Iranian Economic Review, 2025, 29(2), 432-449
DOI: 10.22059/ier.2025.357906.1007692

RESEARCH PAPER

The Environmental Costs of Sanctions: Global Evidence

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Article History: Received 29 April 2023, Revised 12 July 2023, Accepted 14 August 2023, Published 31 July 2025

Publisher: University of Tehran Press.

Abstract

Depending on the amount and scope of the sanctions, the application of international sanctions to various countries can have a variety of environmental effects. Sanctions exert pressure on the environment for a variety of reasons, including making it difficult to access technology, destabilizing investment conditions in the field of enhancing productivity and advancing technology, and limiting the government's ability to protect the environment. In this article, we investigate the impact of sanctions on the environment of sanctioned countries. We use the ecological footprint index as a comprehensive index to measure the amount of pressure on the environment and its destruction, and we seek an answer to the question of whether unilateral, multilateral, American, European, United Nations, economic, and non-economic international sanctions increase the intensity of the ecological footprint. In order to assess the research's hypothesis, data from twenty countries subject to sanctions between 1992 and 2018 are utilized. The findings of this study indicate that various intensities of international sanctions have a direct correlation with the ecological footprint index.

Keywords: Dynamic Panel Data, Ecological Footprint, Environment, Sanctions.

JEL Classification: F51, Q01, Q5.

1. Introduction

Globalization is swiftly becoming a condition characterized by the interconnectedness of the economies of all nations. This globalization is based on "interdependence." The globalization of the international monetary and financial system, coupled with mutual dependence, entails dynamic and ever-changing economic, political, cultural, and social developments at the national, regional, and global levels. In such a scenario, all nations are affected by the actions of the others proportionally to their commercial, financial, and economic connections. The imposition of various sanctions against certain nations is one of the measures and policies that have a significant impact on different nations. International sanctions are typically punitive actions taken by a nation, a group of nations, or international organizations against nations that do not adhere to international commitments and

agreements (Doxey, 1996; Lacy and Niou, 2010). These sanctions are frequently imposed by countries with greater economic strength as a means of combating and weakening the political, economic, and military power of the target nation (Pape, 1997). As coercive diplomacy, sanctions are essentially a combination of diplomacy and intimidation. However, all sanctions have punishment as a primary objective. The rationale and logic behind applying economic sanctions can be summed up in three instances: 1) the desire to influence the policies of a government or even alter its regime, 2) the punishment of a government for its policies, and 3) a symbolic display of protest against the target government's policies (Carter, 1987). Regarding the effect of applying economic sanctions on various aspects of the economies of the target countries and their effectiveness in achieving the desired goals, numerous studies have been conducted, including the following: Afesorgbor et al. (2016) examined the effects of economic sanctions on income inequality. Korotin et al. (2018) analyzed the crisis in Ukraine and economic sanctions and their effect on the exchange rate. Mirkina (2018) examined the short- and long-term effects of sanctions on foreign direct investment. Chen et al. (2019) showed the effect of international sanctions on energy efficiency. Early and Peksen (2020) investigated the shadow economy and the effectiveness of economic sanctions in order to explain why democratic nations are more susceptible to sanctions. Nguyen and Do (2021) studied the impact of economic sanctions on Russia's and its 49 trading partners' trade. Wang and Du (2022) investigate the welfare effects of economic sanctions against Russia using general equilibrium model. Gutmann et al. (2022) evaluate the various economic consequences of international sanctions. Pintor et al. (2023) examined the impact of economic sanctions on health and health systems in low-income and middle-income countries. Chen et al. (2023) investigated the effect of assessment of energy sanctions in geo-conflict in the war between Russia and Ukraine. Moteng et al. (2023) explained the mechanisms by which international sanctions affect energy poverty.

While the above-mentioned studies have examined the impact of sanctions on various factors, very few studies have studied the effects of sanctions on the environment. This is despite the fact that imposing economic sanctions and isolating a nation can have direct and indirect effects on that nation's environment as a platform for achieving development. Among the environmental effects of sanctions are restrictions on the import of environmentally friendly technologies, the violation of citizens' right to a healthy environment, the violation of international environmental obligations regarding financial, technical, and scientific aid to the sanctioned country, and the sanctioned nation's inability to improve its environmental quality standards. In fact, economic sanctions, by exerting pressure on national economies, cause environmental concerns to take a

back seat to other concerns (Carussi, 2000). The increase in types of pollution and the country's inability to optimally utilize international capacities have slowed the process of responding appropriately to environmental problems, resulting in a decline in the quality of life and health of the sanctioned nations' citizens.

