Topic: Environmental Impacts of the US-China Trade War and Possible Solutions

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Abstract. The US-China trade war has been in the spotlight since 2018. However, many papers have only examined the economic issues arising from the trade war without paying much attention to the impact it has on the environment. This paper focuses on the environmental impact of the trade war on the two direct participants, which are China and the United States. It is concluded that the main environmental impact suffered by China is the increase in carbon emissions. This has led to an increase in domestic temperatures, which further leads to economic and social problems for vulnerable populations. This can be addressed through two policies, which are using green premium to implement targeted policy and investing more into the research of the new energy industry. Furthermore, the decrease in soybean production in the United States has led to environmental problems of over-nutrition and increased demand for blue water, which can further lead to water scarcity, triggering a reduction in farmers' income and a decrease in GDP. In this regard, different regulatory standards set in each state to monitor water quality can protect and enhance water quality in watersheds. in addition, investing money in controlling nutrient overload and water scarcity is also an effective measure. Moreover, this paper gives policy recommendations that governments could take to deal with difficult situations, and an assessment of the different policies mentioned.

Keywords: US; China; Trade war; Environmental impacts; Policy.

1. Introduction

China's economic power has grown in recent decades, while the U.S. share of global production and international trade has been declining at the beginning of the 21st century. Therefore, it has led to a change in the geopolitical landscape and the emergence of the "Group of 2". According to P. Samuelson, a noted economist, the total gains from trade are not necessarily beneficial for all countries. He argues that if other countries experience economic growth, it may be detrimental to a country, especially in sectors in which it does not have a competitive advantage. Thus, countries may have a significant impact on trade. This view has stimulated the development of the concept of trade protectionism in some countries, particularly in the United States. Trying to "make America great again", Donald trump added tariffs on Chinese imports, leading to the trade war with China. The trade war has not only put pressure on the environment but also has brought about a ripple effect on the economy and society of both countries.

The research question of this article is what environmental impacts the trade war between the United States and China has led to in both countries. The increased tariffs have caused a decline in Chinese exports to the United States, which in turn have shifted to other developing countries. Moreover, the decline in U.S. soybean production because of China's retaliatory tariffs has created new challenges for domestic agriculture. Based on these, this article also hopes to discuss a range of economic and social issues arising from the environmental impacts and to offer effective policy recommendations to mitigate them.

2. Environmental Impacts

2.1 China - Increased carbon emissions

As a country directly involved in the trade war, China's climate has been affected by it, which is manifested mostly in its carbon emissions. In the short term, China's carbon emissions have been

affected, but not substantially. However, under the continuous US-China trade war, China's import carbon emissions and export carbon emissions have a more obvious impact. Overall, China's net carbon emissions have increased, with an increase in its exports and a slight decrease in its imports.

China's carbon dioxide emissions from exports increased after the trade war due to several reasons. China's annual exports are far more than its yearly imports because it has been the largest exporter of goods in the world since 2009. During the trade war, due to the US raising tariffs on imports from China, China turns its exports to other countries other than the US. In addition, with the influence of spatial location, most of these countries are in Asia although countries in Oceania and the EU are also included. According to table 1 in the paper, in the transport sector, China's exports to South Asia have increased by 0.07, and those to both East and Southeast Asia have increased by 0.05.

Increased carbon emissions are concentrated in industries with high energy consumption, which include non-ferrous metals, minerals, coal and oil, and gas production. The data shows that the percentage increase in carbon emissions of energy production from China's exports is about 6.5%, which is approximately two times greater than that of primary industry. This is due to the high-growing demand for energy with rapid economic growth since 1978. The Chinese government introduced a variety of reform policies to attract investment, including foreign exchange reform, price reform, legal reform, and enterprise reform. To further improve the efficiency of the energy sector's performance, the government has launched several industry restructuring programs in recent years. These plans will have a significant impact on the energy sector in the coming decades, leading to increasing amounts of carbon emissions in the future.

