.013)   | −0.01 (0.013)   | −0.01 (0.014)    |
| LnTrade    | 0.02* (0.013)    | 0.02* (0.014)   | 0.02* (0.014)  | 0.02* (0.013)   | 0.02* (0.013)   | 0.02* (0.013)    |
| LnFDI      | 0.08*** (0.022)  | 0.09*** (0.023) | 0.09*** (0.022) | 0.10*** (0.023) | 0.09*** (0.023) | 0.09*** (0.023)  |
| FO         | 1.14*** (0.163)  | 1.01*** (0.159) | 1.07*** (0.165) | 1.08*** (0.165) | 1.12*** (0.162) | 1.07*** (0.162)  |
| Population | 3.68*** (0.578)  | 3.96*** (0.598) | 3.78*** (0.583) | 3.62*** (0.575) | 3.84*** (0.578) | 3.82*** (0.588)  |
| Industry   | 0.00* (0.003)    | 0.01* (0.003)   | 0.01* (0.003)  | 0.01* (0.003)   | 0.01* (0.003)   | 0.01* (0.003)    |
| Urbanization | 0.10*** (0.017) | 0.10*** (0.017) | 0.10*** (0.017) | 0.11*** (0.017) | 0.10*** (0.017) | 0.10*** (0.017)  |
| Corruption | −2.26*** (0.611) | −2.36*** (0.632) | −2.32*** (0.620) | −2.31*** (0.619) | −2.38*** (0.618) | −2.31*** (0.617) |
| Constant   | 17.89*** (5.597) | 15.08*** (5.759) | 16.75*** (5.664) | 18.13*** (5.589) | 15.96*** (5.624) | 16.26*** (5.695) |
| Observations | 26,077         | 26,077         | 26,077         | 26,077         | 26,077         | 26,077         |
| Number of pair | 2.565           | 2.565           | 2.565           | 2.565           | 2.565           | 2.565           |
| Country FE | YES            | YES            | YES            | YES            | YES            | YES            |
| Year FE   | YES            | YES            | YES            | YES            | YES            | YES            |

Note: Robust standard errors in parentheses.

*** p < .01, ** p < .05, * p < .1.
the economic sanctions and life expectancy. Hence, our empirical strategy assumes that the unobserved variances between firms in treated and untreated groups are time-invariant. The mixture of PSM and diff-in-diff method implies that our empirical strategy search for divergence in the trend of life expectancy year between the treated countries and the matched control countries that possess common features in the pretreatment period. The average treatment effect (ATT) is reported in Table 9. The estimates demonstrate the negative association between economic sanctions and life expectancy. Furthermore, there are heterogeneous effects of sanction types on life expectancy. The findings imply that our results are reliable and robust.

1.5. Conclusions and policy implications

Ever since the end of the Cold War, when the world was no longer dominated by two powerful opposite blocks of nations, international economic sanctions have become more prevalent as a promising and allegedly more ‘humane’ alternative to armed interventions. Sanctions are increasingly used by the UN and the US to punish other nations for political, military and social issues and the sample size for this area of research is extending every year. In this paper, the authors wish to contribute to the literature on the impact of cross-border economic sanctions on the punished countries. We focus on the aspect of national health and find that economic sanctions have significant negative effects on the life expectancy of the affected countries. This conclusion supports findings from Gutmann, Neuenkirch, and Neumeier (2021) that the real effect of sanctions is little different from wars or natural disasters, including the loss of lives and human suffering. On the mechanism of the impacts, we find that sanction affects the health of a nation through reducing the GDP growth rate, which

Table 6. Interaction between economic sanction and financial market properties.