Madani (2020) and Fu (2020) are the only two studies that focused on the effect of sanctions on the environment. Maddani (2020) designed a casual model for the environmental implications of sanctions. Fu (2020) examined the impact of sanctions on countries' environment using the environmental performance index (EPI). The purpose of this study is to explore the hypothesis that environmental destruction is a result of international sanctions. The main contribution of the present study is to provide an empirical quantitative analysis by using the ecological footprint index as a comprehensive index of environmental issues and ecological efficiency (the ability to regenerate the land and respond to the needs of organisms while preserving resources) and using dynamic panel data regression to investigate the role of the sanctions on the environment. We will also see if this effect varies depending on the seriousness and kind of sanctions. We use information from 20 countries that were subject to sanctions between 1992 and 2018 for this purpose. The ecological footprint index is used to determine how much the environment has been damaged. The ecological footprint index highlights the difficulties that humans face in coexisting with nature and the continuity of life with it. It also demonstrates the impact that each society's way of life has on the environment (Wilson and Anielski, 2005).

The remainder of this paper is organized as follows. Section 2 provides the literature on the subject matter (theoretical foundations and empirical background). Section 3 describes the data and the variables. Section 4 presents the empirical results, and Section 5 closes the paper with concluding remarks.

2. Theoretical Foundations

In order to change a country's policies, a country or group of countries may use sanctions, which are actually coercive measures (Carter, 1992). According to Hufbauer et al. (2012), sanctioning nations frequently have multiple objectives, and sanctions can serve as a warning shot for potential future transgressions by the target nation and other nations. Sanctions affect many economic sectors, including trade, investment, employment, and economic growth, whether or not the ultimate goal is accomplished. The negative consequences of sanctions throughout history for various aspects of the target nation, particularly its economy and way of life are undeniable; the most notable examples are the embargoes on Iraq and Cuba. International sanctions may have an impact on politics in the areas of corruption, democracy, and human rights. According to Peksen's 2009 research, economic sanctions, particularly multilateral sanctions, erode the respect for human rights even more. Additionally, government corruption is correlated with democracy, the

history of the legal system, and the proportion of protesters in the population, and the severity of corruption in sanctioned countries is more intense than in non-sanctioned countries. Sanctions also can harm the labor market by restricting international trade, reducing global energy supply through supply chain effects, reducing investment in the sanctioned country, and limiting the structure and preferences of consumption and production. (Chen et al., 2023).

2.1 Sanctions and the Environment

Changes in trade, production, and other factors connected to these sectors, such as investment and employment, are the most significant ways that sanctions have an effect on a nation's economy. As a result, in a straightforward classification, the three major effects of economic sanctions—export, import, and capital inflow and outflow—can be separated.

It is anticipated that the foreign exchange resources from exports will be disrupted and the merchants will incur significant costs as a result of the imposition of economic sanctions against the financial and export channels of the countries. A low level of export diversification in the target nation, such as in oil-producing nations, makes an export embargo very risky because it increases oil output and hastens the depletion of oil reserves.

On the other hand, the high reliance of production on the import of diverse raw materials, intermediate products, and capital goods is one of the channels that are vulnerable to potential threats posed by sanctions imposed on a country's economy. Even if the sanctions procedures do not result in the cessation of imports, the increase in import costs will increase the cost of domestic production, which will increase domestic prices and reduce the competitiveness of manufactured commodities on international markets. Sanctioning imports can lead to a decrease in the quantity of imports on the one hand, and an increase in the price of imports per unit of that quantity on the other. Reducing imports will decrease the government's revenue from tariffs. Yet, the increase in costs, coupled with the rise in inflation by affecting the production sector, consumption, and government budget, has far greater effects on the domestic economy of the target country, especially when the amount of import cannot be reduced due to the existing structures. By severing or restricting a country's trade relations with the international community, the possibility of achieving a higher level of consumption than domestic production will be lost, and the sanctioned country will move toward importing capital goods, thereby increasing smuggling and currency and capital market instability.

The structure of exports and imports has a decisive effect on the level and condition of a country's environment, so that in developed nations, many safeguard themselves from the entry of any polluting activity. With this work, they alter the negative correlation between income and pollution. Obviously, sanctions on the

export and import obscure the connection between the environment and income because it distorts the connection between production and consumption—for instance, when the production structure of developed countries gradually incorporates clean technology, but their consumption structure remains environmentally destructive. In this way, international sanctions significantly increase energy poverty. Sanctions can increase the price of clean and modern energy through different channels and reduce purchasing power. Because of this, low-income people may not be able to afford modern energy prices, which hinders the reduction of energy poverty and could push most countries to use more conventional energy than clean energy (Moteng et al., 2023).