China's carbon emissions from imports are largely affected by the United States. Before the trade war, China and US mainly trade in certain sectors like electronic services and agricultural products. Due to increased tariffs, there was a sharp decline in China's imports from the US. According to Linda Gorman, US exports to China fell by 26.3%, while exports to the rest of the world edged up by 2.2%. As a result, China's carbon emissions from imports declined by about one-third, being controlled by the trade market. In the agricultural products and transportation equipment sectors, which are essential sources imported from the US, China lifted its tariffs as a response, leading to imports declining by 70%.

2.2 US - Increased environmental stress: nutrient overload and water depletion

China's retaliatory tariffs against the U.S. in the trade war have had a profound impact on the U.S. environment. China is one of the largest markets for U.S. agricultural products. Of U.S. agricultural exports, 74% are soybeans. In 2018, China's retaliatory tariffs against the U.S. resulted in a significant decline in China's total agricultural imports from the U.S., particularly soybeans. As a result, soybean production in the U.S. has declined significantly, resulting in a total domestic harvest of 1.25 Mha less.

Despite the overall decline in production, eutrophication in U.S. agriculture has increased. Agriculture requires 70% of global irrigation water and is a major source of nutrient pollution. Much of the nitrogen and phosphorus applied to farmland in excess of crop requirements is lost to the environment and eventually leaches into water bodies, leading to eutrophication or is released as gas into the atmosphere, destroying the ecosystem, altering climate, and affecting human health. Potential production shifts between crops and between countries with different resource use efficiencies (RUE, total product output per unit of resource input) could alter global, national, and local nutrient pollution and water demand. By importing crops, China avoided $2 ± 16 billion in nitrogen pollution damage costs in 2015. In comparison, monetized estimates of the costs of excessive nitrogen pollution from U.S. agriculture range from $59 billion to $340 billion per year.

The demand for blue water in the United States is increasing rather than decreasing, potentially leading to a range of environmental problems. The opportunity costs and environmental impacts of blue water are more significant than those of green water, and blue water use in agricultural irrigation has the potential to cause serious environmental problems such as water depletion, salinization, flooding, or soil degradation. If soybeans alone were subject to Chinese retaliation, U.S. blue water

demand would increase significantly by 1.6 billion liters. However, when non-soybean oilseeds are also subject to retaliation, U.S. water demand would increase by only 100 million liters, far less than if only soybeans were subject to the tariff. However, when non-soybean oilseeds are also retaliated against, U.S. water demand would increase by only 100 million liters, far less than if only soybeans were subject to the tariff, as production of these water-demanding crops would also decline. Although farmers are unlikely to make significant investments in irrigation equipment given short-term policy or market shocks , farmers are likely to increase irrigation water on land already equipped with irrigation infrastructure, change crop types (e.g., from soybean-corn rotations to continuous corn), and perhaps even invest in new equipment when trade tensions increase. This becomes the norm in the context of growing tensions between the U.S. and China. As a result, the reduction in U.S. blue water demand for soybeans may be offset by an increase in water demand for other crops. In both cases, a similar pattern is observed globally: global blue water demand will increase as soybean production shifts (i.e., from the U.S. to Brazil and other South American countries).

3. Potential problems of environmental impacts

3.1 China

3.1.1 Economic issues

China's increasing CO2 emissions will cause climate change due to the greenhouse effect, posing not only a threat to the environment, but also economic issues in many industries.

The transportation industry has been hit hard by more frequent weather extremes. For example, hazards such as landslides, roadbed subsidence and drift ice are likely to increase and could cause damage to infrastructure due to changing weather conditions. Increasingly extreme weather can also affect air traffic. Under global warming scenarios of 1.5°C and 2.0°C, Beijing, Shanghai, and Lhasa airports will experience a significant increase in the number of restricted takeoff days.

In the manufacturing industry, extreme weather can lead to reduced production due to lower productivity and increased costs. Based on data from 500,000 manufacturing firms in China from 1998 to 2007, the relationship between average daily temperature and total factor productivity (TFP) has an inverted U-shaped relationship, which implies that temperature increases due to CO2 emissions can significantly reduce productivity. By the middle of the 21st century, climate change could reduce the annual production of China's manufacturing sector by 12% without adaptation measures, which is equivalent to a loss of about $40 billion. Since manufacturing accounts for 32% of China's GDP, this would reduce China's GDP by at least 4% per year.

