How International Economic Sanctions Harm the Environment

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Abstract As soft political tools, economic sanctions aim at isolating a sanctioned state and hurt its economy to force it to change course, policies, and actions. In response to sanctions and to evade their grip, a sanctioned state adopts a range of survivalist, aggressive, and unsustainable policies that reduce the economic pressure of sanctions at the expense of accelerated environmental degradation. While economic sanctions cannot be blamed as the cause of environmental problems in sanctioned states, their role in catalyzing environmental degradation is noteworthy. This paper takes the first step in setting the theoretical ground for exploring the environmental implications of sanctions by developing a generic causal model that explains how economic sanctions can impact the environment. It is shown that sanctions lower the priority of the environmental sector in the public policy agenda in a sanctioned state and increase the natural resource-intensity of its economy. It is argued that although the environmental damages of sanctions are mainly unintended by the sanctioning and sanctioned states, such damages are unavoidable in practice. The study calls for attention to the transgenerational and transboundary environmental impacts of economic sanctions and their justice and human rights implications for which the sanctioning and sanctioned states must be held accountable.

Plain Language Summary By targeting the economy of a sanctioned state, sanctions are used to force the sanctioned state’s policy makers to change their actions. But the impacts of economic sanctions on a country can go beyond its economic sector and cause significant collateral damages to ordinary citizens and their economic welfare. Economic sanctions are also associated with significant unintended environmental impacts that have major health, justice, and human rights implications. This study explains how the current economic sanctioning schemes turn the environmental sector into an inevitable victim of the battle between the sanctioning states, seeking behavioral change through economic pressure, and the sanctioned state, determined to pursue its so-called “abnormal” plans at the expense of causing damages to its natural resources.

1. Introduction

Economic sanctions are used as policy tools to “normalize” the behavior of a state that is believed to behave “abnormally” and threaten the interests of the sanctioning parties. By imposing pressure on the economy of the sanctioned state (sanctionee), the sanctioning parties (sanctioners) seek to force the sanctionee to change its actions that are deemed “abnormal” according to the sanctioners’ norms. Regardless of their effectiveness, economic sanctions are seen as a soft and more humane option in comparison to wars that are associated with destructive impacts. Yet the impacts of economic sanctions can go beyond the sanctionee’s economy. In practice, sanctions can cause significant collateral damages to ordinary citizens and their economic welfare (Dizaji, 2012; Farzanegan et al., 2015; Gordon, 2013; Marzban & Ostadzad, 2015; Neuenkirch & Neumeier, 2016). The scientific literature has repeatedly raised concerns about the striking impacts of economic sanctions on health, food, and human rights (Butler, 2013; Danaei et al., 2019; Habibzadeh, 2018; Kokabisaghi, 2018; Mohammadi, 2013; Moret, 2015; Palaniappa, 2013; Peksen, 2009; Shahabi et al., 2015; Takian et al., 2020). Sanctions are believed to also have impacts on the environment (Carucci, 2000; Fotourehchi, 2020; Jowkar et al., 2016; Lewis & Madani, 2016; Madani & Hakim, 2016; Portela, 2016; Soroosh & Madani, 2014; UNICEF, 2012). But the short-term and long-term environmental impacts of economic sanctions remain unverified. This is mainly due to the fact that little is known about the causal mechanisms...
through which economic sanctions can directly or indirectly harm the environment. Without discovering such mechanisms, decoupling the impacts of sanctions from the effects of other variables (e.g., mismanagement, corruption, natural variability, and climate change) is infeasible.

This paper intends to fill our knowledge gap regarding the environmental implications of sanctions by illustrating the causal mechanisms that govern the overall behavior and dynamics of the economy of a country under sanction in its pursuit of development. The main objective of the paper is to set a theoretical foundation for analyzing the impacts of sanctions on the environment. In particular, the study tries to answer the following questions:

a. How can international economic sanctions impact the environment?
b. Do economic sanctions cause, prevent, or accelerate environmental degradation?

To answer these questions, the study develops a simple, generic causal model that illustrates how economic sanctions can be associated with significant environmental consequences.