Moreover, by imposing export and import restrictions, economic sanctions impede the provision of food, safe drinking water, medicine and medical equipment, fuel, etc. in the target country, thereby violating the right to health one of the manifestations of which is the optimal use of environment (Petrescu, 2010; Madani, 2020). The imposition of UN sanctions on Iraq under the moniker “oil for food” is an illustration of the negative effects of sanctions on the right to a healthy environment, which jeopardized the Iraqi people’s lives by creating unfavorable food supply, medical care, water purification, and health services (Al-Sammarrai, 1995).

The inflow and outflow of capital is another path that is significantly impacted by sanctions. Studies indicate that foreign direct investment can affect environmental quality due to its impact on economic growth. Foreign direct investment in developing nations causes an increase in environmental degradation and pollution. This is performed in the form of foreign direct investment, and the result of this type of investment for a country with low environmental standards and low income is an increase in pollution (Amri, 2016; Copland and Taylor (1994).

Figure 1 depicts the influence channels of sanctions on the environment.

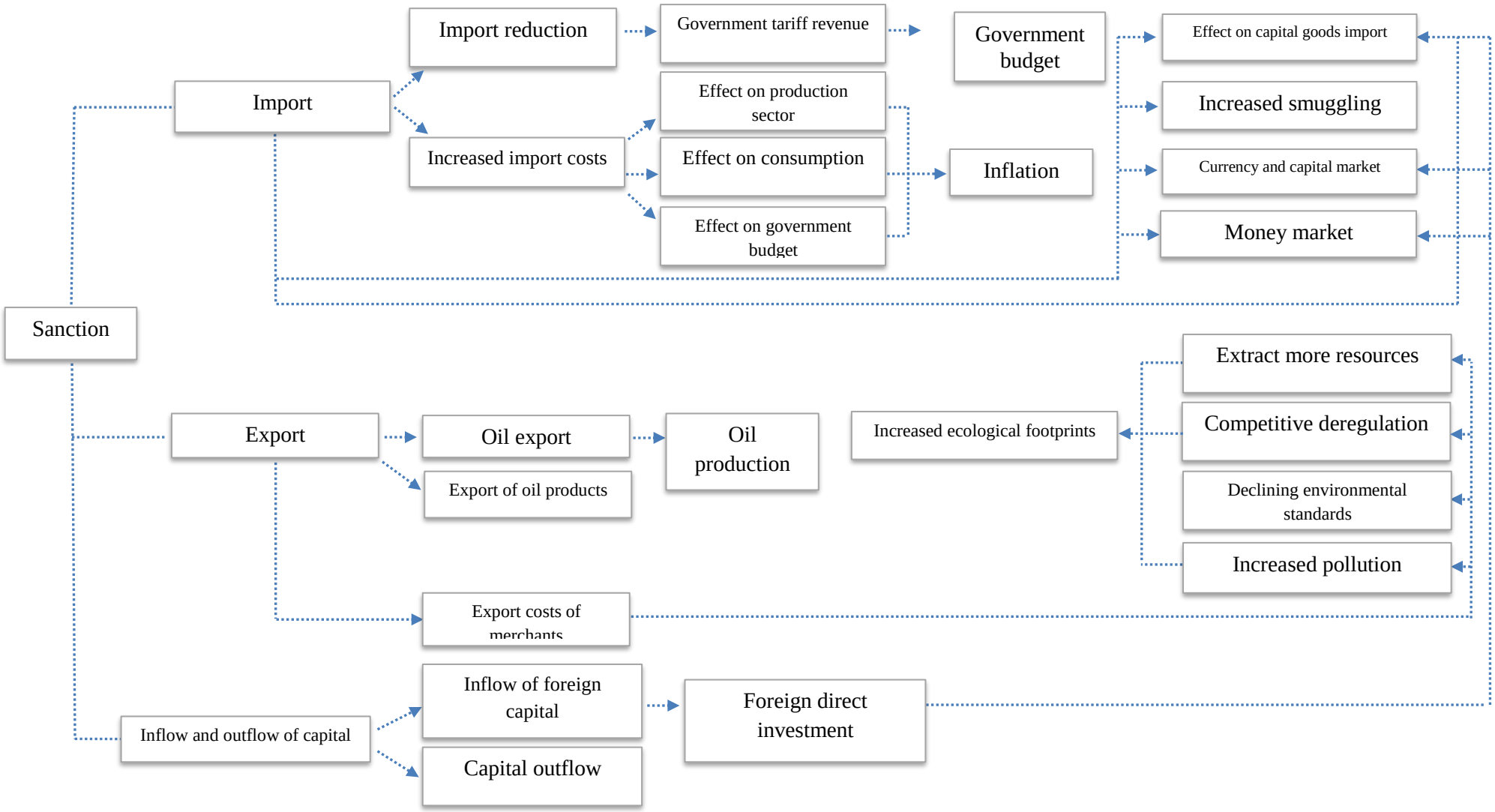

Figure 1. The Impact of Economic Sanctions on Environment
Source: Research finding.

3. Data and Variables

Based on the list of sanctioned countries in the Foreign Assets Control Office and the United Nations Security Council, this paper investigates the effect of sanctions on the ecological footprint of 18 sanctioned countries[1] by studying their data during the years 1992 to 2018. By overcoming the distortions of a small sample, the use of panel data as opposed to a time series approach can prevent a misleading relationship between variables (Granger and Newbold, 1974). In large observations also, taking into account heterogeneity and correlation, it is favored rather than cross-sectional techniques (Wooldridge, 2012). Due to the dynamic nature of the research model, the dependent variable interval is placed as an explanatory variable on the right side of the model. Consequently, based on the research of Yin et al. (2019), the research model is as follows:

$$EF_{it} = \alpha_i + \theta EF_{it-1} + \beta_i \, Sanction_{it} + {}_{\gamma} X_{i} + \varepsilon_{it} \quad (1)$$

where EF_{it} represents the ecological footprint index of sanctioned nations during period t. $Sanction_{it}$ is considered an international sanctions index (including unilateral, multilateral, American, European, United Nations, economic, non-economic and severity of sanctions). X_{it} represents additional variables that influence the ecological footprint (gross domestic product, consumption, trade liberalization, foreign direct investment, industry, technology, population, and urbanization). ε_{it} is random error terms.