| Variables                  | (1) Credit information sharing Health | (2) Bank competition Health | (3) Financial openness Health | (4) Central bank independence Health |
|----------------------------|--------------------------------------|----------------------------|-------------------------------|-------------------------------------|
| Sanction                   | −0.05** (0.023)                      | −0.21* (0.168)             | −0.76*** (0.175)              | −0.46* (0.246)                     |
| FC                         | 0.06*** (0.006)                      | 0.12 (0.079)               | 1.13*** (0.169)               | 0.51** (0.235)                     |
| Sanction+FC                | 0.01** (0.004)                       | −0.65*** (0.194)           | 1.26*** (0.305)               | 0.05 (0.442)                       |
| GDP                        | −0.01 (0.004)                        | −0.01 (0.014)              | −0.02 (0.015)                 | −0.00 (0.014)                      |
| LnTrade                    | −0.00* (0.001)                       | 0.02 (0.013)               | 0.02 (0.014)                  | 0.02** (0.010)                     |
| LnFDI                      | −0.01* (0.066)                       | 0.12*** (0.024)            | 0.10*** (0.023)               | 0.12*** (0.020)                    |
| Population                 | 6.39*** (0.459)                      | 3.87*** (0.572)            | 3.98*** (0.602)               | 3.08*** (0.553)                    |
| Industry                   | 0.00 (0.000)                         | 0.01*** (0.003)            | 0.01*** (0.003)               | 0.00 (0.003)                       |
| Urbanization               | 0.10*** (0.018)                      | 0.08*** (0.018)            | 0.08*** (0.018)               | 0.06*** (0.014)                    |
| Corruption                 | 0.44*** (0.154)                      | −2.14*** (0.580)           | −2.46*** (0.589)              | −2.26*** (0.621)                   |
| Constant                   | −6.07 (4.385)                        | 16.32*** (5.324)           | 15.31*** (5.672)              | 19.92*** (5.144)                   |
| Observations               | 9,324                                | 27,423                     | 26,540                        | 17,688                             |
| Country FE                 | YES                                  | YES                        | YES                           | YES                                |
| Year FE                    | YES                                  | YES                        | YES                           | YES                                |

Note: Robust standard errors in parentheses. *** p < .01, ** p < .05, * p < .1.

Table 7. Interaction between economic sanction and financial crisis.

| Variables | (1) Bank crisis Health | (2) Debt crisis Health | (3) Currency crisis Health |
|-----------|------------------------|------------------------|---------------------------|
| Sanction  | −0.11 (0.127)          | −0.21* (0.115)         | −0.11 (0.123)             |
| FC        | 0.04 (0.057)           | 0.05 (0.187)           | −0.15*** (0.045)          |
| Sanction+FC| −2.03*** (0.483)     | −1.32** (0.562)        | −2.41*** (0.452)          |
| GDP       | −0.02 (0.014)          | −0.02 (0.014)          | −0.02 (0.014)             |
| LnTrade   | 0.02 (0.013)           | 0.02* (0.013)          | 0.02* (0.013)             |
| LnFDI     | 0.11*** (0.023)        | 0.12*** (0.024)        | 0.11*** (0.023)           |
| Population| 3.80*** (0.571)        | 3.79*** (0.573)        | 3.72*** (0.566)           |
| Industry  | 0.01*** (0.003)        | 0.01*** (0.003)        | 0.01*** (0.003)           |
| Urbanization| 0.07*** (0.018)    | 0.07*** (0.017)        | 0.05*** (0.017)           |
| Corruption| −2.20*** (0.584)      | −2.29*** (0.587)       | −2.24*** (0.583)          |
| Constant  | 17.63*** (5.314)       | 18.10*** (5.381)       | 18.30*** (5.262)          |
| Observations| 27,423                    | 27,423                     | 27,423                     |
| Country FE| YES                      | YES                      | YES                        |
| Year FE   | YES                      | YES                      | YES                        |

Note: Robust standard errors in parentheses. *** p < .01, ** p < .05, * p < .1.
Table 8. Interaction between economic sanction and institutional quality.