3.1.2 Social issues

The social problems caused by climate change also deserve attention. The relationship between climate change and inequality patterns is strong. The most vulnerable people, such as the poor, contribute the least to the increase in carbon emissions, but they often bear the brunt of climate change impacts. The economic level of the poor is not sufficient to enable them to cope with sudden climate change. For example, climate change mitigation policies that take into account only the average income of society may place a heavier financial burden on the poor. For another instance, because of the high cost of government investment in low-carbon travel, public transport fares may rise and some people who rely on public transport to get around will have to pay more. As a result, people with low social status are highly likely to suffer unprecedented challenges.

3.2 US

Both nutrient loss and increased demand for blue water will lead to increased water scarcity in the United States. This can cause serious economic problems. Due to the lack of water, farmers need to find new alternative sources of water to farm, which is time-consuming. And if a water source cannot be found, it costs money and time to build a well. In this way, poor harvests for farmers will lead to their decreasing revenues, causing a decline in Gross Domestic Product due to the lower yields.

Therefore, the environmental issues not only lower the income of certain social groups like farmers but also make the economic situation of the whole country worse.

4. Possible solutions (policy suggestions)

4.1 China

The US-China trade war has exacerbated China's carbon emissions. Therefore, it is necessary for the government to develop some policies to control carbon emissions. Sustainability policies are the most critical to balance trade and carbon emissions. These policies will allow the economy to grow while protecting the environment.

4.1.1 Using green premium to implement targeted policy

Since carbon emissions are concentrated in high-energy-consuming industries, it is vital to change the energy structure and thus reduce carbon emissions. Using green premiums to implement targeted policy is a way that can achieve this.

The green premium is the cost of using zero-emission fuels (or technologies) minus the cost of using current fossil fuels (or technologies). A negative value means that the cost of fossil energy is relatively high and economic entities have the incentive to switch to cleaner energy sources, thereby reducing carbon emissions.

The government should encourage companies with a positive green premium to use fossil fuels instead of clean energy to minimize their costs. In this way, not only would the overall cost to society be reduced, but the problem of increasing carbon emissions could be mitigated due to a reduction in carbon emissions for society as a whole. This policy helps Chinese factories to effectively reduce the costs of those factories that have a positive green premium. As a result, the total long-term supply in the market will increase as these factories are more willing to produce at a lower cost. As a result, price levels will fall and real GDP will increase. Thus, this policy can not only reduce carbon emissions but also ensure economic growth.

4.1.2 Investing more in the research of clean energy technologies

China is currently in the stage of a newly industrialized country, meaning that the manufacturing sector contributes a lot to the country's carbon emissions. China's carbon emissions are highly associated with external demand as its exports account for a third of its GDP. As mentioned earlier, the country's carbon emissions from production are much larger than those from consumption. According to input-output analysis (IQA), the average contribution of electricity generation to the implied emission factor is over 35%. This compares to about 20% based on cement production. Therefore, the development of new energy sources to reduce carbon emissions is an essential measure.

This policy would reduce China's climate change issue. By encouraging more and more industries to use clean energy sources, China's carbon emissions will decline, and thus reduce climate change issues in China. If an effective technology is developed, then it will address China's carbon emission issue, replace fossil fuel, and thus address the climate change issue in China. Renewable energy could boost the economy by creating jobs in rural areas and lowering fuel imports. Moreover, the development of technology can help China occupy the market of the foreign new energy industry since China is able to invest money in the development of technology earlier than other countries.

4.2 US

Given the increased environmental pressures on U.S. agriculture caused by China's increased tariffs, the U.S. government should take steps to control eutrophication in crop production and limit the use of blue water. In this regard, I have two policy recommendations that the government can take.

4.2.1 Monitor regulatory programs

For each state in the U.S., the government can set different water quality standards based on the degree of agricultural use. For areas that are not dominated by agricultural production, the government should have higher water quality requirements as a way to equalize the water quality status of the entire country. Watershed prioritization and setting goals for nutrient load reduction can both help achieve this plan. Regulators in each state can keep records of nitrogen and phosphorus discharges while agricultural production is occurring to improve subsequent nitrogen and phosphorus discharge strategies. For water bodies already impaired by nitrogen and phosphorus pollution, maximum loads should be set to protect and restore water.