Sanction data was obtained from the databases of the German Institute for Global and Area Studies[2], Deep Packet Inspection[3], and the International Energy Agency[4], and data related to the ecological footprint index was obtained from the Global Footprint Network website. The World Bank provided information on additional control variables.

The ecological footprint shows information about the pressure and impact of human activity on environmental resources and provides us with the possibility of comparing the demand for resources and the capacity of the earth to respond to this demand. Wackernagel and Rees's (1996) ecological footprint index (EFI) has been taken whose enhanced version is as follows:

$$EF = \frac{P}{Y_n} \quad (2)$$

1. Belarus, Cameroon, China, Colombia, Guatemala, Haiti, Indonesia, Iran Islamic Rep, Niger, Nigeria, Pakistan, Peru, Russian Federation, Sri Lanka, Thailand, Togo, Turkey, and Vietnam.
2. GIGA
3. DPI
4. IEA

In order to achieve acceptable results a fixed global unit called the global hectare (gha) is used to compare consumption structures, ecological footprint, and biological capacity. The global hectare is a standard unit for calculating the productivity and efficiency of diverse types of land. Therefore, the aforementioned relationship must be multiplied by the efficiency factor and the equilibrium factor of the land areas to compute the ecological footprint in global hectares[1] (Global Footprint Network Report, 2016).

$$EF = \frac{P}{Y_n}.YF.EQF \quad (3)$$

where P represents the amount of product obtained or waste (equal to the annual demand of a type of product). Y_n represents the national return average for P. YF is the yield factor (the ratio of the national average yield per hectare of land to the global average yield for that type of land) for the country and land area type. EQF is the equilibrium factor (representing the relative productivity between land and water types) for the country and the category of land area. According to the type of land use and year, the equilibrium factor is the demand for a specific type of land in the average units of biologically productive areas of the world, which is a constant value in a year for each country. According to the 2018 Global Footprint Network reports, the equilibrium and yield factors per global hectare are provided as an example in the table below.

Table 1. Equilibrium Factor and Efficiency of Different Land Areas

Land type	Equilibrium factor	Efficiency factor
Agriculture	2.52	0.14
Jungle	1.28	1.28
Pasture	0.43	6.19
High seas (seas and oceans)	0.35	-
Built-up land	2.52	7.13
Other water resources (lake, etc.)	0.35	8.13

Source: Global Footprint Network (2016).