| Variables  | (1) VAE | (2) PVE | (3) GEE | (4) RQE | (5) RLE | (6) CCE |
|------------|---------|---------|---------|---------|---------|---------|
| Sanction   | −0.04 (0.098) | −0.08 (0.086) | −0.03 (0.085) | 0.01 (0.091) | −0.01 (0.080) | −0.14* (0.073) |
| IQ         | 0.97*** (0.130) | 0.48*** (0.088) | 0.49*** (0.155) | 0.21 (0.155) | 1.17*** (0.182) | 0.64*** (0.185) |
| ES=IQ      | 0.08 (0.087) | −0.09 (0.090) | 0.22*** (0.094) | 0.37*** (0.094) | 0.09 (0.093) | −0.04 (0.093) |
| GDP        | −0.00 (0.011) | −0.01 (0.012) | −0.01 (0.012) | −0.01 (0.012) | −0.02 (0.013) | −0.01 (0.012) |
| LnTrade1   | 0.01 (0.011) | 0.01 (0.011) | 0.01 (0.011) | 0.01 (0.011) | 0.01 (0.010) | 0.01 (0.010) |
| LnFDI      | 0.08*** (0.021) | 0.08*** (0.020) | 0.09*** (0.021) | 0.09*** (0.021) | 0.08*** (0.020) | 0.09*** (0.021) |
| FO         | 1.00*** (0.167) | 1.01*** (0.161) | 0.97*** (0.157) | 0.98*** (0.157) | 0.82*** (0.146) | 0.99*** (0.156) |
| FD         | −0.68 (0.507) | −1.01* (0.529) | −1.18** (0.554) | −0.96* (0.557) | −1.18** (0.542) | −0.96* (0.541) |
| Population | 3.16*** (0.488) | 3.08*** (0.509) | 3.08*** (0.531) | 3.01*** (0.512) | 3.00*** (0.523) | 3.02*** (0.523) |
| Industry   | 0.01*** (0.002) | 0.01*** (0.002) | 0.01*** (0.002) | 0.01*** (0.002) | 0.01*** (0.002) | 0.01*** (0.002) |
| Urbanization | 0.14*** (0.018) | 0.14*** (0.018) | 0.13*** (0.018) | 0.13*** (0.018) | 0.13*** (0.018) | 0.13*** (0.018) |
| Constant   | 21.17*** (4.823) | 21.53*** (5.037) | 22.25*** (5.143) | 22.61*** (5.020) | 23.57*** (5.080) | 22.73*** (5.090) |
| Observations | 24,292 | 24,292 | 24,288 | 24,289 | 24,292 | 24,289 |
| Number of pair | 2,641 | 2,641 | 2,641 | 2,641 | 2,641 | 2,641 |
| Country FE | YES | YES | YES | YES | YES | YES |
| Year FE    | YES | YES | YES | YES | YES | YES |

Note: Robust standard errors in parentheses.

*** p < .01, ** p < .05, * p < .1.
led to a cut in health care spending. Additionally, sanctions also decrease a country’s environmental performance as well as increase the level of corruption within the country’s government.

The second purpose of this paper is to explore the mediating effect of various factors that either mitigate or magnify the detrimental effects of sanctions on national health. In this direction, we find that better quality of the financial system (including both the financial institutions and the financial markets) can help reduce the impact on life expectancy. On the other hand, the existence of a financial crisis can worsen the health impact of a sanction. Institutional quality, especially government effectiveness and regulatory quality, also have similar ameliorating effects.

On the policy front, this paper is, first and foremost, a warning against the widespread use of economic sanctions. Although sanctions usually do not involve weapons or armies, their costs in economic assets, environmental impacts as well as human lives are similar to that of wars or major natural disasters. The value of economic sanctions should also be taken into account, Peksen (2011) surmises that economic sanctions failed as often as 65% of the time. Sometimes, sanctions are established only for the politicians of the sender countries appear to appease their voters. The authors strongly recommended that economic sanctions be used sparingly with the utmost care and caution, taking into account all the potential economic, social and environmental effects.

For the targeted countries, apparently, the best possible outcome is to avoid getting sanctioned. Failing that, it is inevitable that the country would have to endure considerable hardship, especially on the more vulnerable groups of citizens. However, the consequence could be partially mitigated if the country has a healthy financial system with strong fundamentals to help avoid financial crises. Similarly, better institutional quality: a less corrupted and more effective government and regulations could also bring about a better outcome for the health of the people during sanctioned periods.

2. The Global Sanctions Database that was used in this article collects information about instances of sanction on a variety of sources including United Nations Security Council Resolutions, national database, international and history books. The data was also cross checked against other existing sources. In our article, the variable ES take on the value of 1 if on that year, the country was the subject of any type of sanction identified in the GSDB.

3. The data is available from https://fragilestatesindex.org/.

4. This corruption index is scaled from 0 to 100, where 0 is the highest level of political corruption and 100 equals the lowest level of political corruption. This index measure how frequently corruption required in business.

