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The Impact of US Sanctions on Food Security: Evidence from a Global Panel

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The Impact of US Sanctions on Food Security: Evidence from a Global Panel

Abstract

We examine the impact of U.S. sanctions on food security using a panel of 185 economies over 1990–2017, linking the World Food Programme (WFP) multidimensional food security indicator system to sanction episodes. Using difference-in-differences identification strategy and an event-study design, we show that sanctions significantly reduce food security in target countries, widening the gap with non-sanctioned countries by about 30 percent. Effects are concentrated in food access and stability—key dimensions of household food affordability and resilience—and are primarily driven by trade and financial restrictions. Mechanism analysis indicates that sanctions operate through both supply and demand channels. On the supply side, they reduce food imports and domestic production. On the demand side, they lower income, raise inflation and unemployment, and weaken political stability. Notably, the sanction impacts are strongest in low- and lower-middle-income countries, where food systems are more vulnerable to external shocks. These results highlight substantial and uneven humanitarian costs of sanctions for food security.

***Keywords:** Economic sanctions; Food security; Event Study; United States; Trade disruptions; Agricultural production; Developing countries*

***JEL Classification:** F51, F14, O13, O19, Q18*

1. Introduction

Economic sanctions have become a central instrument of foreign policy, increasingly deployed by major powers to influence the behavior of target states. Over the past few decades, both the frequency and scope of sanctions have expanded markedly, affecting countries such as Iran, Venezuela, and North Korea. While sanctions are intended to exert political pressure, a growing body of evidence documents their unintended economic and humanitarian consequences, including declines in economic activity, deteriorations in public health, and rising inequality (e.g., Hufbauer et al., 2007; Allen, 2008; Peksen, 2011; Neuenkirch and Neumeier, 2015, 2016). More recently, their implications for food security have attracted increasing scholarly and policy attention, reflecting rising concerns about the broader welfare consequences of economic coercion (Alwadeai et al., 2026).

This concern is well founded. Food security is a cornerstone of human well-being and a central policy priority, particularly in developing economies. Sanctions represent a large and persistent external shock that can disrupt multiple components of food systems simultaneously. By restricting trade and financial flows, they may constrain food imports and increase transaction costs (Larch et al., 2024). By depressing economic activity and destabilizing macroeconomic conditions, they can erode household purchasing power and amplify food price volatility (Rajinikanth, 2022; Afesorbor, 2025). Moreover, by tightening fiscal constraints, sanctions may induce governments to reallocate resources away from agriculture and social protection (Madani, 2020). While a growing literature documents adverse effects of sanctions on specific dimensions of food security—such as food prices, undernourishment, or availability—existing evidence remains fragmented and often focuses on individual countries or isolated outcomes, and thus falling short of capturing the systemic effects of international sanctions on food systems.

This paper contributes by providing a systematic and causal analysis of how US sanctions affect food security across countries. We move beyond analyses that focus on individual aspects of food security and instead conceptualize food security as a multidimensional system, allowing us to examine how sanctions propagate through distinct margins—availability, access, utilization, and stability. In doing so, we provide new evidence on which components of food systems are most vulnerable to external economic coercion and how these vulnerabilities vary across countries. Empirically, we construct a novel panel dataset combining information on US sanctions with the Proteus food security index¹ and its sub-components for a global sample spanning 1990–2017. To identify causal effects, we employ a difference-in-differences (DID) framework complemented by an event-study design. A central identification challenge is the non-random assignment of sanctions, as sanctioned countries differ systematically from non-target countries in political characteristics that also shape food security. To address this concern, we implement entropy balancing (Hainmueller, 2012) to construct a counterfactual control group that closely matches treated countries along pre-treatment political and conflict-related dimensions. This approach allows us to

¹ Developed by Caccavale and Giuffrida (2020), the Proteus composite index contributes to food security monitoring by being robust over time and comparable both within and across countries, thereby enabling the tracking of country-level progress toward food security. While it identifies countries requiring priority attention due to chronic food insecurity, the index is also sufficiently flexible to capture sudden-onset crises. Moreover, it reflects the main drivers that can dramatically affect a country's food security in the short run, thus suggesting potential areas for policy intervention. The index is currently used by the World Food Programme (WFP) to monitor and compare food security conditions and trends across different economies over time.

credibly estimate the average treatment effect on the treated while improving comparability between treated and control observations.

Our results yield three main findings. First, US sanctions have a statistically significant and economically meaningful negative impact on food security in target countries. On average, sanctions reduce the overall food security index by approximately one percentage point of the sample mean, accounting for roughly 30% of the observed gap between sanctioned and non-sanctioned countries. Event-study estimates further show no evidence of differential pre-trends, while indicating that food security deteriorates immediately following the imposition of sanctions and remains persistently lower over the medium term, with gradual attenuation over time. These dynamics suggest that the effects of sanctions are both immediate and sustained, with potentially long-lasting consequences for vulnerable populations. Second, the effects of sanctions are highly uneven across the dimensions of food security. The adverse impacts are concentrated in food access and food stability, while the estimated effects on food availability and utilization are small and statistically insignificant. This pattern suggests that sanctions affect food security primarily through economic and systemic channels that hinder households' ability to obtain food and amplify exposure to price and supply volatility, rather than through a direct contraction of overall food availability or deterioration in food utilization conditions. Third, the effects are heterogeneous and disproportionately borne by structurally vulnerable countries. The negative impacts are significantly larger for multilateral and economically intensive sanctions, and are concentrated in low- and lower-middle-income countries, particularly in Latin America and Sub-Saharan Africa. These findings highlight that the burden of sanctions is not evenly distributed, but instead falls most heavily on countries with limited capacity to absorb external shocks.

To ensure the reliability of our findings, we also incorporate a number of robustness checks. First, we present results using standard DID panel regressions to verify our main findings. Second, we assess the robustness of our entropy balancing analysis by modifying the entropy model settings and altering the selection of covariates. Third, we apply the method proposed by Oster (2019) to check for potential omitted variable bias. Finally, we perform a placebo test with random assignments to address potential over-rejection issues caused by serial correlation. The results of these robustness check further support our main conclusions.

To shed light on the underlying mechanisms, we examine how sanctions propagate through both supply-side and demand-side channels of food systems. On the supply side, sanctions—particularly trade and financial restrictions—disrupt access to international markets and critical agricultural inputs, thereby reducing food imports and constraining domestic production. Our evidence shows that economic sanctions significantly depress food imports and lower domestic agricultural output, indicating that sanctioned countries face a “double burden” of restricted external supply and weakened internal production capacity. On the demand side, sanctions primarily operate by constraining households' economic access to food. We find that economic sanctions lead to declines in income, sharp increases in inflation, and worsening labor market conditions, collectively eroding purchasing power and food affordability. In contrast, non-economic sanctions do not exert significant macroeconomic effects but instead undermine political stability, suggesting an institutional channel through which food distribution systems and policy effectiveness may be impaired. Taken together, these findings indicate that sanctions affect food security through multiple, interacting channels, with economic sanctions operating primarily through macroeconomic and trade disruptions, and non-economic sanctions exerting more indirect effects through institutional

deterioration.

This paper contributes to several strands of literature. First, it adds to the growing body of research on the unintended consequences of economic sanctions by identifying food security as a key and previously underexplored dimension of welfare. While a small number of studies examine sanctions and food-related outcomes (Afesorbor et al., 2025; Larch et al., 2024; Afesorbor, 2021; Kanfash, 2022), they are typically limited to individual country cases or lack credible counterfactuals, making it difficult to draw causal conclusions. By contrast, we provide cross-country evidence based on a transparent identification strategy that combines difference-in-differences method, event-study analysis, and entropy balancing. Moreover, we also conduct a comprehensive analysis by identifying specific dimensions of food security affected, exploring differential effects based on sanction and country characteristics, and elucidating underlying mechanisms.

Second, we contribute to the literature on food security by highlighting the role of external political shocks as a determinant of food system performance and by showing that different dimensions of food security respond differently to such shocks. The global food trade structure remains largely dominated by a few major exporting countries (Xie et al. 2017; Guan et al. 2022). Conflicts or instability in major exporting countries not only directly disrupt local food production but also indirectly transmit shocks to the global food market, thereby reducing global food supply and intensifying price volatility (Sun et al., 2026). Geopolitical risks are associated with higher inflation uncertainty and an elevated risk of substantial inflation increases; moreover, sanctions significantly amplify the inflationary effects of such geopolitical shocks (Bondarenko et al., 2024; Caldara et al., 2026).

Third, by documenting systematic heterogeneity across sanction types, intensity, and country characteristics, we show that the welfare consequences of sanctions are highly uneven and closely linked to structural vulnerabilities. Long-term factors affecting food security, such as slow economic growth (Songwe and Awiti, 2021), gender inequality, rising food prices (Botreau and Cohen, 2020), low agricultural productivity, drought (Ngcamu and Chari, 2020), insufficient investment in irrigation (Onwujekwe and Ezemba, 2021), climate change (Sirba and Chimdessa, 2021), and rapid population growth (Hossain et al., 2019), have persisted over time. Sub-Saharan Africa, for instance, exemplifies a region facing severe food insecurity (Wudil et al., 2022). These persistent challenges undermine the capacity of developing countries to ensure food security, while sanctions further exacerbate regional disparities in food distribution.

The findings carry important policy implications. While sanctions may serve geopolitical objectives, their unintended effects on food systems raise significant humanitarian concerns. The concentration of adverse effects in economically vulnerable countries suggests that sanctions may exacerbate existing inequalities in global food security. These results underscore the importance of designing sanction regimes that minimize disruptions to essential sectors and of implementing complementary policies to mitigate their impact on food access and stability.

The remainder of the paper is organized as follows. Section 2 presents a conceptual framework and develops testable hypotheses. Section 3 describes the data and variable construction. Section 4 outlines the empirical strategy and presents the main results. Section 5 explores the underlying mechanisms. Section 6 concludes.

2. Theoretical considerations and hypotheses

Economic sanctions have become an increasingly prominent instrument of international policy, yet their broader welfare consequences—particularly for food security—remain insufficiently understood. While sanctions are primarily intended to exert political pressure on targeted governments, they simultaneously operate as large external shocks that disrupt trade, production, and macroeconomic stability. Given the multidimensional nature of food security—encompassing availability, access, utilization, and stability—such disruptions are likely to propagate through multiple channels, with potentially significant consequences for civilian welfare.