2. Caveats

Before exploring the problem, one must note these important caveats:

i. The problem to be studied here belongs to the class of complex, coupled human-environmental systems problems, involving multiple interacting subsystems, drivers, and variables. These systems are continuously evolving and associated with trade-offs (Madani & Shafiee-Jood, 2020). Identifying a single root cause or driver of the environmental degradation problem within a complex human-environmental system is impossible. On the same basis, disaggregating the impact of sanctions from other drivers of environmental degradation, i.e., determining the exact share of sanctions in the whole degradation process, is not feasible.

ii. When dealing with complex problems, one must be cautious about the difference between drivers and catalysts. For example, drought has been frequently introduced as the cause of the Syrian crisis. Even though drought has certainly played a role in catalyzing the Syrian crisis, introducing drought as the root cause of this crisis is reckless. In understanding the Syrian crisis and its root causes, one must not disregard the roles of political economy, foreign interventions, domestic politics, ideological conflicts, and the accumulation of problems in multiple sectors over decades as the result of bad governance, weak economy, unemployment, etc. in Syria (Madani & Shafiee-Jood, 2020). While sanctions might impact the environment, in analyzing the impacts of sanctions, one must not overlook the other major variables, coincidences, and circumstances that could play a role in environmental degradation, e.g., the planners' foresight level, quality of governance, power of institutions, and climate variability.

iii. Environmental degradation is a multiattribute problem. So one cannot judge the status of the sanctee's environment based on limited variables or indicators. For example, CO2 emissions have been frequently used as a control proxy variable for the level of environmental degradation in the economics literature (e.g., Fotourehchi (2020)). But this indicator does not provide a comprehensive picture of a country's environmental performance. For example, environmental damages such as groundwater depletion, biodiversity losses, soil erosion, and water pollution that can occur in a sanctioned state have no immediate impacts on a country's carbon emissions in the short run and cannot be captured when using CO2 as a proxy control variable. So in order to properly examine the impact of sanctions on the sanctee's environment, one must consider additional variables and the trade-offs among them. More importantly, to examine the long-term and short-term environmental changes under sanctions, rather than examining the behavior of a selective control variable, one must discover the causal mechanisms that govern the problem.

Keeping these points in mind, instead of focusing on statistical correlations and numbers, the paper focuses on uncovering the underlying mechanisms that can explain why and how international economic sanctions might impact the environment.

3. Underlying Causal Structures

In order to understand how sanctions can directly or indirectly impact the environmental sector, this section illustrates the macroscale mechanisms that relate economic development and environmental degradation
through a series of causal loop diagrams (CLDs). CLDs illustrate the causal relationships between the subsystems of a complex, dynamic system. They provide valuable information on the drivers, dominant causal loops and feedback effects that govern the overall behavior of the system. Here, CLDs are used to develop a generic causal model that explains how economic sanctions can impact the environment through a series a causal relationships and feedback effects. Table 1 illustrates some basic concepts that help readers better understand the CLDs developed in this section. Readers are referred to Sterman (2000), Mirchi et al. (2012), and Bahaddin et al. (2018) for more information on CLDs and their applications in environmental policy analysis and modeling.

a. Natural resource-dependent growth

In the early stages of development (e.g., in an agrarian society), economic growth is natural resource-dependent (Figure 1). The process of development normally starts with agriculture, i.e., producing and maintaining crops and farmlands. Agricultural growth involves using water and land, and increases natural resource stress through pollution and ecological damages. The extraction of natural resources increases income and leads to economic growth, enlarging the society’s capacity for further expansion of natural resource-dependent economy (top reinforcing [R] loop in Figure 1). As the economy grows and natural resource extraction/stress increases, more jobs are created and more people get employed in natural resource-dependent sectors (e.g., farming, animal husbandry, hunting, fishing, and mining). Increased employment rate (reduced unemployment) further increases economic growth and natural resource extraction/stress (bottom reinforcing loop in Figure 1) leading to environmental degradation (or the deterioration of the environment in different forms, including ecosystem destruction and depletion of natural resources like water, air, and soil). Together, the two reinforcing loops form the engine of natural resource-dependent growth that makes economic growth and unemployment reduction possible at the expense of environmental degradation (the scale effect, i.e., when the composition of the economy and the techniques used for economic production remain unchanged, growth in the scale of the economy leads to a proportional increase in environmental degradation).

