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Paying For Pollution: Carbon Tax as A Mitigation for Carbon Emission Problem

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Abstract
There is a need to evaluate the effectiveness of carbon tax policies across different sectors in reducing emissions and increasing government revenue, while assessing their practical implementation and impact on economic and environmental outcomes. This study aims to determine the effectiveness of carbon tax implementation in various sectors and whether it can reduce carbon emissions and increase government revenue, thereby helping to mitigate climate change and improve environmental, social, and economic conditions. The sample in this study includes 24 countries that have implemented a carbon tax, allowing for the analysis of carbon emissions levels and government revenue indices. Regression analysis is used to determine the strength of the relationship between carbon tax implementation in various sectors, the share of jurisdiction emissions covered, and government revenue. The results indicate that implementing a carbon tax in various sectors significantly reduces carbon emissions and increases government revenue. These findings suggest that a carbon tax is essential as an environmental policy in all countries and represents the most effective way to mitigate carbon emissions. This evidence should be considered by countries contemplating its implementation

Keywords: carbon tax; carbon emissions; government revenue; environmental policy

INTRODUCTION

The Paris Agreement, approved by 195 countries in December 2015, aims to strengthen the global response to the threat of climate change. It builds upon the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 1997 Kyoto Protocol. The increase in global temperatures must be anticipated to avoid further problems (Nar, 2021;

Tsai, 2020). Climate Watch partners with the United Nations Climate Change and the World Bank provides information related to the primary emissions of greenhouse gases. It shows that 74% of the total greenhouse gas emissions are CO2, 17% CH4, 6.3% N2O, and 2.6% F-Gases in 2021. Therefore, CO2 emissions are the most important cause of global warming. The World Bank shows a significant increase in CO2 emissions from 1990 to 2020. The indicator shows that the level of carbon emissions in the world is still high and continues to rise in most countries due to economic development. The annual accumulation of CO2 emissions could become an overwhelming burden if not addressed promptly or become irreversible (Riyono & Widianingsih, 2024b).

Sustainable Development Goal 3 Good Health and Well-Being can represent the level of health of human resources in the country (United Nations, 2016). The trendline index obtained from the United Nation shows that countries classified as major challenges are still decreasing from 2019 - 2023, with an average decrease of 0.39% per year. There are still many countries that still face the problem of lack of health facilities and human resources that are in a healthy condition to work. This condition is still not indicated as an increase over the 5 years. Matching it with the carbon emission index obtained from the Emissions Database for Global Atmospheric Research (EDGAR), countries in the red group also have an average carbon emission that increases by 2.15% annually for 5 years. So, from these two indexes, over 5 years the sustainable development goal 3 obtained is decreasing, while carbon emissions are increasing. This is in line with previous research that the more CO2 emissions released, the more polluted and damaged the environment. This environmental damage also has a negative impact on humans themselves. The amount of CO2 emissions and pollution results in various diseases that can potentially occur (Xu et al., 2023; Yüksel & Mikhaylov, 2022). The increase in the number of sick individuals will lead to job losses, lower income, and severe illness.

It is also known that the economy, represented by gross domestic product, increased by 2.95% annually over the 5 years (World Bank, 2024). In line with research by Guo et al. (2022), the more the country develops, the more industrial activities will increase, resulting in more carbon emissions being

released. So that from the development also requires awareness of carbon emissions and an effort to continue to develop but also anticipate excessive amounts of carbon emissions. Carbon emissions impact every aspect of society and the environment, but releasing carbon emissions is also inevitable as countries develop. CO2 remains in the atmosphere for decades. Environmental and economic conditions rely on the levels of greenhouse gases, which can be influenced by future economic developments, domestic climate policies, and global policies (Prasad, 2022).

To overcome the problems mentioned above, the carbon tax is one of the policies that can be implemented to achieve the targeted national emissions reduction. Its implementation also plays a vital role in forming a very constructive or devastating effect on society (Khastar et al., 2020; Nar, 2021). Taxing carbon has two effects: helping climate change mitigation efforts and raising revenue. Putting a price on carbon is the most effective regulatory approach to reduce greenhouse gas emissions (Steenkamp, 2021; Yuan et al., 2017). Not only that, but it also significantly increases government revenue (World Bank, 2024). Government revenue is obtained from the sectors where the carbon tax is implemented.

The tax encourages polluters to adopt greener practices and use renewable energy, also high taxes encourage investment in cleaner resources (Gevrek & Uyduranoglu, 2015). A carbon tax can make the price of the output from the taxed sector increase because of higher tax expenses, causing buyers to no longer be interested in buying goods from the taxed sectors. So, the only way for companies to reduce tax expenses is by reducing carbon emissions by using greener practices (King et al., 2019; Xu et al., 2023). Indirectly, implementing a carbon tax will limit the productivity of major emitting sectors and force them to reduce their emissions, thereby reducing excessive carbon emissions. The World Bank provides data showing the average total CO2 emissions released by all countries that implement carbon tax. Countries that implement carbon tax have lower average CO2 emissions than countries that do not implement it in 2020. Meanwhile, most countries that implement it initially have higher average CO2 emissions than countries that do not. Most countries that implemented the carbon tax began enforcing it in 2008, so it is consistent

that starting in 2008, the average CO2 has started to decrease.