In recent years, concerns over the humanitarian implications of sanctions have intensified. Episodes such as the tightening of sanctions on Iran, the prolonged restrictions on North Korea, and more recent sanctions on Venezuela and Russia have highlighted how economic isolation can spill over into food systems. Reports from international organizations and media coverage frequently document rising food prices, supply shortages, and deteriorating nutritional conditions in sanctioned economies. These observations underscore the importance of understanding the mechanisms through which sanctions affect food security.

We conceptualize these mechanisms through two broad and interrelated channels: (i) supply-side disruptions, which mainly affect the availability and stability of food, and (ii) demand-side constraints, which shape households' ability to access and utilize food. While analytically distinct, these channels interact in equilibrium, jointly determining food security outcomes.

2.1 Supply-Side Channel: Agricultural Trade Disruptions and Food Production

Sanctions can directly constrain the supply of food by disrupting both international trade and domestic agricultural production. Sanctions usually encompass trade restrictions and the suspension of agricultural development assistance—including technology transfer and food aid. Trade-related sanctions—particularly those targeting financial transactions, shipping, and insurance—raise the cost of cross-border exchange and may effectively limit access to international markets (Hufbauer et al., 2007; Crozet and Hinz, 2020). Even when food products are formally exempted, financial sanctions often generate “over-compliance” by banks and firms, impeding payments and reducing trade in essential goods. In addition, many target countries rely on developed nations for access to advanced agricultural inputs and technology to enhance productivity. Moreover, most target countries are primary recipients of food assistance from donor (developed) countries. The United States, for instance, is both a frequent sender of sanctions and a major food donor (Afesorgbor et al., 2025; Cardwell and Ghazalian 2020).

Recent real-world cases illustrate these dynamics. Sanctions frequently restrict the bilateral exchange of food and agricultural products between sanctioning states and their target countries. For instance, the United States sanctions against Iraq suspended agricultural export credits to Iraq, and the lack of agricultural innovation may lead to low agricultural productivity and thus to increased food insecurity (Hufbauer et al., 2007). Sanctions on Iran have complicated access to foreign exchange and international payment systems, leading to difficulties in importing staple foods and agricultural inputs despite humanitarian exemptions. Another example is the application of direct and indirect sanctions on Syria. These sanctions have undermined Syrian food security across various dimensions by damaging the agricultural sector and constraining the import capacity

of both state and private entities with respect to food, equipment, and fertilizer (Kanfash, 2022). Similarly, restrictions on North Korea have constrained imports of fuel and fertilizers, which are critical for agricultural production, contributing to chronic food shortages. More recently, disruptions associated with sanctions on Russia have affected global grain and fertilizer markets, with spillover effects on food availability in import-dependent economies (Diplomatic Academy of Russia's MFA, 2022).

Beyond trade, sanctions may also weaken domestic food production. Agricultural systems in many developing countries rely heavily on imported inputs such as fertilizers, pesticides, machinery, and improved seeds. By incorporating capital-embodied technology, the importance of capital as a determinant of cross-country differences in agricultural labor productivity is substantially elevated (Caunedo and Keller, 2021). Sanctions that restrict access to these inputs—or increase their cost—can reduce agricultural productivity and output. In addition, financial constraints may limit investment in agriculture, while logistical disruptions can hinder the functioning of supply chains. These mechanisms are consistent with a broader literature showing that external shocks to input markets and trade can have persistent effects on domestic production capacity (Allen, 2008; Peksen, 2011).

Taken together, these effects suggest that sanctions can reduce food availability through two complementary pathways: by limiting imports and by constraining domestic production. The relative importance of these channels is likely to depend on structural characteristics such as import dependence, agricultural capacity, and integration into global markets.

2.2 Demand-Side Channel: Domestic Economic and Political Constraints

In addition to affecting supply, sanctions can undermine food security by constraining households' economic and effective access to food. This channel operates through both macroeconomic conditions and institutional factors that shape the distribution and accessibility of food.

From a macroeconomic perspective, sanctions are often associated with declines in economic output, currency depreciation, and rising inflation (Neuenkirch and Neumeier, 2015). These effects reduce real incomes and purchasing power, particularly among low-income households that allocate a large share of their expenditures to food (Afesorgbor and Lim 2023). At the same time, supply disruptions and exchange rate pressures can increase food prices, further eroding affordability. For example, Afesorgbor et al. (2025) establish that economic sanctions adversely affect food security, with sanctions associated with a 1.2% increase in real food prices and a 2.1% increase in the prevalence of undernourishment. In Venezuela, sanctions coincided with severe macroeconomic instability—including hyperinflation and currency collapse—which sharply reduced households' ability to afford basic food items and contributed to widespread food insecurity.

Labor market conditions provide an additional transmission mechanism. Sanctions may lead to firm closures (Crozet et al., 2021), reduced international trade (Afesorgbor, 2019) and foreign direct investment (Mirkina, 2018), and declining economic activity (Neuenkirch and Neumeier, 2015), thereby increasing unemployment (Nosratabadi, 2023) and income volatility (Neuenkirch and Neumeier, 2016). The international economic sanctions on Iran in 2012 led to an overall decline in the manufacturing employment growth rate by 16.4 percentage points (Kelishomi and Nisticò, 2022). In settings with limited social protection systems, such shocks can translate directly into reduced food consumption and deteriorating nutritional outcomes.

Importantly, demand-side constraints are also shaped by political and institutional factors. Sanctions may weaken state capacity, exacerbate internal instability, and undermine governance (Dashti-Gibson et al., 1997; Peksen, 2009). Such institutional deterioration can disrupt food distribution systems, reduce the effectiveness of subsidy programs, and hinder the delivery of humanitarian assistance (Oechslin, 2014). Historical evidence from Iraq in the 1990s, for instance, shows that comprehensive sanctions were associated with a breakdown in public service provision and food distribution mechanisms, contributing to significant declines in nutrition and health outcomes (Garfield, 1999). Geopolitical risks are associated with higher inflation uncertainty and the risk of significant inflation increases, while sanctions substantially worsen the inflationary impact of such shocks (Bondarenko et al., 2024; Caldara et al., 2026).

In fragile contexts, these institutional effects can be particularly pronounced. Weak governance may lead to coordination failures in supply chains, delays in imports, or unequal access to food across regions and population groups. As a result, even when aggregate food availability is not severely constrained, households may still face substantial barriers to accessing food. These mechanisms are especially relevant for the access and stability dimensions of food security.

Taken together, this framework highlights that the impact of sanctions on food security is inherently multidimensional. Supply-side disruptions constrain the physical availability of food, while demand-side effects—encompassing both economic and political factors—limit households' ability to access and utilize it. The interaction between these channels may amplify the overall impact of sanctions, particularly in countries with high import dependence, weak institutions, and limited policy capacity.

This conceptual framework yields several testable implications. First, sanctions are expected to exert a negative effect on overall food security in targeted countries. Second, they are likely to reduce food availability by disrupting both imports and domestic agricultural production. Third, sanctions may constrain food access by lowering household incomes, increasing prices, and weakening labor market conditions. In addition, institutional deterioration may further exacerbate food insecurity by impairing distribution systems and reducing policy effectiveness. These hypotheses provide the foundation for the empirical analysis that follows.

3. Data

In this section, we describe the construction of our key variables of interest. Our full sample is a global panel dataset which includes 185 countries over the period 1990-2017. It comprises 4660 country-year observations for which data is available for all control variables. A total number of 2227 of country-year observations were exposed to US sanctions. In contrast, the number of country-years without US sanctions is 2433. The summary statistics of key variables are presented in Table 1.

3.1 US sanctions

Our data on international sanctions are drawn from the Global Sanctions Database, Release 4 (GSDB-R4), compiled by Yalcin et al. (2025), which extends the original dataset introduced by Felbermayr et al. (2020). The GSDB has been systematically cross-validated with other widely used sources, including Hufbauer et al. (2007) and the Threats and Imposition of Economic Sanctions

(TIES) database (Morgan et al., 2014). The latest version provides comprehensive coverage of 1,547 sanction episodes over the period 1950–2023, including detailed information on sanction timing, senders and targets, policy objectives, sanction types (e.g., trade, financial, travel, and arms restrictions), as well as whether sanctions are unilateral or multilateral.

We focus specifically on sanctions imposed by the most frequent sender, the United States. This choice is motivated by two considerations. First, U.S. sanctions encompass both measures implemented within multilateral frameworks (e.g., United Nations sanctions) and those imposed unilaterally, thereby capturing a broad spectrum of sanction regimes. Second, restricting attention to a single sender mitigates heterogeneity arising from differences in sanction design, enforcement, and geopolitical objectives across countries, improving comparability and identification.

Between 1950 and 2023, the United States imposed sanctions on 155 countries, including several now-dissolved states. Since 2000, 132 countries have been subject to U.S. sanctions, with a marked increase in frequency after 2010. As illustrated in Figure 1, the United States is the dominant sender of sanctions, accounting for a substantial share of global sanction activity in most years. Table A2 presented the list of all sanctioned countries in our sample.

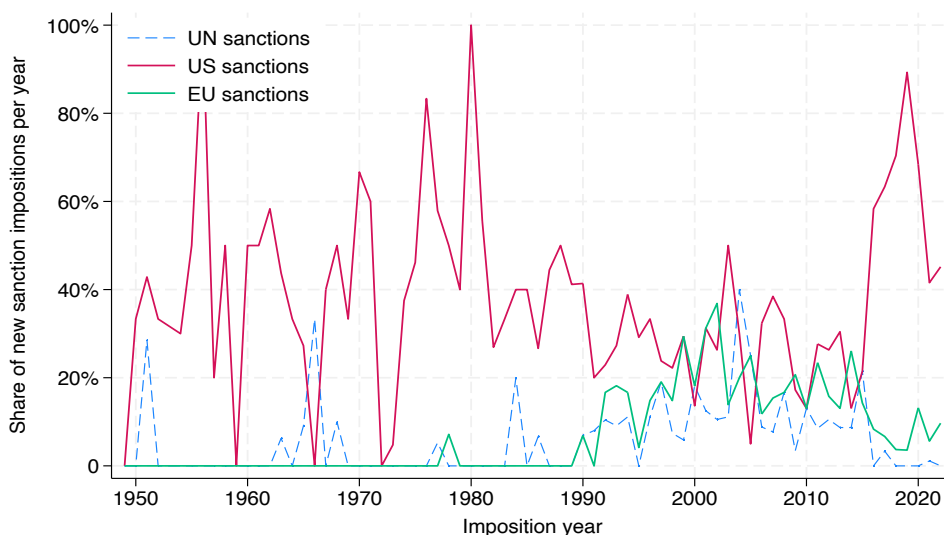


Figure 1. Yearly Statistics on the Number of New Sanctions Imposed

Notes: US sanctions and EU sanctions in the figure1 refer to cases of sanctions that do not include those initiated by the United Nations. If cases of sanctions initiated by participating United Nations are added to the statistics, the weight of US sanctions will be higher.