5. The CPIA social protection rating is ranged from 1 (low) to 6 (high).

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### Notes

1. Data available on request due to privacy/ethical restrictions.
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## Appendix

### Table A.1. Variable description.

| Variable     | Description                                                                 | Source                                      |
|--------------|----------------------------------------------------------------------------|---------------------------------------------|
| Health       | The year of life expectation                                               | WDI                                         |
| CES          | The dummy taking a value of 1 if there are any type of sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Arm} | The dummy taking a value of 1 if there are arm sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Military} | The dummy taking a value of 1 if there are military sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Trade} | The dummy taking a value of 1 if there are trade sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Finance} | The dummy taking a value of 1 if there are financial sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Travel} | The dummy taking a value of 1 if there are travel sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| CES\textsubscript{Other} | The dummy taking a value of 1 if there are other sanctions between country i and j, and 0 otherwise. | Felbermayr et al. (2020b)                   |
| BBS2100089 - XML export is missing for Response article. | the GDP per capita (constant 2010 US dollars) in year t. | WDI                                         |
| Ln\textsubscript{Trade} | The natural logarithm of trade flows (exports and imports) in year t. | WDI                                         |
| Ln\textsubscript{FDI} | The natural logarithm of FDI inflows in year t. | WDI                                         |
| Population   | The population of target country in year t. | WDI                                         |
| Industry     | The proportion of industrial value added to GDP in year t. | WDI                                         |
| Urbanization | The percentage of urban population in total population in year t. | WDI                                         |
| FO           | Financial openness index.                                                   | Chinn and Ito (2006)                        |
| CBI          | Central bank independence.                                                  | World Bank                                  |
| FD           | The financial market development index.                                     | FDID                                       |
| FI           | The financial institution index.                                            | FDID                                       |
| FID          | The depth of financial institution.                                         | FDID                                       |
| FIA          | The access of financial institution.                                        | FDID                                       |
| FIE          | The efficiency of financial institution.                                    | FDID                                       |
| FM           | The financial market index.                                                 | FDID                                       |
| FMD          | The depth of financial market.                                              | FDID                                       |
| FMA          | The access of financial market.                                             | FDID                                       |
| FME          | The efficiency of financial market.                                         | FDID                                       |
| Bankcrisis   | The dummy taking the value of 1 for a presence of bank crisis in the sanctioned country. | Del Prete and Federico (2020)              |
| Debtcrisis   | The dummy taking the value of 1 for a presence of debt crisis in the sanctioned country. | Del Prete and Federico (2020)              |
| Currencycrisis | The dummy taking the value of 1 for a presence of currency crisis in the sanctioned country. | Del Prete and Federico (2020)              |

Note: WDI: World development indicators; FDID: Financial development index database.
Table A.2. Countries in the sample.