b. Industrialization

Once an economy grows, its capacity for economic diversification increases (Figure 2). Economic diversification leads to the growth of non-natural resource-dependent sectors (e.g., service, education, healthcare, and

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**Table 1**

| Term                  | Description                                                                                                                                                                                                 |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Positive relationship | A positive causal relationship between two variables suggests that a change in the state of the cause variable in a certain direction (increase/decrease) results in a change in the state of the effect variable in the same direction (increase/decrease). |
| Negative relationship | A negative causal relationship between two variables suggests that a change in the state of the cause variable in a certain direction (increase/decrease) results in a change in the state of the effect variable in the opposite direction (decrease/increase). |
| Reinforcing loop (R)  | A reinforcing loop reflects a causal cycle in which when the state of one variable in the loop changes (increase/decrease), the effect through the reinforcing cycle returns a change in the state of the same variable in the same direction, reinforcing the initial deviation by causing a change in the same direction (increase/decrease). A feedback loop becomes reinforcing when the number of its negative causal links is even. |
| Balancing loop (B)    | A balancing loop reflects a causal cycle in which when the state of one variable in the loop changes (increase/decrease), the effect through the b cycle returns a change in the state of the same variable in the opposite direction, balancing the initial deviation by causing a change in the opposite direction (decrease/increase). A feedback loop becomes balancing when the number of its negative causal links is odd. |
| Delay (/)             | A delayed effect (shown by doubles bars in CLDs) suggests that the change in the effect variable as the result of a change in the cause variable is not immediate and happens with some time delay. |

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**Figure 1.** Natural resource-dependent growth causal loop diagram (CLD). Extracting natural resources facilitates economic growth, increasing the capacity to extract more natural resources and create more jobs. Economic growth and natural resource-dependent job opportunities continuously increase at the expense of rising pressure on natural resources and environmental degradation. + / − reflects a positive/negative impact, and R stands for reinforcing loop.
research) and their income (a non-natural resource sector is defined here as a sector which does not use natural resources as its main engine of growth. Non-natural resource sectors still benefit from natural resources and have some degree of ecological footprint). This leads to further increase in economic growth (top-right reinforcing loop in Figure 2). Also, the expansion of non-natural resource-dependent sectors creates more job opportunities in these sectors, leading to more economic growth (bottom-right reinforcing loop in Figure 2). In the meantime, the natural resource-dependent growth continues (left reinforcing loops in Figure 2). Non-natural and natural resource-dependent growths amplify each other and economic growth continues while natural resource extraction and stress rise. The expansion of oil and natural gas drilling, manufacturing, industrial and service sectors can gradually transform a preindustrial natural resource-dependent (e.g., agrarian) economy into an industrial economy, leading to higher levels of economic growth and environmental degradation.

c. Technology, imports, and environmentalism

As the economic growth and economic diversification continue, societies make innovations and production efficiency improvements (Figure 3), changing the techniques and technologies they use for economic production. With improved good and service production techniques and the resulting efficiency gains, producing the same level of output requires lower amount of natural resources, reducing natural resource extraction and stress per unit of produced income (the technique or technology effect, resulting from the balancing [B] loop, depicted in Figure 3).

While the increased production efficiency reduces the pressure on resources per unit of produced good, production efficiency improvement on its own cannot necessarily reduce the overall consumption of natural resources. In practice, increased production efficiency and economic growth can be associated with an increase in total resource consumption (Jevons' paradox or rebound effect) (Jevons, 1986; Polimeni & Polimeni, 2006). This effect can be balanced by taking advantage of replacing domestic goods with imported goods and changing the composition of the economy in favor of the environment (making it less natural resource-dependent).
Economic growth increases the capacity for importing goods and technology (Figure 4). Importing goods reduces the need for domestic production, thereby reducing pressure on natural resources (Imports are also associated with pollution and emissions. Nevertheless, the net ecological footprint of imports at the national scale is positive, assuming that imports reduce the need for the domestic production of substitutable goods). Importing technology can also reduce pressure on natural resources and environmental degradation by increasing access to improved technologies that are less harmful to the environment. These combined impacts (balancing loops shown in Figure 4) constitute the import effect, an amplifier of the technique effect (described above) and composition effect (discussed next).