3.2 Food Security

Food security is inherently multidimensional, requiring comprehensive measurement to capture its various dimensions. The Food and Agriculture Organization (FAO) conceptualizes food security along four pillars: availability, access, utilization, and stability (FAO, 2020). This framework has become the standard in both academic and policy analyses, with most existing indicators building upon it. In addition, the literature has proposed complementary measures focusing on specific

dimensions, such as household food expenditure shares, domestic production capacity, and food trade (e.g., Hejazi and Emamgholipour, 2022; Voronin et al., 2018; Bělín and Hanousek, 2021).

To capture these multiple dimensions, we employ the Proteus composite index developed by Caccavale and Giuffrida (2020). This index is among the most comprehensive measures of food security and is explicitly aligned with the FAO’s four-pillar framework. It aggregates 21 indicators covering 185 countries over the period 1990–2017, spanning availability (2 indicators), access (7), utilization (2), and stability (10). The index has been adopted by international organizations such as the World Food Programme and is widely regarded as methodologically rigorous.

A key advantage of the Proteus index is its careful treatment of methodological challenges inherent in composite indicators, including weighting, normalization, and sensitivity to model assumptions. It also allows for meaningful comparisons across countries and over time, making it well suited for panel analysis (Manikas et al., 2023). The original index ranges from 0 to 1, with lower values indicating better food security outcomes (see Figure 2). Following the approach of Campi et al. (2021), we transform the index as “1 – index” in the empirical analysis, so that higher values correspond to better food security. The structure and composition of the food security indicator system are detailed in Table A1.

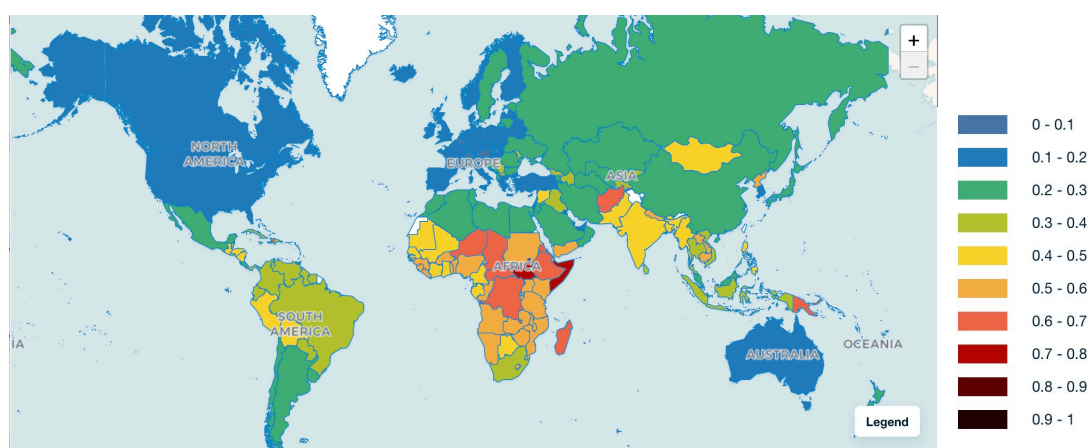


Figure 2. Global Distribution of Proteus Composite Index in 2017

Notes: This figure is based on the original Proteus Composite Index, where higher values indicate a greater level of food insecurity. However, in the empirical regression analysis presented in this paper, the “1-PCI” transformation is employed to more clearly demonstrate the negative impact of sanctions.

3.3 Control Variables

To ensure credible identification, it is important to compare treated and untreated countries that are similar along relevant pre-treatment characteristics. Guided by the determinants of sanction imposition identified in the literature (e.g., Neuenkirch and Neumeier, 2016; Sun and Wang, 2025), we include a set of control variables capturing political and conflict-related factors that may affect both the likelihood of being sanctioned and food security outcomes. Figure A1 in the Appendix presents the distribution of eight distinct objectives that recur in sanction policies. Figure A2 summarizes the distribution of sanction objectives from 1995 to 2022. This distribution allows us

to categorize sanction objectives into three broad groups based on their frequency of occurrence. The most commonly stated objectives are improvements in human rights and the restoration of democracy. The second category includes objectives aimed at ending wars and changing policies in target countries. Finally, the third category consists of sanctions with objectives such as preventing war, combating terrorism, resolving territorial conflicts, and destabilizing regimes.

Based on the above information, we introduce a set of matching variables to capture factors that influence the likelihood of a country being sanctioned. Specifically, we include: (i) an electoral democracy index, which measures the extent to which democratic institutions are realized (ranging from 0 to 1); (ii) a physical violence index, capturing the absence of state-perpetrated violence such as political killings and torture (also ranging from 0 to 1, higher index values represent a higher level of physical integrity); and (iii) indicators of armed conflict intensity, distinguishing between minor and major conflicts. These variables capture key dimensions of political institutions and security conditions that may confound the relationship between sanctions and food security.

To further verify the extent to which sanction objectives are consistent with our dataset, we also examine the correlation between US sanctions and the political control variables mentioned above. The estimated results, where the dependent variable is either a binary indicator or the frequency of US sanctions, are presented in Table A3 in the Appendix. We find that these results align with the sanction objectives outlined in the GSDB (Figure A1 and A2). These results reinforce our confidence that the political control variables are reliable predictors of US sanctions.

Table 1. Summary statistics

Variables	N	Mean	Std. Dev.	min	max
Proteus	4660	0.613	0.163	0.081	0.924
Availability	4660	0.445	0.246	0	1
Access	4660	0.457	0.17	0.003	0.922
Utilization	4660	0.688	0.31	0	1
Stability	4660	0.81	0.079	0.257	0.94
US sanction	4660	0.478	0.5	0	1
Electoral democracy	4660	0.505	0.269	0.013	0.922
Physical violence	4660	0.79	0.356	0	1
Major conflict	4660	0.039	0.193	0	1
Minor conflict	4660	0.112	0.315	0	1
Food import (logged)	3572	25.627	1.779	18.382	30.316
Food production index	4576	83.557	23.821	3.08	321.57
GDP per capita (logged)	4574	8.33	1.456	5.112	11.63
Inflation by GDP	4577	42.084	517.139	-31.566	26762
Unemployment	4633	8.078	6.129	0.14	38.8
Political stability	4660	0.581	0.264	0	1

4. Empirical results

Based on the data set described above, we empirically test the hypotheses proposed in Section 2. First, we introduce our empirical strategy. Second, we present results on the causal effect of US sanctions on food security in target countries.

4.1 Empirical strategy

The aim of this paper is to study whether US sanctions have a detrimental impact on food security in the target countries. However, the key challenge to the identification of treatment effects is the endogeneity problem concerning the imposition of sanctions. The reasons for imposing sanctions, such as human rights violations, interstate conflict, or political repression, could be closely associated with the sanctioned country's political and economic situation (Neuenkirch and Neumeier, 2016), which in turn, are related to that country's food security. This implies that countries exposed to US sanctions could have exhibited a poor levels of food security even if the sanctions had not been imposed.

To account for this problem, we employ a difference-in-differences method and conduct an event study to test the parallel trend assumption between sanctioned countries (treatment group) and non-sanctioned countries (control group). To make treatment group and control group as similar as possible, we use entropy balancing to select matches for the units exposed to treatment, so as to get a more precise estimation of the average treatment effect on the treated (ATT). Our basic empirical model is specified as follows:

$$y_{i,t} = \beta_0 + \beta_1 \text{sanction}_{i,t} + \gamma X_{i,t-1}^{\text{Control}} + \alpha_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the food security (the Proteus composite index and its sub-indicators) of country i at year t ; $\text{sanction}_{i,t}$ is the treatment indicator, which equals to one if country i was exposed to US sanctions at year t . The coefficient β_1 is the average treatment effect of US sanctions on food security of target countries; $X_{i,t-1}^{\text{Control}}$ denote a set of time-variant control variables, where the political covariates include electoral democracy index, physical violence indicator, and the occurrence of major conflicts and minor conflicts. We lag these political control variables by one year to mitigate problems of reverse causality. In addition, α_i are the country-fixed effects, which control for country time-invariant unobservable characteristics; and τ_t are year fixed effects, which account for variables constant across countries but varying across years. Finally, $\varepsilon_{i,t}$ is the error term.

The comparability of treatment and control groups is strengthened through pre-treatment balancing. We employ the method of entropy balancing proposed by Hainmueller (2012). Table 2 presents comparisons of the sample means of all covariates across treatment and control groups before and after entropy balancing, respectively. In Panel A of Table 2, it is observed that covariates of country-year observations subject to sanctions significantly differ from those without sanctions, with generally poorer political performance in countries facing US sanctions.² However, Panel B of Table 2 demonstrates that after entropy balancing, all covariates are nearly perfectly balanced, with no remaining statistically significant differences. As a result, we are confident that the control group utilized in subsequent empirical analyses consists of credible counterfactuals for the sample

² Compared to country-year observations without sanctions, country-year observations that face US sanctions are characterized by a lower electoral democracy level, a higher degree of physical integrity rights violations, and a higher occurrence of major and minor conflicts.

of country-year observations subjected to US sanctions.

Table 2. Covariates before and after entropy balancing

Panel A					
	(1)	(2)	(3) = (2)-(1)		
	Sanctions	No sanctions	Difference	t-Test	p-Value
Electoral democracy _{t-1}	0.423	0.572	0.149	19.476	0.000
Physical violence _{t-1}	0.713	0.853	0.140	13.431	0.000
Major conflict _{t-1}	0.059	0.023	-0.036	-6.106	0.000
Minor conflict _{t-1}	0.128	0.097	-0.031	-3.290	0.001
Observation	2227	2433			
Panel B					
	(1)	(4)	(5) = (4)-(1)		
	Sanctions	No sanctions	Difference	t-Test	p-Value
Electoral democracy _{t-1}	0.423	0.426	0.003	-0.408	0.683
Physical violence _{t-1}	0.713	0.715	0.002	-0.215	0.830
Major conflict _{t-1}	0.059	0.059	0.000	0.072	0.943
Minor conflict _{t-1}	0.128	0.127	-0.001	0.091	0.927
Observation	2227	2227			

Notes: Column (1) shows the average conditions for country-year observations with sanctions; Column (2) shows the average conditions for country-year observations without sanctions; Column (3) shows differences in the average conditions between both groups alongside the corresponding t-test statistics and p-values; Column (4) shows the average conditions of the synthetic control group using entropy balancing method; Column (5) shows differences in the average conditions between both groups alongside the corresponding t-test statistics and p-values.