| Country | % | Country | % | Country | % | Country | % | Country | % |
|---------|---|---------|---|---------|---|---------|---|---------|---|
| ABW     | 0.33 | AUT     | 0.76 | BIH     | 0.45 | CAF     | 0.31 | COM     | 0.18 |
| AFG     | 0.38 | AZE     | 0.36 | BOL     | 0.44 | CAN     | 0.84 | CPV     | 0.32 |
| AGO     | 0.50 | BEL     | 0.75 | BMJ     | 0.70 | CHL     | 0.71 | CUB     | 0.46 |
| ALB     | 0.37 | BEN     | 0.32 | BRA     | 0.77 | CVI     | 0.45 | CYP     | 0.70 |
| ARE     | 0.68 | BGD     | 0.56 | BRB     | 0.47 | CMR     | 0.42 | CZE     | 0.67 |
| ARG     | 0.74 | BGR     | 0.64 | BRN     | 0.42 | COD     | 0.40 | DEU     | 0.84 |
| ARM     | 0.36 | BHR     | 0.60 | BTN     | 0.16 | COG     | 0.38 | DJI     | 0.25 |
| AUS     | 0.73 | BHS     | 0.72 | BWA     | 0.48 | COL     | 0.63 | DMA     | 0.40 |
| Country % | Country % | Country % | Country % | Country % | Country % |
| DNK     | 0.73 | FJI     | 0.34 | GIN     | 0.35 | HND     | 0.44 | ISR     | 0.73 |
| DOM     | 0.48 | FLK     | 0.10 | GMB     | 0.30 | HRV     | 0.53 | ITA     | 0.81 |
| DZA     | 0.48 | FRA     | 0.77 | GNB     | 0.24 | HTI     | 0.33 | JAM     | 0.44 |
| ECU     | 0.54 | FRO     | 0.18 | GNQ     | 0.26 | HUN     | 0.68 | JOR     | 0.56 |
| EGY     | 0.65 | FSM     | 0.09 | GRC     | 0.71 | IDN     | 0.72 | JPN     | 0.84 |
| ERI     | 0.26 | GAB     | 0.33 | GRD     | 0.31 | IND     | 0.79 | KAZ     | 0.44 |
| ESP     | 0.81 | GBR     | 0.84 | GRL     | 0.18 | IRL     | 0.78 | KEN     | 0.58 |
| EST     | 0.53 | GEO     | 0.43 | GTM     | 0.49 | IRN     | 0.64 | KGZ     | 0.29 |
| ETH     | 0.47 | GHA     | 0.56 | GUY     | 0.28 | IRQ     | 0.44 | KHM     | 0.46 |
| FIN     | 0.75 | GIB     | 0.52 | HKG     | 0.80 | ISL     | 0.56 | KIR     | 0.12 |
| Country % | Country % | Country % | Country % | Country % | Country % |
| KOR     | 0.74 | LTU     | 0.51 | MKD     | 0.47 | MYS     | 0.72 | OMN     | 0.53 |
| KWT     | 0.56 | LUX     | 0.73 | MLI     | 0.35 | NCL     | 0.33 | PAK     | 0.65 |
| LAO     | 0.35 | LVA     | 0.52 | MLL     | 0.64 | NER     | 0.34 | PAN     | 0.74 |
| LBN     | 0.59 | MAC     | 0.48 | MMR     | 0.35 | NGA     | 0.55 | PER     | 0.60 |
| LBR     | 0.52 | MAR     | 0.58 | MNE     | 0.21 | NIC     | 0.45 | PHL     | 0.67 |
| LBY     | 0.51 | MDA     | 0.35 | MNG     | 0.30 | NLD     | 0.78 | PLW     | 0.07 |
| LCA     | 0.28 | MDG     | 0.36 | MOZ     | 0.48 | NOR     | 0.79 | PNG     | 0.34 |
| LIE     | 0.51 | MDV     | 0.26 | MRT     | 0.30 | NPL     | 0.46 | POL     | 0.70 |
| LKA     | 0.55 | MEX     | 0.72 | MUS     | 0.52 | NRU     | 0.18 | PRK     | 0.30 |
| LSO     | 0.28 | MHL     | 0.35 | MWI     | 0.38 | NZL     | 0.67 | PRT     | 0.76 |
| Country % | Country % | Country % | Country % | Country % | Country % |
| PRY     | 0.55 | SGP     | 0.80 | SUR     | 0.33 | THA     | 0.73 | TZA     | 0.56 |
| PSE     | 0.25 | SHN     | 0.06 | SVK     | 0.54 | TJK     | 0.20 | UGA     | 0.46 |
| PYF     | 0.35 | SLB     | 0.20 | SVN     | 0.52 | TMM     | 0.23 | UKR     | 0.60 |
| QAT     | 0.53 | SLE     | 0.38 | SWE     | 0.78 | TLS     | 0.14 | URY     | 0.61 |
| ROU     | 0.63 | SLV     | 0.43 | SWZ     | 0.41 | TON     | 0.16 | USA     | 0.76 |
| RUS     | 0.70 | SMR     | 0.26 | SYC     | 0.50 | TTO     | 0.45 | UZB     | 0.37 |
| RWA     | 0.36 | SOM     | 0.24 | SYR     | 0.50 | TUN     | 0.51 | VAT     | 0.32 |
| SAU     | 0.65 | SRB     | 0.32 | TCA     | 0.43 | TUR     | 0.73 | VCT     | 0.41 |
| SDN     | 0.40 | SSD     | 0.05 | TCD     | 0.28 | TUV     | 0.06 | VEN     | 0.63 |
| SEN     | 0.43 | STP     | 0.21 | TGO     | 0.32 | TWN     | 0.74 | VNM     | 0.58 |
| Country % | Country % | Country % | Country % | Country % | Country % |
| VUT     | 0.34 | WSM     | 0.33 | ZAF     | 0.73 | ZWE     | 0.51 |
| WLF     | 0.11 | YEM     | 0.42 | ZMB     | 0.52 |