The realization of the resulting environmental damages of natural resource-dependent growth together with increased awareness and better quality of life promote environmentalism. A society with a better socioeconomic condition is less concerned about satisfying its basic needs (food, water, shelter, employment, etc.) and has better knowledge of the value of environment and the scale of long-term consequences of environmentally reckless development plans. Thus, it has more concerns about the environment, has interest in developing new environmental regulations, and has the ability to enforce them without disrupting its economic growth, as a stronger economy has more power to decouple itself from natural resources through diversification. A stronger economy also has more budget to allocate to environmental protection, restoration, and innovation. Additionally, a more prosperous society sees higher levels of involvement of the civil society, activists, and nonprofit organizations in fights against environmental degradation, and for protecting and reclaiming their environmental rights.

Figure 5 shows how economic growth and quality-of-life improvements (employment rate can be considered as one of the major quality-of-life indicators) activate two balancing loops that reduce natural resources extraction and stress by increasing environmental awareness and protection. Once these loops are activated, the reinforcing natural resource-dependent growth loops on the leftside decelerate. The acceleration continues in the right branch, leading to economic diversification and the increased contribution of non-natural resource-dependent sectors to the economy and employment. Environmentalism, economic diversification,
and imports change the composition of the economy and production, leading to a change to a rate of environmental damages per unit of income/job (composition effect).

The relative weights of the scale effect, technique effect, and environmental stress-reduction composition effects determine the relationship between the economic growth and environmental degradation. This rela-

Figure 4. Imports CLD. Economic growth increases the capacity to import goods and technologies, leading to reduced environmental degradation. \(+/−\) reflects a positive/negative impact, B stands for balancing loop, and double bars reflect lag time.

and imports change the composition of the economy and production, leading to a change to a rate of environmental damages per unit of income/job (composition effect).

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Figure 5. Environmentalism CLD. Economic growth and the improved quality of life are accompanied by environmentalism and efforts to reduce natural resource extraction and pressure. Once the environmentalism balancing loops are activated, the relative contribution of the natural resource-dependent growth loops (left branch, shown in Figure 4) to the economy and employment declines. \(+/−\) reflects a positive/negative impact, B stands for balancing loop, and double bars reflect lag time.
tionship would be something like the well-known environmental Kuznets curve (EKC) (Figure 6), which hypothesizes an inverted-U-shaped relationship between economic growth and environmental pollution (Dinda, 2004; Grossman & Krueger, 1991). The rate of environmental degradation increases with natural resource-dependent growth (scale effect). Industrialization accelerates environmental degradation and economic growth. Gradually, the technique effect and environmental stress-reducing composition effect appear, reducing the rate of environmental degradation per unit of income/job produced as the economy grows. Once these effects outweigh the scale effect, economic growth can continue while environmental degradation is reduced though further economic diversification, decreasing the share of natural resource-dependent sectors in the economy, and reducing the society's ecological footprint.

d. Recession viability

In practice, the economic growth-environmental degradation relationship is not as smooth as the curve shown in Figure 6. A range of endogenous (e.g., poor management of the economy, corruption, and population increase) and exogenous (e.g., global recession and inflation increase, changes in the oil price, global pandemics, and natural disasters) variables and factors can occasionally impact the economic growth and employment rate. A deteriorating economy loses its power to diversify itself, faces import and technology acquisition problems, and is challenged with increasing unemployment. In this situation, the reinforcing loops shown

Figure 6. The relationship between economic growth and environmental degradation resembling the environmental Kuznets curve (EKC) hypothesis. Once the technique (technology) and composition effects together outweigh the scale effect, economic growth will be associated with lower levels of environmental degradation.