Ecological footprint is compared with biological capacity (BC) (the amount of available land, both dry and wet, to provide the required resources and absorb people's waste, expressed in global hectares). It is calculated as follows:

$$BC = A.YF.EQF \quad (4)$$

In Equation 4, BC represents the biocapacity (global hectare) and A represents the areas available for a particular land use type in hectares.

In accordance with Portela & Soest (2012), Fu and et al. (2020), our classification of international sanctions includes unilateral, multilateral, United States, European

[1]. Global Footprint Network, Ecological Footprint Atlas (2016)

Union, and economic sanctions. Unilateral sanctions indicate that only the United States or the European Union apply international sanctions. Multilateral sanctions represent sanctions imposed by the United States and the European Union. We also adjust the economic sanctions variable to demonstrate the effect of sanctions on the economy of the target country.

Taylor and Copland (1994) and Kretschmer et al. (2011) utilized the variable of foreign investment (one of the variables conveying development) to analyze the degree of efficiency and environmental degradation. This study measures the impact of foreign direct investment as a control variable on the ecological footprint index. The ratio of net foreign direct investment to GDP is used for this purpose.

The use of the GDP index as a fundamental variable in calculating the rate of economic growth and measuring a country's level of development can have negative environmental effects. In pursuit of economic growth, various nations will make greater use of their environment; consequently, the pressure they exert on the environment will increase. Following Yang et al. (2010), Zhang et al. (2015), Yu and Liu (2016), who utilized the GDP index as a measure affecting the relationship between environmental degradation and efficiency, in this paper we employ GDP per capita (constant 2015 US dollars) in sanctioned nations. Population is a significant contributor to environmental pollution, particularly the rise in the emission of air pollutants like CO2 (Zhao et al., 2005). Continuous population growth are a worsening of ecological conditions and a worsening of environmental pollution. Consequently, we use the total population as a control variable that influences the ecological footprint. As a result of rising consumption and GDP, trade liberalization will increase exports and imports, which may increase the ecological footprint. Therefore, it will have a negative impact on the environment (Chang et al., 2015). As a trade liberalization variable, we use exports plus imports as a percentage of GDP in this study. Consumption is one of the fundamental factors in calculating the ecological footprint of societies, so it follows that people will need to consume more resources to provide consumer products, services, and infrastructure (in the form of companies). As a result, the quantity of ecological footprint will increase as consumer spending rises. In fact, final consumption expenditures are expenditures made on consumer products that generate benefits in the present. In this study, final consumption expenditures are expressed as a percentage of gross domestic product. Urbanization is a significant contributor to environmental pollution, particularly the increase in emissions of air pollutants such as carbon dioxide (CO2) (Poumanyvong and Kaneko, 2010; Zhao et al., 2006). The deterioration of ecological conditions and the worsening of environmental pollution are the results of the continuous growth of the urban population and the expansion of the urban scale. Therefore, we use the urbanization variable, which is measured by the ratio of urban population to total population, as a control variable. All the knowledge, processes, tools, products, methods, and

systems used in the production of goods or services constitute technology. Improving the quality of the environment in various countries requires a focus on environmentally friendly technologies. In the meantime, the imposition of sanctions can restrict the sanctioned country's access to these technologies, which contribute to the destruction of the environment. In fact, the quality of the sanctioned country's environment will deteriorate as a result of a variety of economic sanctions that reduce the level of sustainable development and damage environment, as well as the target country's decreased concern for the environment and its lack of access to green technologies and assistance from developed nations. Environmental impact of the industrialization structure is controversial. According to Wang et al. (2010), Yang et al. (2010), Yu and Liu (2016), an increase in industrialization leads to a decline in environmental performance and, thus, environmental degradation. While Meng and Dai (2016), Hu and Li (2012), noted that the proportion of industrial value added to GDP has a positive effect on environmental efficiency because it contributes to the growth of GDP. Hence, the industry may result in a larger ecological footprint. Therefore, we use the industry variable (the percentage of industrial value added to GDP) in this study.

According to Table 2, the average number of unilateral and multilateral sanctions is 0.18 and 0.16, respectively, indicating that there are slightly more unilateral sanctions than multilateral sanctions. The United States imposes more sanctions on average (0.30%) than the European Union (0.16%) and the United Nations (0.04%) which is in line with Neuenkirch and Neumeier (2015). The average economic and non-economic sanctions are 0.34 and 0.008 respectively, indicating that the majority of sanctions are economic. The average intensity of international sanctions is 1.18, indicating that the majority of sanctions are moderate. The standard deviation of GDP is 1.45, with a minimum of 9.83 and a maximum of 1.39, indicating that the level of economic development among the target countries varies significantly. Comparing the upper limit and lower limit of the variables of foreign direct investment, population and urbanization, consumption, trade liberalization, technology and industry leads to the conclusion that the target countries differ greatly in terms of the value of foreign direct investment, population and urbanization, the balance between consumption and production, the level of technology and industry, and trade liberalization.