4.2. Baseline results

Table 3 reports the average treatment effect on the treated (ATT) of US sanctions on the overall food security index and its four sub-indicators. Column (1) presents estimates controlling for country and year fixed effects, while column (2) further incorporates the first lag of political and conflict-related covariates. The results consistently indicate that sanctions exert a negative impact on food security levels in targeted countries, with coefficients that are statistically significant at least at the 5% level. Quantitatively, the estimates suggest that US sanctions reduce the food security index by 0.006 on average, which corresponds to approximately 0.98 percentage points of the sample mean. This marginal effect is sizable, as it accounts for roughly 30% of the average difference in the Proteus index between sanctioned and non-sanctioned countries (0.006/0.02). In other words, the imposition of US sanctions has widened the gap between target countries and non-target states by about 30 percent. These results suggest that sanctions have exacerbated the imbalance of global food security across countries.

Columns (3)–(10) examine the effects of US sanctions on the four sub-components of the Proteus food security index: availability, access, utilization, and stability. The findings reveal that sanctions have a statistically significant negative impact on food access and food stability, which suggest that the effects concentrated on these two dimensions. In terms of magnitude, sanctions are associated

with reductions of approximately 1.3 percentage points in the access indicator and 1.1 percentage points in the stability indicator, relative to comparable non-sanctioned countries with similar observable pre-treatment characteristics. These effects represent about 27% and 39% of the average differences in the access and stability sub-indices, respectively, between sanctioned and non-sanctioned countries. By contrast, sanctions do not exhibit a statistically significant effect on food availability, and while the coefficient for food utilization is negative, it is not statistically significant at conventional levels ($p = 0.12$). Nonetheless, these average effects may conceal substantial heterogeneity across different types of sanctions and across regions, which we explore in subsequent sections.

The validity of the difference-in-differences (DID) identification strategy relies on the parallel trends assumption—that, in the absence of treatment, the outcome trajectories of treated and control groups would have evolved similarly over time. To assess the plausibility of this assumption, we estimate a dynamic event-study specification that traces the evolution of food security outcomes before and after the imposition of US sanctions. This approach allows us to examine whether treated and control country-year observations exhibited differential trends prior to treatment.

Figure 3 presents the results, where point estimates are shown as solid dots and the associated 95% confidence intervals are depicted by vertical whiskers. The pre-treatment periods are indexed from -5 to -1 , while the post-treatment periods span from 0 to 9 . The figure provides no evidence of differential pre-trends between treated and control observations. The estimated coefficients for the pre-treatment periods are close to zero and statistically insignificant, supporting the validity of the parallel trends assumption. Following the imposition of sanctions, however, food security declines immediately. The estimated effects in the first six post-treatment years are approximately -0.0028 , -0.0054 , -0.0057 , -0.0068 , -0.0075 , and -0.0075 , respectively, indicating a persistent negative impact over the medium term. The magnitude of the effect stabilizes after several years and gradually attenuates, becoming statistically insignificant after approximately seven years and diminishing further by the tenth year (-0.002). Overall, the event-study results provide strong support for the identification strategy and suggest that the adverse effects of US sanctions on food security are both immediate and sustained, albeit with some attenuation over time.

To further address concerns arising from treatment heterogeneity and staggered adoption, we complement our baseline analysis with the heterogeneity-robust difference-in-differences estimator proposed by de Chaisemartin and D’Haultfoeuille (2024).³ Figure A3 presents the estimated dynamic effects of sanctions on food security. Consistent with our baseline findings, we observe a significant and persistent decline in food security following the imposition of sanctions, with effects becoming more pronounced over time. Importantly, the pre-treatment coefficients are small and statistically insignificant, indicating no evidence of differential pre-trends between treated and control groups. This conclusion is further supported by placebo tests based on pre-treatment periods. The joint test of the null hypothesis that all pre-sanction coefficients are equal to zero cannot be rejected (p -value = 0.813), providing strong support for the parallel trends and no-anticipation assumptions underlying the identification strategy.

³ This approach is well suited to our setting, as it accommodates variation in the timing of sanction imposition across countries and allows for treatment reversals, which are common in sanction episodes where measures may be lifted or reintroduced over time. However, one limitation of this approach is the estimation may lead to a major reduction in sample size. In our case, the number of observations decreases from 4,660 in the baseline sample to 3,723 in the staggered DID estimation.

Table 3. The impact of US sanctions on food security.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Proteus	Proteus	Availability	Availability	Access	Access	Utilization	Utilization	Stability	Stability
Sanction	-0.00680*** (0.00246)	-0.00563** (0.00234)	0.00411 (0.00534)	0.00442 (0.00537)	-0.00690* (0.00382)	-0.00627* (0.00352)	-0.00942 (0.00597)	-0.00920 (0.00593)	-0.0113*** (0.00378)	-0.00904** (0.00366)
Electoral democracy _{t-1}		-0.0159 (0.0177)		0.0119 (0.0407)		-0.00725 (0.0199)		-0.0148 (0.0294)		-0.0229 (0.0301)
Physical violence _{t-1}		0.0117* (0.00647)		-0.0183 (0.0171)		0.0173** (0.00770)		0.0384*** (0.0129)		0.0129 (0.0115)
Major conflict _{t-1}		-0.0237*** (0.00590)		-0.0123 (0.00864)		-0.00632 (0.0100)		0.0107 (0.00711)		-0.0479*** (0.0108)
Minor conflict _{t-1}		-0.00827*** (0.00288)		-0.00817 (0.00644)		-0.00472 (0.00430)		0.00348 (0.00461)		-0.0187*** (0.00524)
Constant	0.276*** (0.00313)	0.299*** (0.00680)	0.0822*** (0.00867)	0.0981*** (0.0126)	0.282*** (0.00398)	0.285*** (0.0116)	0.101*** (0.00570)	0.0826*** (0.0104)	0.583*** (0.00479)	0.630*** (0.0117)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	4,660	4,660	4,660	4,660	4,660	4,660	4,660	4,660	4,660	4,660
R-squared	0.976	0.977	0.945	0.945	0.963	0.964	0.978	0.978	0.731	0.744

Notes: Table shows average treatment effects on the treated obtained by weighted least squares regressions. Standard errors clustered at the country level are in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

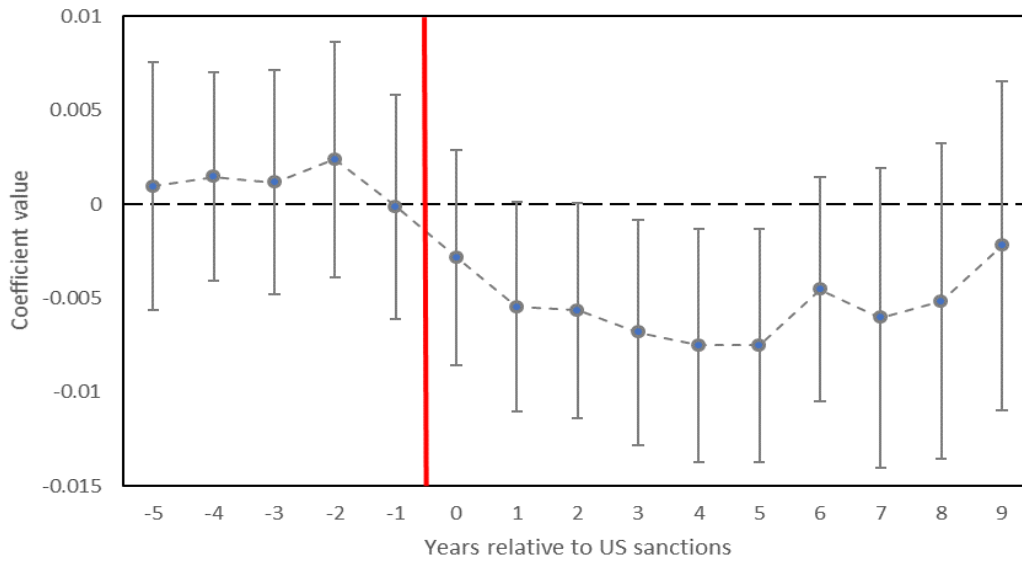


Figure 3. The dynamic effects of US sanctions on food security.

4.3. Heterogeneity in effects

In this section, we further examine the heterogeneous effects of different categories of sanctions on food security. The results are reported in Table 4, which presents five sets of treatment effect estimates based on alternative definitions of the treatment indicator. First, we compare the differential effects of unilateral sanctions imposed solely by the United States with those of multilateral sanctions, where the United States acts in coordination with other countries or international organizations such as the United Nations or the European Union. The estimates in column (1) indicate that multilateral sanctions exert a larger and more statistically significant negative effect on food security than unilateral sanctions. Specifically, multilateral sanctions are associated with a decline of approximately 2 percentage points in the food security index, whereas unilateral sanctions correspond to a more modest reduction of about 0.6 percentage points in the Proteus index.

Second, we assess whether sanctions imposed on a single target country (Target unilateral) differ in their impact from those imposed simultaneously on multiple countries (Target multilateral). The results reported in column (2) suggest that sanctions directed at a single country have a statistically significant negative effect on food security, while sanctions applied to multiple targets do not yield statistically significant effects. In particular, single target sanctions reduce the food security index in target countries by approximately 1.4 percentage points, whereas the estimated effect of multi-target sanctions is statistically insignificant.

Third, we distinguish between economic sanctions (i.e., trade and financial restrictions) and non-economic sanctions (e.g., travel bans, military measures, arms restrictions, and other forms of intervention). This classification also enables an assessment of sanctions by severity. Following the

typology proposed by Wood (2008), mild sanctions typically involve arms restrictions or diplomatic measures such as travel bans targeting political elites, while moderate to severe sanctions include fuel restrictions, asset freezes (both public and private), and comprehensive economic measures such as broad trade embargoes. As shown in column (3), only economic sanctions have a statistically significant negative impact on food security, leading to a reduction of approximately 1.6 percentage points in the Proteus index. By contrast, the estimated effect of non-economic sanctions is not statistically significant. These results suggest that the adverse effects of US sanctions on food security are primarily driven by economic measures.