Figure A1. Mean of economic sanction and life expectation year by country level of economic development.
Table A.3. Economic sanctions and environmental performance: By a group of developing, transition and developed countries.

| Variables | Developing countries | Developed countries |
|-----------|----------------------|---------------------|
|           | Health               | Health              |
| Sanction  | -0.43*** (0.138)     | 0.07 (0.068)        |
| GDP       | 0.03 (0.022)         | 0.01** (0.006)      |
| LnTrade   | 0.01 (0.016)         | -0.00 (0.007)       |
| LnFDI     | 0.19*** (0.035)      | -0.00 (0.006)       |
| FO        | 1.58*** (0.252)      | 0.30*** (0.098)     |
| FD        | -3.18*** (1.039)     | -1.47*** (0.246)    |
| Population| 3.34*** (0.774)      | -2.56*** (0.403)    |
| Industry  | 0.00 (0.004)         | 0.00 (0.001)        |
| Urbanization | 0.12*** (0.022)    | -0.01 (0.009)       |
| Corruption| -2.29*** (0.701)     | -0.87*** (0.329)    |
| Constant  | 20.18*** (7.519)     | 104.84*** (3.805)   |

Observations: 16,845 9,232
Country FE: YES YES
Year FE: YES YES

Note: Robust standard errors in parentheses.
*** p < .01, ** p < .05, * p < .1.

Table A.4. Balancing tests for propensity score matching.

| Unmatched Variable matched | Mean Treated | Mean Control | %reduct | %bias | t-test bias |
|----------------------------|--------------|--------------|---------|-------|-------------|
| GDP                        |              |              |         |       |             |
| U                          | 5.923        | 18.120       | -83.100 | -34.860|             |
| M                          | 5.923        | 6.532        | -4.100  | 95.000 |             |
| LnTrade                    |              |              |         |       |             |
| U                          | 11.346       | 12.309       | -34.000 | -17.140|             |
| M                          | 11.346       | 11.549       | -7.200  | 79.000 |             |
| LnFDI                      |              |              |         |       |             |
| U                          | 0.889        | 0.945        | -4.400  | -2.130 |             |
| M                          | 0.889        | 0.760        | 10.100  | -129.700|             |
| FO                         |              |              |         |       |             |
| U                          | 0.409        | 0.661        | -72.400 | -34.220|             |
| M                          | 0.409        | 0.368        | 12.000  | 83.400 |             |
| FD                         |              |              |         |       |             |
| U                          | 0.274        | 0.424        | -70.000 | -31.240|             |
| M                          | 0.274        | 0.282        | -3.600  | 94.800 |             |
| Educ                       |              |              |         |       |             |
| U                          | 2.179        | 2.930        | -58.300 | -30.540|             |
| M                          | 2.179        | 2.192        | -1.000  | 98.200 |             |
| Population                 |              |              |         |       |             |
| U                          | 9.896        | 9.756        | 8.699   | 4.340 |             |
| M                          | 9.896        | 9.926        | -1.800  | 78.900 |             |
| Industry                   |              |              |         |       |             |
| U                          | 22.204       | 24.147       | -37.400 | -18.000|             |
| M                          | 22.204       | 23.270       | -20.500 | 45.100 |             |
| Urbanization               |              |              |         |       |             |
| U                          | 53.998       | 63.282       | -45.500 | -21.520|             |
| M                          | 53.998       | 53.332       | 3.3     | 92.800 |             |
| PoliDemo                   |              |              |         |       |             |
| U                          | 0.138        | 0.212        | -63.100 | -28.680|             |
| M                          | 0.138        | 0.148        | -8.300  | 86.900 |             |
| Corruption                 |              |              |         |       |             |
| U                          | 0.652        | 0.432        | 80.700  | 36.170 |             |
| M                          | 0.652        | 0.631        | 7.6     | 90.600 |             |

* if variance ratio outside [0.93; 1.08] for U and [0.93; 1.08] for M.

Figure A2. Propensity scores of treated and control group before and after matching.