Table 2. Descriptive Statistics

Variable	Mean	Median	Max	Min	Std.Dev	Skewness	Kurtosis	Jarque-Bera	Prob
Efi	-0.596864	-0.53446	0.669397	-3.63978	0.874264	-1.07135	4.511061	139.2087	0.0000
Consumption	285000000000	68300000000	7650000000000	871000000	805000000000	6.156203	45.42772	37245.08	0.0000
Fdii	2.17206	1.692558	18.81778	-5.0882	2.226709	1.762876	11.37892	1669.962	0.0000
Gdp	444000000000	82400000000	13900000000000	983000000	1450000000000	6.479433	48.46721	45169.66	0.0000
Industry	30.29682	28.88444	49.63725	14.59647	8.348895	0.371794	2.395571	17.56166	0.0000
Population	134000000	52705001	1400000000	3945902	290000000	3.604404	14.77572	3860.348	0.0000
Technology	25.94695	24.91915	50.52867	1.819031	11.92967	-0.12326	2.000126	20.28236	0.0000
Trade	56.44011	47.26435	157.9743	20.72252	28.7527	1.638287	4.94192	277.4461	0.0000
Urban	48.14395	45.9735	80.778	15.529	19.478898	0.060263	1.78752	30.06384	0.0000
Unilateral	0.18107	0.0000	1.0000	0.0000	0.385473	1.656452	3.743833	233.4545	0.0000
Plurilateral	0.168724	0.0000	1.0000	0.0000	0.374894	1.769124	4.1298	279.3618	0.0000
Us	0.304527	0.0000	1.0000	0.0000	0.460681	0.849502	1.721654	91.54587	0.0000
Eu	0.166667	0.0000	1.0000	0.0000	0.373062	1.788854	4.2	288.36	0.0000
Un	0.043321	0.0000	1.0000	0.0000	0.203539	4.493108	21.18802	8334.011	0.0000
Economic	0.341564	0.0000	1.0000	0.0000	0.474723	0.668177	1.446461	85.03638	0.0000
Intensity	1.183128	0.0000	5.0000	0.0000	1.766061	1.092248	2.650778	99.10308	0.0000
Non-Economic	0.00823	0.0000	1.0000	0.0000	0.090441	10.88615	119.5083	284476.4	0.0000

Source: Research finding.

Table 3. Panel Unit Root Test

Variable	ADF			PP			LLC			IPS		
	statistic	prob	Situation	statistic	prob	Situation	statistic	prob	situation	statistic	Prob	situation
Lefi	74.0675	0.0002	I (0)	101.715	0.0000	I (0)	-5.65897	0.0000	I (0)	-8.01931	0.0000	I (0)
Lconsumption	213.93	0.0000	I (1)	217.95	0.0000	I (1)	-14.6096	0.0000	I (1)	-13.2822	0.0000	I (1)
Lfdii	94.1707	0.0000	I (0)	82.5546	0.0000	I (0)	-4.68286	0.0000	I (0)	-5.47486	0.0000	I (0)
Lgdp	221.552	0.0000	I (1)	231.73	0.0000	I (1)	-14.2096	0.0000	I (1)	-13.3864	0.0000	I (1)
Lindustry	252.176	0.0000	I (1)	49.2156	0.0000	I (0)	-16.216	0.0000	I (1)	-1.66324	0.0000	I (0)
Lpopulation	215.695	0.0000	I (0)	158.481	0.0000	I (0)	-9.01759	0.0000	I (0)	-20.5358	0.0000	I (0)
Ltechnology	76.6419	0.0000	I (0)	126.374	0.0000	I (0)	-4.14094	0.0000	I (0)	-4.25122	0.0000	I (0)
Ltrade	75.9119	0.0000	I (0)	76.8159	0.0000	I (0)	-3.74063	0.0000	I (0)	-3.92009	0.0000	I (0)
Lurban	216.842	0.0000	I (0)	156.829	0.0000	I (0)	-67.805	0.0000	I (0)	-72.1023	0.0000	I (0)

Source: Research finding.