Fourth, we directly examine how varying levels of sanction intensity affect food security by exploiting variation in the number of sanction types imposed. Our dataset identifies six categories of sanctions: trade, financial, travel, military, arms, and other measures. We interpret the number of sanction types imposed concurrently as a proxy for overall sanction intensity. Specifically, exposure to fewer than three types is classified as mild or moderate, while exposure to three or more types is classified as severe. The estimates in column (4) show that the negative impact of sanctions increases with their intensity. Mild and moderate sanctions are associated with a decline of approximately 0.5 percentage points in the food security index, whereas severe sanctions lead to a substantially larger reduction of about 2.9 percentage points. The difference between these effects is economically large and marginally statistically significant ($F(1, 173) = 3.72; p = 0.055$). Moreover, the degree of statistical significance differs, with the effect of severe sanctions being significant at the 5% level, while the impact of mild and moderate sanctions is statistically insignificant.

We further examine whether the impact of US sanctions varies across countries at different income levels. The results indicate substantial heterogeneity in the effects of sanctions along the income distribution. Column (5) demonstrates that the burden of sanctions is borne almost exclusively by lower-income nations. The coefficients for low-income and lower-middle-income countries are negative and statistically significant, with the latter showing the largest magnitude (-0.0130). In stark contrast, the point estimates for high-income and upper-middle-income countries are small and statistically insignificant. This pattern highlights a profound disparity in resilience; poorer nations, with their thinner margins of subsistence, weaker social safety nets, and greater dependence on imported food and inputs, are uniquely vulnerable to the external shocks induced by sanctions. These findings suggest that the adverse effects of sanctions on food security are disproportionately concentrated in economically more vulnerable countries, whereas higher income countries appear to be more resilient to such external shocks.

Finally, although the targets of sanctions have become more geographically diversified and more evenly distributed across regions in recent years (Yalcin et al., 2025), substantial regional heterogeneity persists in their effects on food security. To investigate this dimension, we further estimate the impact of US sanctions across six world regions—East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia, and Sub-Saharan Africa.

Table 4. The heterogenous effect of US sanctions on food security.

	(1)	(2)	(3)	(4)	(5)
	Proteus	Proteus	Proteus	Proteus	Proteus
Unilateral	-0.00361 (0.00239)				
Multilateral	-0.0122** (0.00469)				
Target unilateral		-0.00878** (0.00375)			
Target multilateral		-0.00242 (0.00290)			
Non-economic			-0.00211 (0.00312)		
Economic			-0.00961* (0.00494)		
Mild and moderate				-0.00332 (0.00252)	
Severe				-0.0174** (0.00674)	
high income level					0.00378 (0.00252)
low income level					-0.00974* (0.00529)
lower-middle income level					-0.0130*** (0.00428)
Upper-middle income level					-0.000972 (0.00324)
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	4,660	4,660	4,660	4,660	4,660
R-squared	0.977	0.977	0.978	0.978	0.978

Notes: The dependent variable is Proteus food security index. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

The results, reported in Table 5, reveal substantial and economically meaningful variation in the magnitude of these effects across regions. Importantly, the adverse consequences of sanctions are not uniformly distributed but are concentrated in specific geographic areas. The most pronounced and statistically significant effects are observed in Latin America and the Caribbean (column (3)) and Sub-Saharan Africa (column (6)), where the estimated coefficients are -0.0105 and -0.00919 , respectively, both significant at the 5% level. These findings suggest that structural characteristics—such as higher baseline poverty, limited economic diversification, and weaker institutional

capacity—may amplify the disruptive impact of sanctions on local food systems in these regions. The estimated effects for East Asia and the Pacific, as well as for the Middle East and North Africa, are also negative, although they are not statistically significant at conventional levels. By contrast, the estimated coefficients for Europe and Central Asia and for South Asia are close to zero and statistically insignificant, indicating a comparatively higher degree of resilience. Such resilience may reflect stronger fiscal capacity, more diversified trade networks, or policy frameworks that better insulate domestic food markets from external shocks.

Taken together, these results underscore that the collateral effects of sanctions on food security are highly context-dependent and shaped by regional characteristics. The concentration of significant negative impacts in Latin America and Sub-Saharan Africa raises important policy concerns, as these regions are already among the most vulnerable to food insecurity. More broadly, the findings suggest that aggregate estimates may obscure substantial distributional consequences, with the burden of sanctions falling disproportionately on the most vulnerable regions, thereby exacerbating existing global inequalities in development outcomes.

Table 5. Heterogeneous effects by the regions of target countries.

	(1)	(2)	(3)	(4)	(5)	(6)
	Proteus	Proteus	Proteus	Proteus	Proteus	Proteus
Region	EAS	ECS	LCN	MEA	SAS	SSF
Sanction	-0.0117 (0.00925)	0.000292 (0.00341)	-0.0105** (0.00430)	-0.00657 (0.00447)	0.00802 (0.00697)	-0.00919** (0.00417)
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
Observations	594	1,279	675	567	216	1,275
R-squared	0.969	0.954	0.948	0.966	0.972	0.939

Notes: The dependent variable is Proteus food security index. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Column (1)-(6) denote sample of East Asia and the Pacific (EAS), Europe and Central Asia (ECS), Latin America and the Caribbean (LCN), Middle East and North Africa (MEA), South Asia (SAS), and Sub-Saharan Africa (SSF), respectively.

Motivated by the regional heterogeneity documented in Table 5, we further examine the specific aspects of food security affected by focusing on regions exhibiting adverse effects. Specifically, we decompose the aggregate food security index into its four core dimensions—availability, access, utilization, and stability—to identify which components are most affected within each regional context. The results of this decomposition are presented in Figure 4. The analysis reveals substantial heterogeneity in the transmission channels of sanctions across regions. In East Asia and the Pacific, food utilization experiences the most pronounced decline, suggesting deteriorations in dietary quality and food safety. In contrast, the Middle East and North Africa exhibits the strongest effects on food stability, with estimates significant at the 1% level, indicating increased vulnerability to supply disruptions. Meanwhile, Latin America and the Caribbean and Sub-Saharan Africa display the largest negative impacts on food availability, with the effect in Sub-Saharan Africa significant

at the 1% level, pointing to constraints on the physical supply of food.

These findings highlight the importance of region-specific policy responses. Efforts to mitigate the food security consequences of sanctions should be tailored to the most affected dimensions within each region, taking into account underlying structural vulnerabilities and local socioeconomic conditions.

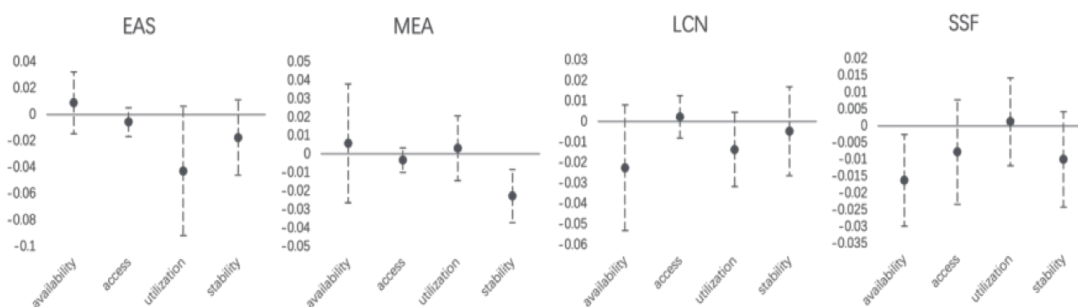


Figure 4. Regional Heterogeneity in Food Security Impacts of US Sanctions

Notes: The four regions shown in the figure are East Asia and the Pacific (EAS), Middle East and North Africa (MEA), Latin America and the Caribbean (LCN), and Sub-Saharan Africa (SSF), respectively.

4.4. Robustness checks

4.4.1. Standard panel regressions

We begin by re-estimating the baseline specifications using standard panel data techniques. The results are reported in Tables A4–A6 in the Appendix. Table A4 confirms that US sanctions continue to exert a negative and statistically significant impact on food security in target countries, with effects primarily concentrated in food access and food stability—consistent with the baseline findings in Table 3. Tables A5 and A6 further demonstrate that the magnitude and statistical significance of the estimated effects remain largely unchanged when alternative specifications are employed. In particular, the adverse effects of sanctions are (i) stronger for multilateral sanctions than unilateral ones, (ii) more pronounced when sanctions target a single country rather than multiple countries, (iii) primarily driven by economic sanctions, and (iv) concentrated among lower-income countries, especially in Latin America and Sub-Saharan Africa. Taken together, these results indicate that our baseline findings are robust to alternative panel estimation strategies.

4.4.2. Robustness of entropy balancing

The effectiveness of entropy balancing may depend on the specification of the balancing constraints and the set of covariates included. To assess the robustness of our results, we conduct two sets of sensitivity analyses. First, we modify the entropy balancing specifications. In the baseline, only the first moment of the covariates is adjusted and the normalization constant is set to one.⁴ In columns

⁴ By adjustment it means that the control group data will be reweighted such that the specified moments match the

(1) and (2) of Table A7, we additionally impose constraints on the second and third moments of the covariates, respectively, while in column (3) we alter the normalization constant from one to two. Across all specifications, the estimated effect of US sanctions remains negative and statistically significant, indicating that our results are not sensitive to the choice of balancing moments or normalization. Second, we examine the sensitivity of the results to alternative covariate selections. In column (4) of Table A7, we replace the Electoral Democracy Index with the Property Rights Index from the V-Dem dataset and substitute the Physical Violence Index with the Political Terror Scale (PTS) indicator.⁵ The results remain qualitatively unchanged, suggesting that our findings are robust to alternative measures of political conditions.

4.4.3. Omitted variable test

We also utilize the method proposed by Oster (2019) to address potential biases arising from time-variant unobserved characteristics. The details and results of the Oster test are presented in Table A8 in the Appendix. The findings reveal that the 'true' β interval does not include zero and is within the 95% confidence interval of the estimated coefficient $[-0.010245, -0.001011]$. Moreover, the Oster δ is negative (-4.32310), suggesting that selection on unobservables would have to be substantially stronger than selection on observables to overturn our results. These results suggest that the estimated treatment effect is unlikely to be driven by unobserved differences between sanctioned and non-sanctioned states.

4.4.4. Placebo test

Finally, we implement a placebo test with random assignments to address any potential over-rejection issue caused by serial correlation (Bertrand et al., 2004; Chetty et al., 2009). The intuition is that if our baseline estimates are not driven by unobserved confounders, then a randomly generated treatment variable—by construction unrelated to food security—should yield no systematic effect. Specifically, we construct a pseudo-treatment variable, $sanction_{fake}$, by randomly assigning sanction status across country-year observations, and re-estimate our baseline specification. Because this variable is orthogonal to the true data-generating process, its estimated coefficient should be centered around zero in the absence of spurious correlation induced by omitted variables.