After the water quality is improved, compliant water will be more available and easier to access even if the demand for blue water is still high. Therefore, this policy indirectly alleviates the problem of high demand for blue water.

4.2.2 Invest more in developing technology to deal with nutrient pollution and more efficient irrigation methods

Even if the monitoring and regulation program is effectively implemented, this policy does not address the problem of nitrogen and phosphorus pollution of water bodies at the source. Therefore, the government should invest in how nitrogen and phosphorus affect the ecosystem and the pathways and solutions, recruiting professionals to control nitrogen and phosphorus pollution and develop water treatment technologies. Researchers could use the funds to buy relevant equipment and collect data on nitrogen and phosphorus pollution in various regions for further study.

Furthermore, effective irrigation practices can increase the efficiency of farming, meaning that a small amount of blue water is consumed to obtain a large agricultural harvest. This will reduce the demand for blue water to some extent, making the problem of water scarcity for blue water alleviated.

5. Policy Evaluation

5.1 China

5.1.1 Using green premium to implement targeted policy

It is undeniable that using the green premium to develop a targeted policy is good for the environment and the GDP of the country as a whole. However, an obvious drawback of this policy is that for companies that previously had no CO2 emissions, their pollution of the environment increases. As a result, carbon emissions increase in the areas where these companies are located, resulting in local governments needing to invest additional money and time to deal with the environmental problems, such as air pollution, caused by the increased carbon emissions. This can be fatal for some governments with average or low economic status and may lead to a series of social problems as a result. Since governments do not have enough money to fight pollution, they may raise taxes or reduce government spending to get enough money. Increasing taxes is a heavy burden for the people and may cause their discontent and resistance, which may lead to strikes in serious cases. In addition, the lack of public facilities that may result from reducing government spending will lead to inconvenience in people's lives, leading to the decline of people's living standards.

5.1.2 Investing more in the research of clean energy technologies

The development of new energy technologies requires a lot of budget and time to implement. Although this policy can address the root cause of carbon emissions because it can replace fossil fuels used in many factories, it is risky because the input and output may not be proportional. Therefore, it is almost impossible to use this policy to control carbon emissions in the short term.

5.2 US

5.2.1 Monitor regulatory programs

If regulatory monitoring were effectively implemented, this would greatly improve water quality in the United States and allow nutrient overload to be controlled. However, this is time-consuming and labor-intensive. Each state government needs to appoint professionals to conduct field research and then plan reasonable water quality standards based on a comprehensive and detailed survey.

5.2.2 Invest more in developing technology to deal with nutrient pollution and more efficient irrigation methods

The development of new technologies in the field is time and money-consuming. While in the long term, this can be a very effective solution to the environmental issues of nutrient overload and blue water demand, the prolonged capital investment also greatly increases the cost of the technology.

6. Conclusion

The trade war between the US and China has had significant environmental impacts on the two countries. This paper discusses the environmental impacts of the trade war between China and the United States on both countries and a series of ripple effects. The strength of this article is that it not only analyzes the situation in China and the United States but also proper solutions (policy recommendations) and evaluates them. While its limitation is that it only focuses on the two countries directly involved in the trade war but lacks a global perspective.

It is concluded that the main impact of the trade war on China's environment is an increase in its carbon emissions. Climate change caused by this may also lead to economic and social issues, especially for vulnerable social groups. The government can reduce carbon emissions by setting targeted policies with a green premium and by investing more in new energy industries, although both policies have some drawbacks.

Moreover, the trade war has caused increased eutrophication in U.S. agricultural production and a higher demand for blue water, which will cause water scarcity and other serious environmental issues. Economic problems may be decreasing income of farmers and a lower GDP. The U.S. could strengthen its regulatory policies to do a better job of testing water quality in each state to effectively control nitrogen and phosphorus discharges. In addition, it is necessary for the government to invest in the control of nitrogen and phosphorus pollution and water treatment.

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