Figure 7. Recession viability CLD. Societies increase natural resource extraction to address deficit in income/production and to fight increasing unemployment. +/− reflects a positive/negative impact, B/R stands for balancing/reinforcing loop, and double bars reflect lag time.
in Figure 2 can cause more economic degrowth and increase unemployment. To defeat recession and address income and production deficits, societies increase the pressure on natural resources (Figure 7). Creating more jobs is also possible by giving boost to natural resource-dependent growth in this condition to decrease the unemployment levels. For example, a country that is facing a recession can take advantage of mining and keeping its coal industry active as they create income and reduce unemployment. This strategy intensifies environmental degradation and has long-term downsides (e.g., increased deforestation during a recession) but helps with reducing the pressure on the economy in the short run.

e. Sanctions effect

Economic sanctions function similarly to economic recessions but are much more impactful and paralyzing. Sanctions lead to increased environmental degradation by dampening the technique and composition effects (Figure 8). Like economic recessions, sanctions cause major economic disruptions and reduce income in both natural resource-dependent and non-natural resource-dependent sectors, limit economic diversification, and increase the economy’s dependence on natural resources. But they also directly hinder trade, imports, and access to goods and technologies, having more pronounced effects than economic recessions.

Under sanctions and embargos, even when the capacity to export (e.g., oil) or the required funds for purchasing a product (e.g., gasoline) exists, the obstacles to transferring funds through official banking systems and trade sanctions limit income; reduce the capacity for the acquisition and import of goods, services, and technologies; and increase unemployment and the need for domestic production (e.g., need for wheat production in a sanctioned state with limited water availability like Iraq or Iran). By increasing the inefficiencies in trades, sanctions also lead to changes in the cost of goods and services, thereby reducing purchasing power and limiting economic growth in the sanctioned economy.

Reduced/negative economic growth and increased unemployment reduce environmentalism and the sanctionee’s capacity for environmental protection, leading to increased environmental degradation. The
Reduced environmental budgets due to shrinking national income and blocked international aid funds can further weaken the environmental protection capacity and environmentalism. Overall, sanctions constitute a major barrier to decoupling income from natural resources, accelerate environmental degradation, and make economic growth costlier to the environment (Figure 9).

4. Reduced Urgency Under Pressure

In addition to reducing the sanctionee's ability to decouple its economy from natural resources, economic sanctions have a major impact on environmental public policy in a sanctioned state. Generally, the relative societal and public policy urgency of environmental problems is significantly reduced under sanctions. Even in developed economies, the environment loses its priority in public policy during economic recessions. So it is not surprising to see a country under sanctions overlooking its environmental sector. Madani (2019) used the urgency-importance matrix (Figure 10) for explaining why water and environmental matters do not generally have a high priority in public policy. He argued that for a problem to have top priority in the agenda of decision makers, it must be both relatively important and urgent. The relative importance and urgency of different sectors vary between societies based on their socioeconomic status and the circumstances they experience. Yet, almost in all societies, the environment is relatively less important for the public and/or policy makers than issues like economic growth, employment, defense, food, energy, and national security. Additionally, while extreme events (e.g., droughts, floods, wildfire, dust storms, and extraordinary air pollution) can periodically raise the relative urgency of environmental issues, the environment is generally considered a nonurgent subject in comparison to many other topics for both societies and policy makers.
In developing economies and more so in sanctioned economies, environment cannot earn the attention it deserves. Issues that can cause immediate national security problems, such as unemployment, poverty, hunger, and shortage of essential goods (e.g., pharmaceuticals) and energy sources, are prioritized over environmental degradation. Defense is an example of a topic that has been treated as a top priority in sanctioned countries such as Iran, Iraq, North Korea, and Cuba. Access to weapons and missiles is considered vital in the perspectives of the leaders whose ideological principles and goals have caused the enforcement of sanctions in the first place. This explains why some heavily sanctioned countries have been successful in building missiles and launching military satellites but not in producing the technologies that can benefit their environment although the development of such technologies could be far less challenging and costly.

Generally, the sanctioners must not expect the sanctionee to easily give up on the actions that are considered “abnormal” by them. Instead, under pressure, the sanctionee can get more motivated to pursue its “abnormal” plans. An ambitious sanctionee is willing to aggressively use its resources and compromise long-term national benefits in favor of its “abnormal” goals. This is, of course, an unsustainable strategy and has long-term national costs, including major environmental damages, but it works in the short run for a sanctionee that is functioning in a survival mode. Sanctions and international political pressure can also increase the sanctionee’s “thirst for development” (Madani, 2014) and its desire to building engineering (hard) infrastructure that can be presented as symbols of development (e.g., dams, roads, and refineries). These infrastructures are generally associated with long-term environmental costs, although their development can periodically create jobs, boost the economy, and earn pride.