We repeat this randomization procedure 500 times and obtain the distribution of the corresponding coefficient estimates. As shown in Figure 5, the estimated coefficients are approximately normally distributed and centered around zero. This result indicates that our empirical specification does not spuriously attribute effects to unrelated variation, providing supporting evidence that over-rejection problem is unlikely to drive our baseline findings.

values of the same moments in the treatment group data. The resulting entropy balancing weights for the control units are multiplied with this specified real number. For instance, if we set the normalization constant to 2, it means that the total of the entropy balancing weights for the control units is two times the total of the weights for the treated units.

⁵ The Property Rights Index measures the extent to which citizens enjoy secure private property rights, including the rights to acquire, possess, inherit, and transfer property (including land), and ranges from 0 to 1. The Political Terror Scale (PTS) captures the level of physical integrity rights violations based on US State Department reports, and ranges from 1 (low repression) to 5 (high repression).

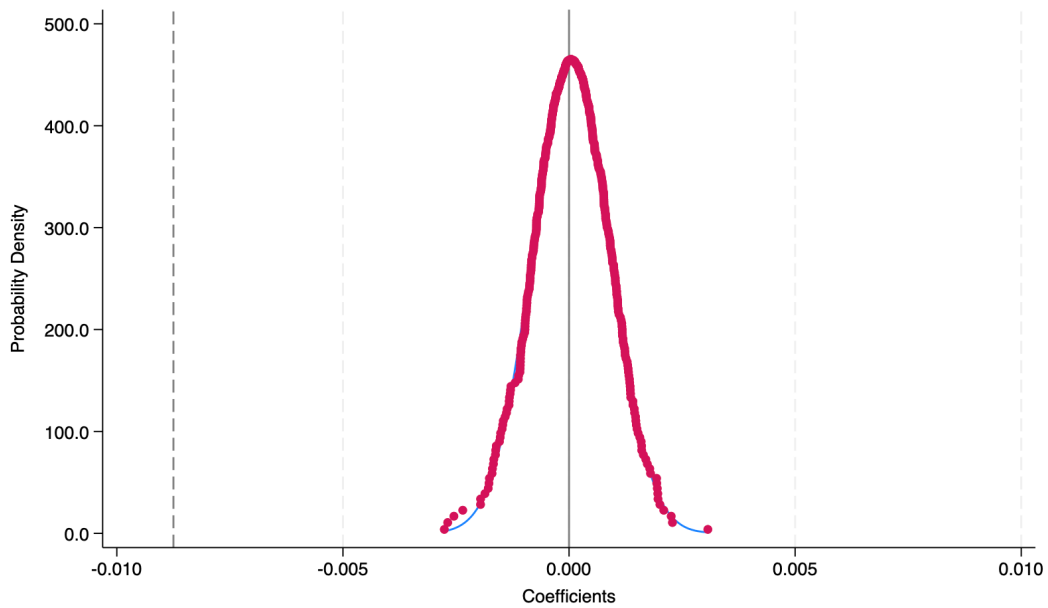


Figure 5. Placebo test

5. Mechanisms

In the previous section, we have documented a robust negative impact of US sanctions on food security in target countries. While these findings establish the overall effect, they do not by themselves reveal the underlying transmission channels. Understanding these mechanisms is crucial for interpreting the welfare consequences of sanctions and for identifying which dimensions of food systems are most affected. Building on the conceptual framework outlined earlier, we investigate two broad and complementary sets of mechanisms. First, we examine supply-side channels, focusing on how sanctions disrupt food imports and domestic food production, thereby affecting food availability. Second, we explore demand-side channels, analyzing how sanctions influence households' access to food through changes in income, prices, labor market conditions, and political stability. Together, these analyses provide a more comprehensive account of how sanctions translate into deteriorating food security outcomes.

5.1 Supply-Side: Trade and Production Effects

Sanctions—particularly those targeting trade and financial transactions—can disrupt international exchange and constrain access to foreign markets. A large body of literature suggests that sanctions increase transaction costs, limit access to trade finance, and induce over-compliance by financial intermediaries, thereby reducing imports even for goods that are formally exempted (Hufbauer et al., 2007; Crozet and Hinz, 2020). In the context of food systems, such disruptions can directly reduce food availability, especially in countries that rely heavily on imports to meet domestic demand. For example, sanctions on Iran have been shown to impede food imports through

restrictions on payment systems and foreign exchange access, despite humanitarian exemptions.

In addition to affecting trade, sanctions may also undermine domestic food production. By restricting access to essential inputs such as fertilizers, machinery, seeds, and agricultural technologies, as well as limiting credit and investment, sanctions can reduce agricultural productivity and output (Allen, 2008; Peksen, 2011). Furthermore, broader economic uncertainty and disruptions to labor markets may weaken agricultural supply chains, exacerbating production constraints. Similar patterns of supply chain disruption have been observed during global crises such as the COVID-19 pandemic (Aday and Aday, 2020), highlighting the sensitivity of food production systems to external shocks.

To empirically evaluate this mechanism, Table 6 reports the effects of sanctions on food imports and domestic food production. We distinguish between economic sanctions (i.e., trade and financial restrictions) and non-economic sanctions (e.g., travel bans, arms embargoes, and other targeted measures), as these categories may operate through different channels. Columns (1) and (2) show that economic sanctions exert a negative and statistically significant effect on food imports, with the estimated coefficient statistically significant at the 5% level. The magnitude of the coefficient indicates that compared to non-sanctioned states, economic sanctions lead to trade imports of target countries reduce by 5.3%. This finding suggests that trade and financial restrictions substantially reduce a country's ability to procure food from international markets, thereby constraining food availability. In contrast, the estimated coefficients for non-economic sanctions are statistically insignificant, consistent with their more targeted nature and limited impact on broad commercial activities.

Table 6. Mechanisms: Trade and Production Effects

	Food import		Food production	
	(1)	(2)	(3)	(4)
Economic sanction	-0.0520** (0.0216)	-0.0528** (0.0217)	-0.760** (0.375)	-0.751** (0.368)
Non-economic sanction	0.0151 (0.0176)	0.0197 (0.0177)	-0.639** (0.297)	-0.563* (0.297)
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Controls	NO	YES	NO	YES
Observations	3,384	3,384	4,548	4,548
R-squared	0.986	0.986	0.912	0.912

Notes: The dependent variable from columns (1)-(2) are food imports (logged), the dependent variable from columns (3)-(4) are food production index. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Columns (3) and (4) present the results for domestic food production. Both economic and non-economic sanctions are associated with reductions in the food production index, although the magnitude and statistical significance differ. Economic sanctions exhibit a large and statistically significant negative effect (-0.75), reflecting the impact of input constraints, reduced access to

technology, and financing limitations on agricultural output. Non-economic sanctions also reduce domestic production (-0.56), albeit with somewhat weaker statistical significance, suggesting that their effects may operate through indirect channels such as economic uncertainty and disruptions to coordination within supply chains.

Taken together, these results indicate that sanctions affect food security through multiple supply-side mechanisms. Economic sanctions, in particular, impose a “double burden” by simultaneously restricting food imports and depressing domestic production. While non-economic sanctions do not significantly disrupt trade, they nevertheless contribute to food insecurity by weakening domestic agricultural output. These findings provide important insights into the channels through which sanctions translate into reduced food availability and, ultimately, deteriorating food security outcomes.

5.2 Demand-Side: Macroeconomic and Institutional Effects

In addition to supply-side mechanisms, sanctions may affect food security by constraining households’ economic access to food through macroeconomic and institutional channels. A large body of literature shows that sanctions are often associated with economic contraction, rising inflation, and labor market deterioration (Neuenkirch and Neumeier, 2015; Peksen, 2011). These effects reduce purchasing power and increase the cost of food, thereby limiting households’ ability to maintain adequate nutrition. At the same time, sanctions may undermine political stability and state capacity, disrupting food distribution systems and weakening the effectiveness of public policies and humanitarian responses (Dashti-Gibson et al., 1997; Peksen, 2009).

To examine these demand-side mechanisms, Table 7 reports the impact of sanctions on key indicators of economic performance—GDP per capita, inflation, and unemployment—as well as political stability. As in the previous section, we distinguish between economic and non-economic sanctions to assess whether they operate through different channels.

Columns (1)–(2) show that economic sanctions have a negative and statistically significant effect on GDP per capita, with coefficients of approximately -0.033 , indicating a decline of about 3.3% in average income. This contraction in economic activity directly reduces households’ purchasing power. Columns (3)–(4) further indicate that economic sanctions are associated with a substantial increase in inflation, with coefficient estimates exceeding 160, suggesting severe macroeconomic instability and rapidly rising prices. Given that food constitutes a large share of household expenditures—particularly in low-income settings—such inflationary pressures can sharply erode food affordability. In addition, Columns (5)–(6) show that economic sanctions lead to a statistically significant increase in unemployment of approximately 2.3 percentage points, reflecting labor market deterioration and further income losses. Taken together, these results suggest that economic sanctions constrain food access through a combination of income reduction, price increases, and employment losses.

By contrast, non-economic sanctions do not exhibit statistically significant effects on GDP per capita, inflation, or unemployment, indicating that they do not operate primarily through macroeconomic channels. However, Columns (7)–(8) reveal that non-economic sanctions have a negative and statistically significant impact on political stability. This finding suggests that even targeted sanctions can weaken governance structures and exacerbate social and political tensions. Such institutional deterioration may disrupt food distribution networks, reduce the effectiveness of

agricultural and social protection policies, and hinder the delivery of humanitarian assistance. In turn, these effects can impair food security by limiting households' ability to access food, even in the absence of large aggregate economic shocks.

Overall, the results highlight distinct demand-side transmission mechanisms through which sanctions affect food security. Economic sanctions operate primarily through macroeconomic channels, generating a “triple burden” of declining income, rising prices, and worsening labor market conditions. In contrast, non-economic sanctions exert their effects mainly through institutional channels, undermining political stability and the functioning of food distribution systems. These findings underscore the multidimensional nature of sanction impacts and the importance of considering both economic and institutional factors when assessing their consequences for food security.

6. Conclusion

In this paper, we examine the impact of US sanctions on food security over the period 1990–2017. Econometrically, we employ a difference-in-differences (DID) framework and an event-study design to estimate the causal effects of sanctions, and we use entropy balancing to construct a comparable control group based on pre-treatment political and conflict characteristics.