4. Empirical Results

4.1 Panel Unit Root Tests

To conduct a unit root test, we use the statistics of Fisher-ADF, Fisher-PP (Maddala and Wu, 1999), LLC and IPS (Levin et al., 2002; Im et al., 2003) for the research variables except for international sanctions that is virtually inserted into the model. According to the data in Table 3, the variables for ecological footprint, foreign direct investment, technology, trade liberalization, and urbanization are at stationary level, while the variables for GDP and consumption have been stationary by one time differentiation. The industry variable is stationary at level with the PP and IPS statistics, but it has a common unit root with the ADF and LLC statistics, so it will be stationary with one time differentiation.

4.2 Estimation Results

In this research, we employ the generalized method of moments developed by Arellano and Bond (1991) to estimate the dynamic panel model. Since the dependent variable in the dynamic panel model is dependent on the error term, we use the second lag of the dependent variable and the lags of other variables in the form of a recursive form as a tool for the dependent variable lag based on the generalized method of moments. Therefore, it is regarded as the most appropriate instrument variable in circumstances where: the error term lacks serial correlation, follows a moving average process of a specific order, and the future value of the dependent variable has no impact on the explanatory variables' present values. The reliability of the employed tools determines the consistency of dynamic panel estimators. This is assessed using the Sargan Test.

The model estimation findings are shown in Table 4. American, European, United Nations, unilateral, multilateral, economic, and non-economic sanctions all have positive, statistically significant coefficients. In this manner, the research's hypothesis regarding the influence of global sanctions and the severity of different types of sanctions on the ecological footprint index is confirmed. The results of this study are consistent with Fu et al. (2020) and Madani (2020) show that international sanction harms the environment of targeted countries.

Based on additional findings, the coefficients of GDP, population, trade liberalization, and foreign direct investment of consumption and industry all have positive and significant correlations with the ecological footprint index, which is to be anticipated. Additionally, there is a negative and significant correlation between the two variables of urbanization and technology.

Table 4. Model Estimation Results

variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
LCONSUMPTION	1.787581* (0.018771) [0.0000]	1.733542* (0.019485) [0.0000]	1.924756* (0.017565) [0.0000]	1.543822* (0.012392) [0.0000]	1.704724* (0.010654) [0.0000]	1.828014* (0.070573) [0.0000]	1.741778* (0.038258) [0.0000]	1.722258* (0.011032) [0.0000]
LFDII	0.150766* (0.000617) [0.0000]	0.159177* (0.000482) [0.0000]	0.151886* (0.000579) [0.0000]	0.145521* (0.000393) [0.0000]	0.148436* (0.000378) [0.0000]	0.157866* (0.001146) [0.0000]	0.157539* (0.001017) [0.0000]	0.135983* (0.000645) [0.0000]
LGDP	1.559252* (0.021281) [0.0000]	1.52626* (0.020987)]0.0000]	1.763939* (0.019270) [0.0000]	1.315159* (0.013434) [0.0000]	1.482891* (0.011697) [0.0000]	1.599084* (0.074988) [0.0000]	1.520137* (0.042996) [0.0000]	1.496855* (0.014260) [0.0000]
LINDUSTRY	0.735064* (0.006630) [0.0000]	0.869338* (0.006369) [0.0000]	0.923145* (0.006310) [0.0000]	0.81927* (0.005779) [0.0000]	0.681399* (0.007683) [0.0000]	0.87126* (0.016130) [0.0000]	0.942627* (0.007051) [0.0000]	0.263418* (0.006759) [0.0000]
LPOPULATION	1.539265* (0.034352) [0.0000]	1.872081* (0.029680) [0.0000]	2.023811* (0.016388) [0.0000]	1.916491* (0.036324) [0.0000]	1.46361* (0.038001) [0.0000]	1.864127* (0.055301) [0.0000]	1.988236* (0.050653) [0.0000]	0.938749* (0.031327) [0.0000]
LTECHNOLOGY	-0.18828* (0.004752) [0.0000]	-0.2509* (0.002836) [0.0000]	-0.13866* (0.005702) [0.0000]	-0.06434* (0.003624) [0.0000]	0.211926* (0.003697) [0.0000]	-0.06894* (0.007397) [0.0000]	-0.1106* (0.006821) [0.0000]	-0.43008* (0.009314) [0.0000]
LTRADE	.0152502* (0.006903) [0.0000]	0.368859* (0.003124) [0.0000]	0.387574* (0.003955) [0.0000]	0.224751* (0.003880) [0.0000]	-0.10105* (0.007612) [0.0000]	0.36379* (0.013134) [0.0000]	.0399532* (0.006062) [0.0000]	0.265293* (0.265293) [0.0000]
LURBAN	-1.80851* (0.052420) [0.0000]	-1.99628* (0.056570) [0.0000]	-1.60648* (0.038492) [0.0000]	-2.01021* (0.070355) [0.0000]	1.773119* (0.029690) [0.0000]	-1.78192* (0.048540) [0.0000]	-1.62476* (0.080834) [0.0000]	1.640408* (0.049952) [0.0000]
UNILATERAL	0.151158* (0.002032) [0.0000]							
PLURILATERAL		0.500657* (0.003466) [0.0000]						
US			0.487463* (0.002221) [0.0000]					
EU				0.5284* (0.004069) [0.0000]				
UN					0.195546* (0.012921) [0.0000]			
ECONOMIC						0.458287* (0.458287) [0.0000]		
INTENSITY							0.137096* (0.000744) [0.0000]	
NON-ECONOMIC								18.77682* (2.225057) [0.0000]
J-STATISTIC	216.3587	215.7184	213.8993	217.6692	208.2136	212.0049	217.9005	210.6978
PROB(J-STATISTIC)	0.648455	0.65989	0.708206	0.624713	0.782383	0.723481	0.620481	0.744554