5. A Catalyst or Cause?

Although economic sanctions have impacts on the environment, they must not be used to justify environmental degradation in sanctioned states. As other countries in the global south that have not been under sanctions, sanctioned countries like Iran, Iraq, Cuba, North Korea, Sudan, and Venezuela would have had environmental problems even in the absence of sanctions. In these countries, economic sanctions have accelerated environmental degradation. But they were not the main driver of environmental degradation and the short-sighted development policies in these countries. Thus, sanctions must not be presented as an excuse for all environmental problems and apologetic interpretations of the bad environmental governance in sanctioned states.

The environmental impacts of sanctions are mainly unintended but inevitable under the economic sanction schemes that have been in use over the last decades. It is fair to conclude that neither the sanctioners nor the sanctionee have intentions to cause lasting environmental damages that have major health, human rights, and justice implications. Sanctions have not been designed to cause environmental damages, and the response strategies to sanctions have not been developed with the objective of hurting the environment. Nonetheless, the current economic sanction schemes cause considerable damages to the environment for which both the sanctioners and sanctionees are liable and must be held accountable. Countries have major human rights obligations that relate to “the enjoyment of a safe, clean, healthy, and sustainable environment” (Human Rights Council, 2012, 2018). The current economic sanctioning practices cause inevitable violations of human rights relating to the environment by both the sanctioning and sanctioned states.

The environmental impacts of sanctions do not always appear immediately, and once they appear, they cannot be removed promptly. Sometimes these impacts might be even irreversible, making them transgenerational. So one must not expect to see the environmental impacts of sanctions to be removed immediately after lifting sanctions. Environmental problems are also transboundary, and their impacts cross political and geographical borders. The environmental problems of a sanctioned state (e.g., biodiversity loss, dust storms, and delayed climate action) can have implications for its neighbors and the whole globe.

6. Concluding Remarks

This study set the theoretical foundation for analyzing the role of economic sanctions on environmental degradation. While sanctions cannot be blamed as the cause of environmental problems, their impact on the environment as an environmental degradation catalyst is undeniable. By impacting the sanctioned state's economy and trades, sanctions can effectively limit the sanctionee's access to technology and goods, with major implications for the sanctionee's environmental sector. But economic sanctions have some impacts.
on the sanctionee’s economic development path that are more significant and last longer. Essentially, sanctions limit the sanctionee’s economic growth and its ability to decouple its economy from natural resources, thereby growing the role of natural resources in the sanctionee’s political economy. This makes economic production much costlier to the environment, a sector that is not considered as a priority in the policy agenda of the sanctionee’s leaders who are focused on managing the country in the survival mode.

The paper argued that the current practices in economic sanctioning and the common response strategies to cope with economic sanctions make the environment an unintended but unescapable victim, for which both the sanctioner and sanctionee must be held accountable. This is of particular importance given the major violations of human rights that can be caused by the enforcement of sanctions and the sanctionee’s efforts to avoid their grips. Environmental problems take a long time to address and some environmental damages are irreversible within a reasonable time frame. Thus, the environmental implications of sanctions will not be reversed immediately once the sanctions are lifted and their impacts can go beyond generations as well as geographical borders. The transgenerational and transboundary environmental impacts of sanctions are significant and need to be further explored from the “environmental justice” standpoint.

The existing humanitarian exemptions of the sanctions (mainly related to food and medicine) do not cover environmental matters. If the use of sanctions is going to be continued, the humanitarian exemptions must be improved noting the major impacts of sanctions on the environment and their humanitarian and justice implications. Future studies can explore what new schemes, mechanisms, reforms, and legal exemptions can be introduced to minimize the lasting environmental implications of economic sanctions.

Data Availability Statement

All data used in this study can be obtained from the main body of the paper and its figures.

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