Our results show that US sanctions have a significant adverse effect on food security. Specifically, sanctions reduce overall food security in target countries in a persistent and economically meaningful manner. Another key finding is that the impacts are highly uneven across dimensions of food security. Sanctions primarily reduce food access and food stability, while effects on food availability and utilization are limited. We further document substantial heterogeneity. The adverse effects are (i) larger for multilateral sanctions than unilateral sanctions; (ii) more pronounced for sanctions targeting a single country rather than multiple countries; (iii) primarily driven by economic sanctions (i.e., trade and financial restrictions); and (iv) stronger for more severe sanctions. In addition, the effects are particularly concentrated in low- and lower-middle-income countries, especially in Latin America and Sub-Saharan Africa. Mechanism analysis shows that sanctions reduce food imports and domestic food production, while also lowering income, increasing inflation and unemployment, and weakening political stability.

Food security is a fundamental dimension of human welfare, and our findings highlight that sanctions impose significant unintended humanitarian costs. These costs are unevenly distributed across countries and across dimensions of food systems, underscoring the importance of considering food security consequences when designing and evaluating sanction policies.

Table 7. Mechanisms: Macroeconomic and Institutional Effects

	GDP per capita		Inflation rate		Unemployment rate		Political stability	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic sanction	-0.0336*** (0.00917)	-0.0328*** (0.00892)	166.7*** (59.13)	164.2*** (56.29)	0.227*** (0.0774)	0.225*** (0.0774)	0.00111 (0.00421)	0.00126 (0.00426)
Non-economic sanction	-0.00504 (0.00575)	-0.00395 (0.00583)	0.201 (28.65)	-5.624 (28.70)	-0.0809 (0.0914)	-0.0774 (0.0894)	-0.00996** (0.00387)	-0.00949** (0.00386)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Observations	4,569	4,569	4,558	4,558	4,468	4,468	4,660	4,660
R-squared	0.997	0.997	0.127	0.129	0.977	0.977	0.956	0.957

Notes: The dependent variable from columns (1)-(2) is GDP per capita (logged), the dependent variable from columns (3)-(4) is inflation rate by GDP, the dependent variable from columns (5)-(6) is unemployment rate, the dependent variable from columns (7)-(8) is political stability and absence of violence/terrorism. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

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Appendix

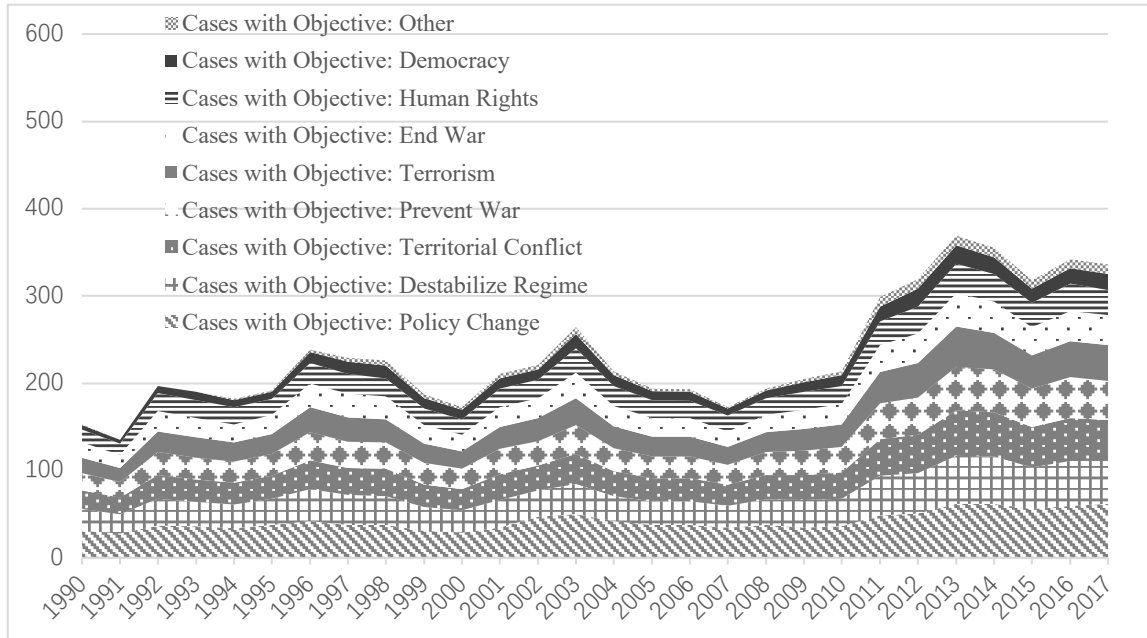


Figure A1. US sanctions by objectives, 1990-2017

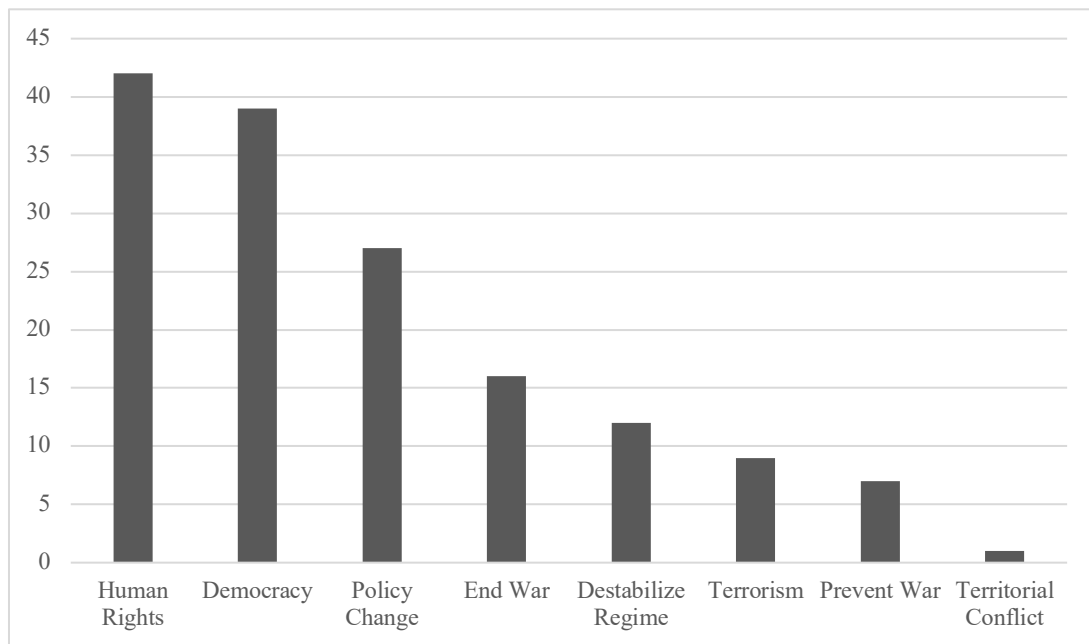


Figure A2. Frequency of US sanctions by objectives, 1990-2017

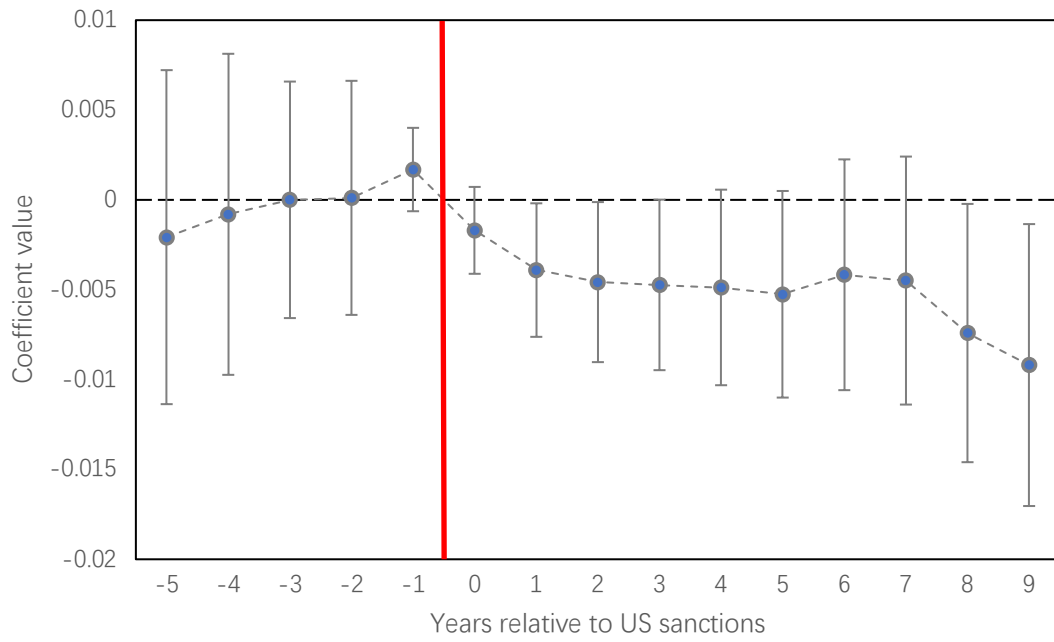


Figure A3. Staggered DID Event-Study Estimates: Sanctions and Food Security

Table A1. Proteus Food security indicator system

Pillar	Sub-pillar	Indicator	Theoretical relation
Availability		Adequacy of average dietary energy supply	+
		Average protein supply	+
Access	Economic	Food inflation rate	-
		GDP per capita, constant 2011 US\$	+
		Remittance inflows per capita, constant 2011 US\$	+
		Incidence of malnutrition	-
	Physical	Paved roads over total roads (%)	+
		Road density (per 100 square km of land area)	+
Utilization		Rail-lines density (per 100 square km of land area)	+
		People using at least basic sanitation services (% of population)	+
		People using at least basic drinking water services (% of population)	+
Stability	Economic	Cereal stock-to use ratio	+
		Current account balance, share of GDP	+
		Real effective exchange rate	-
		Food imports as a percentage of total merchandise exports	-
	Socio-political	Political stability and absence of violence/terrorism	+
		Violent deaths, share of total population	-
		People of concern originated (IDPs and refugees), share of total population	-
		People of concern hosted (IDPs and refugees), share of total population	-
	Natural hazards	People affected by disasters, share of total population	-
		Damage from disasters in US\$, share of GDP	-

Source: World Food Program, Caccavale and Giuffrida (2020).