Source: Research finding.

Note: Standard error is written in parenthesis, prob. value is written in brackets, and * shows 1% level of significance.

According to the Sargan test, PROB (J-STATISTIC) is 0.64 for unilateral sanctions, 0.65 for multilateral sanction, 0.7 for American, 0.62 for European, 0.78 for UN, 0.72 for economic, and 0.62 for noneconomic sanctions, and 0.74 for sanction severity that are higher than 0.05, indicating the significance of the total regression.

5. Conclusion

In the economic literature and according to the Pollution Haven Hypothesis, countries with capital (primarily developed countries) tend to transfer their capital in polluting industries to countries with a lower commitment to environmental protection. It is accomplished through direct foreign investment and trade liberalization. In the estimation of the model, foreign direct investment and the trade liberalization variable have a positive and significant effect on the ecological footprint in embargoed nations. Embargoed countries, due to factors such as lack of active presence in the economy and global competition, lack of security and political stability, legal and political obstacles, inefficiency of the banking and monetary system, and pervasive corruption, are compelled to seek foreign direct investment from unsuitable business partners. It turns out that there is a high risk that the efforts of the target countries to achieve economic development will result in environmental degradation. In addition, when countries deregulate competition to reduce the costs of environmental regulations, unrestricted trade may lead to a general decline in international environmental standards. As the majority of sanctioned countries are exporters of raw materials and importers of processed goods, which is the transfer of dirty (polluting) industries, less stringent environmental regulations in a country disrupts the relative cost of production among other trading partners in this instance. The pollution haven hypothesis suggests that environmental regulations may have dynamic effects on capital flows and encourage the relocation of polluting industries to nations with less stringent environmental regulations. In this approach, export-driven economic growth resulting from free trade agreements and foreign direct investment encourages the exploitation of natural resources at an unsustainable rate. Therefore, trade liberalization and foreign direct investment result in the growth of more polluting industries in embargoed nations and increase the pressure on resources, thereby increasing the ecological footprint. The majority of sanctioned nations are developing or underdeveloped nations with a large population, taking into account that the use of natural products and services to meet the requirements of life and ensure the continuation of life will have an effect on the planet. As a result, as the population of a region increases, the ecological footprint of that region will increase and fewer resources will be available; consequently, the population variable coefficient has a positive significant effect on the increase of the ecological footprint, as determined by the model estimation. Similarly, given that the activities and efforts of countries to increase their GDP take place in the context

of the environment; in order to achieve more economic development in a variety of ways under the conditions of sanctions, the aforementioned nations must use more resources. As a consequence, the impact on the environment will increase, as will the ecological footprint. Thus, there will be a positive relationship between the GDP index and the increase in the ecological footprint. Moreover, one of the fundamental factors in calculating the ecological footprint of societies is their consumption, so it can be concluded that governments and individuals need to increase their consumption in order to provide consumer products, infrastructure, and services. Hence, the ecological footprint will increase as consumption rises.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

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Cite this article: Zobeiri, H., & Younesi, P. (2025). The Environmental Costs of Sanctions: Global Evidence. *Iranian Economic Review, 29*(2), 432-449.