Table A2. List of sanctioned states

Number	Country	Freq.	Percent	Number	Country	Freq.	Percent
1	Afghanistan	22	0.95	34	Congo, Dem. Rep	24	1.04
2	Albania	22	0.95	35	Congo, Rep	7	0.30
3	Algeria	28	1.21	36	Costa Rica	17	0.73
4	Angola	14	0.60	37	Cote d'Ivoire	18	0.78
5	Argentina	7	0.30	38	Croatia	15	0.65
6	Armenia	26	1.12	39	Cuba	28	1.21
7	Australia	7	0.30	40	Cyprus	28	1.21
8	Austria	8	0.35	41	Czech Republic	7	0.30
9	Azerbaijan	26	1.12	42	Denmark	7	0.30
10	Bahrain	28	1.21	43	Djibouti	28	1.21
11	Bangladesh	7	0.30	44	Dominica	2	0.09
12	Barbados	7	0.30	45	Dominican Republic	14	0.60
13	Belarus	21	0.91	46	Ecuador	13	0.56
14	Belgium	7	0.30	47	Egypt, Arab Rep	28	1.21
15	Belize	19	0.82	48	El Salvador	4	0.17
16	Benin	7	0.30	49	Equatorial Guinea	6	0.26
17	Bolivia	14	0.60	50	Eritrea	17	0.73
18	Bosnia and Herzegovina	26	1.12	51	Estonia	10	0.43
19	Botswana	7	0.30	52	Ethiopia	5	0.22
20	Brazil	8	0.35	53	Fiji	18	0.78
21	Bulgaria	22	0.95	54	Finland	7	0.30
22	Burkina Faso	7	0.30	55	France	22	0.95
23	Burundi	15	0.65	56	Gabon	7	0.30
24	Cabo Verde	7	0.30	57	Gambia	17	0.73
25	Cambodia	20	0.86	58	Georgia	10	0.43
26	Cameroon	7	0.30	59	Germany	7	0.30
27	Canada	7	0.30	60	Ghana	7	0.30
28	Central African Republic	16	0.69	61	Greece	12	0.52
29	Chad	8	0.35	62	Guatemala	23	0.99
30	Chile	9	0.39	63	Guinea	11	0.47
31	China	28	1.21	64	Guinea-Bissau	8	0.35
32	Colombia	23	0.99	65	Guyana	7	0.30
33	Comoros	25	1.08	66	Haiti	28	1.21

Number	Country	Freq.	Percent	Number	Country	Freq.	Percent
67	Honduras	10	0.43	100	Moldova	10	0.43
68	Hungary	12	0.52	101	Mongolia	12	0.52
69	Iceland	7	0.30	102	Montenegro	26	1.12
70	India	19	0.82	103	Morocco	28	1.21
71	Indonesia	25	1.08	104	Myanmar	27	1.17
72	Iran, Islamic Rep	28	1.21	105	Namibia	7	0.30
73	Iraq	28	1.21	106	Nepal	1	0.04
74	Ireland	17	0.73	107	Netherlands	7	0.30
75	Italy	7	0.30	108	New Zealand	7	0.30
76	Jamaica	7	0.30	109	Nicaragua	5	0.22
77	Jordan	28	1.21	110	Niger	15	0.65
78	Kazakhstan	3	0.13	111	Nigeria	23	0.99
79	Kenya	15	0.65	112	Norway	7	0.30
80	Korea, Dem. People's Rep	28	1.21	113	Oman	28	1.21
81	Korea, Rep	7	0.30	114	Pakistan	14	0.60
82	Kuwait	28	1.21	115	Panama	14	0.60
83	Kyrgyz Republic	3	0.13	116	Paraguay	7	0.30
84	Lao Pdr	6	0.26	117	Peru	14	0.60
85	Latvia	10	0.43	118	Philippines	16	0.69
86	Lebanon	28	1.21	119	Poland	12	0.52
87	Lesotho	7	0.30	120	Portugal	7	0.30
88	Liberia	25	1.08	121	Qatar	28	1.21
89	Libya	28	1.21	122	Romania	14	0.60
90	Lithuania	10	0.43	123	Russian Federation	7	0.30
91	Luxembourg	7	0.30	124	Rwanda	17	0.73
92	Macedonia, Fyr	26	1.12	125	Samoa	7	0.30
93	Madagascar	13	0.56	126	Saudi Arabia	28	1.21
94	Malawi	10	0.43	127	Senegal	7	0.30
95	Mali	10	0.43	128	Serbia	26	1.12
96	Malta	7	0.30	129	Seychelles	7	0.30
97	Mauritania	28	1.21	130	Sierra Leone	15	0.65
98	Mauritius	7	0.30	131	Slovak Republic	7	0.30
99	Mexico	7	0.30	132	Slovenia	13	0.56

Number	Country	Freq.	Percent	Number	Country	Freq.	Percent
133	Somalia	28	1.21				
134	South Africa	16	0.69				
135	South Sudan	4	0.17				
136	Spain	7	0.30				
137	Sudan	28	1.21				
138	Sweden	7	0.30				
139	Switzerland	7	0.30				
140	Syrian Arab Republic	28	1.21				
141	Tajikistan	10	0.43				
142	Tanzania	8	0.35				
143	Thailand	9	0.39				
144	Togo	10	0.43				
145	Trinidad and Tobago	7	0.30				
146	Tunisia	28	1.21				
147	Turkmenistan	3	0.13				
148	Uganda	7	0.30				
149	Ukraine	7	0.30				
150	United Arab Emirates	28	1.21				
151	United Kingdom	7	0.30				
152	Uruguay	7	0.30				
153	Uzbekistan	13	0.56				
154	Venezuela, Rb	16	0.69				
155	Vietnam	19	0.82				
156	West Bank and Gaza	28	1.21				
157	Yemen, Rep	28	1.21				
158	Zambia	10	0.43				
159	Zimbabwe	15	0.65				

Table A3. The determinants of US sanctions

	(1)	(2)
	US sanction (0/1)	US sanction (frequency)
Electoral democracy _{t-1}	-0.225*** (0.0693)	-1.548*** (0.180)
Physical violence _{t-1}	-0.102*** (0.0330)	0.0385 (0.0858)
Major conflict _{t-1}	0.179*** (0.0326)	0.741*** (0.0849)
Minor conflict _{t-1}	0.0834*** (0.0219)	0.240*** (0.0570)
Country FE	YES	YES
Year FE	YES	YES
Observations	4,660	4,660
R-squared	0.579	0.621

Notes: Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table A4. Robustness test: panel estimates for binary US sanction indicator.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Proteus	Proteus	Availability	Availability	Access	Access	Utilization	Utilization	Stability	Stability
Sanction	-0.00609** (0.00235)	-0.00452** (0.00220)	0.00612 (0.00536)	0.00544 (0.00542)	-0.00656** (0.00321)	-0.00472 (0.00315)	-0.00958 (0.00594)	-0.00755 (0.00602)	-0.0109*** (0.00330)	-0.00924*** (0.00311)
Electoral democracy _{t-1}		-0.0149 (0.0182)		-0.00326 (0.0440)		-0.00371 (0.0197)		0.0137 (0.0340)		-0.0254 (0.0296)
Physical violence _{t-1}		0.0115* (0.00694)		-0.0203 (0.0183)		0.0166** (0.00826)		0.0396*** (0.0138)		0.0124 (0.0114)
Major conflict _{t-1}		-0.0279*** (0.00584)		-0.0142 (0.00973)		-0.00900 (0.0116)		0.00278 (0.00810)		-0.0507*** (0.0106)
Minor conflict _{t-1}		-0.00785** (0.00304)		-0.00812 (0.00699)		-0.00290 (0.00393)		0.00268 (0.00521)		-0.0175*** (0.00536)
Constant	0.282*** (0.00293)	0.303*** (0.00662)	0.0535*** (0.00673)	0.0713*** (0.0137)	0.288*** (0.00371)	0.288*** (0.0122)	0.121*** (0.00591)	0.102*** (0.0117)	0.601*** (0.00435)	0.646*** (0.0112)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	5,180	4,660	5,180	4,660	5,180	4,660	5,180	4,660	5,180	4,660
R-squared	0.975	0.977	0.936	0.942	0.966	0.967	0.975	0.976	0.714	0.742

Notes: Standard errors clustered at the country level are in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table A5. Robustness: Panel estimates for different categories of sanctions.

	(1)	(2)	(3)	(4)	(5)
	Proteus	Proteus	Proteus	Proteus	Proteus
Unilateral	-0.00244 (0.00229)				
Multilateral	-0.0113** (0.00453)				
Target unilateral		-0.00769** (0.00368)			
Target multilateral		-0.00134 (0.00277)			
Non-economic			-0.00133 (0.00299)		
Economic			-0.00887* (0.00483)		
Mild and moderate				-0.00231 (0.00241)	
Severe				-0.0166** (0.00664)	
high income level					0.00311 (0.00253)
low income level					-0.0104** (0.00474)
lower-middle income level					-0.0131*** (0.00408)
Upper-middle income level					0.00126 (0.00327)
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
Observations	4,660	4,660	4,660	4,660	4,660
R-squared	0.978	0.978	0.978	0.978	0.978

Notes: The dependent variable is Proteus food security index. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table A6. Robustness: Panel estimates for effect of sanction by regions.

	(1)	(2)	(3)	(4)	(5)	(6)
	Proteus	Proteus	Proteus	Proteus	Proteus	Proteus
Region	EAS	ECS	LCN	MEA	SAS	SSF
Sanction	-0.0115 (0.00876)	-0.00112 (0.00306)	-0.00942* (0.00480)	-0.00669 (0.00427)	0.0122 (0.00886)	-0.00733* (0.00379)
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
Observations	594	1,279	675	567	216	1,275
R-squared	0.960	0.958	0.949	0.967	0.968	0.938

Notes: The dependent variable is Proteus food security index. Controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table A7. Robustness checks of entropy balancing

	2 nd moment	3 rd moment	Normalization constant = 2	Alternative political controls
	(1)	(2)	(3)	(4)
Sanction	-0.00517** (0.00237)	-0.00527** (0.00238)	-0.00566** (0.00233)	-0.00475** (0.00221)
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Baseline controls	YES	YES	YES	NO
Alternative controls	NO	NO	NO	YES
Observations	4,660	4,660	4,660	4,458
R-squared	0.978	0.978	0.979	0.978

Notes: The dependent variable is Proteus food security index. Baseline controls include the first lag of electoral democracy index, physical violence indicator, major conflicts, and minor conflicts. Alternative controls include the first lag of property rights index, political terror scale indicator, major conflicts, and minor conflicts. Standard errors clustered at the country level are presented in parentheses. *** denotes statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table A8. Results of the Oster tests

Dependent variable	Parameter assumptions	Testing criteria
Proteus food security index	1.3 R ² ; $\delta = 1$	$\beta^*(R_{\max}, \delta) \in [-0.00707, -0.00563]$
Proteus food security index	Estimated β_1 from equation (1) = 0	$\delta = -4.32310$

Notes: All control variables are included. β^* represents the bias-adjusted coefficient assuming $\delta=1$, δ is the degree of selection on unobserved variables relative to that on observed variables.