Compared to other domestic climate policies such as emission trading systems, a carbon tax is more efficient. The emission trading system or ETS is often referred to as 'cap and trade' in the carbon market. ETS provides certainty of quantity which is the cap that has been set by the government, it contains the upper limit of how much carbon emissions can be emitted by an entity. ETS guarantees emissions to stay within the cap, it helps to control and reduce the carbon emissions in the country. The cost will vary, depending on the scarcity of allowance. Meanwhile, carbon tax adheres to the 'polluter pays' principle. It provides a certainty of cost which is set by the government. However, there is no limit on emissions, which means that entities are willing and able to pay the tax. Both have the same goal of mitigating carbon emissions but operate differently. Carbon tax is easier to implement and does not cost higher administration costs than implementing ETS (Gorman, 2023). Since it provides price certainty per unit of carbon emitted and fewer technical requirements compared to monitoring and verifying emissions in ETS. It also offers immediate revenue generation and predictable revenue for development. ETS is harder to implement due to the need for a robust regulatory framework, technical requirements, market infrastructure continuous adjustments to maintain, and market volatility. In conclusion, a carbon tax is easier and faster to implement, making it way more efficient and practical for many regions. However, an ETS can be phased in later as technical expertise and regulatory capacity grow. It is still possible to adopt both carbon pricing and domestic climate policy to have a greater impact just like in Switzerland, British Columbia, the United Kingdom, Mexico, and Canada.

Although the carbon tax has benefits, it also has negative effects in its implementation. Carbon tax helps businesses, people, and governments reduce CO2 emissions but also may increase the burden on consumers, producers, communities, and the economy (Y. hua Chen et al., 2020; Marron & Morris, 2016). There will be price increases for electricity, gasoline, heat fuels, and other fossil fuel-based energy sources following carbon tax implementation (Q. Wang et al., 2016). Low-income individuals will be affected the most by these increases as they will surpass their budgets. Implementing a carbon tax will add to the economic burden

through taxation, therefore it is essential to utilize the revenue to alleviate this burden and to promote economic growth. A good carbon tax policy must have a limitation, as the goal is to gradually reduce carbon use to reduce taxable activities over time (Mintz-Woo, 2024). Therefore, the implementation of a carbon tax in each sector is not burdensome but beneficial if the government is involved by returning the revenue to households, cutting other taxes, reducing the regressivity of the carbon tax, subsidizing environmentally beneficial technologies or policies, or reducing debt (Prasad, 2022). So that the potential negative risk of price increases can be minimized so that the main objective of the carbon tax can be achieved.

It can be concluded that carbon tax is easier to implement than ETS and has a good purpose to protect the environment. But it also has the potential risk of price increases that will burden the community, so a concrete and appropriate design is needed to reduce this risk. Most countries have implemented ETS rather than a carbon tax, with a total of 41 countries having implemented ETS and 16 countries under consideration, while there are only 28 countries with a carbon tax. There are still many issues regarding the effectiveness of the carbon tax itself which causes countries to prefer ETS. Research by (Lin & Li, 2011) shows that the carbon tax in Denmark, Sweden, and Netherlands is weakened due to the tax exemption policies on certain sectors. While in Norway, the rapid growth of energy products drives a significant increase in CO2 emissions in oil drilling and natural gas sectors. In China, even though it has implemented a carbon tax, the carbon emission is still rising significantly (X. Zhang & Zhang, 2021). While other researchers believe that carbon tax is effective to mitigate carbon emissions, with increased tax rate allowing to reduce carbon emissions and promoting low-carbon technology innovation (Nar, 2021; Parry, 2019; M. Wang et al., 2023; Q. Wang et al., 2016). From this, it is found that design plays an important role in the implementation of a carbon tax, especially the revenue management. Inappropriate design may weaken the effectiveness of carbon tax. Therefore, further research on the effect of carbon tax is needed, whether it will be effective in mitigating carbon emissions or not.

This study aims to determine the effectiveness of the amount of carbon tax implementation in various sectors and whether it can reduce carbon emissions and increase government

revenue or not to avoid climate change and improve environmental, social, and economic conditions. The results can be used as a consideration for countries that have not yet implemented a carbon tax. This study also delivers valuable insights on how to effectively design a carbon tax that can drive meaningful environmental change. The contribution in practice, research highlights how carbon taxes encourage industries and businesses to adopt cleaner technologies, leading to lower carbon emissions, and explores mechanisms to reduce potential economic burdens on vulnerable populations through revenue recycling or exemptions. In literature, this study contributes to combines insights from economics, environmental science, and political science, fostering holistic approaches to climate change mitigation and providing empirical evidence with robust data and case studies from implemented carbon taxes to validate the theoretical models.

Most of the studies use the country as the subject variable and dummy variable of carbon tax based on whether the country has implemented carbon tax regulations or not, without seeing how much of it is enforced (Xu et al., 2023). While in this study carbon tax is measured more specifically, namely by the number of sectors imposed with carbon tax, so it clarifies the implementation of carbon tax. This research not only examines the effect on carbon emissions but also government revenue. Research on whether a carbon tax can generate so much revenue that it benefits the state is still needed and has yet to be quantified. So far it has been said that with taxes comes revenue, but whether carbon tax revenue will be as much as taxes in general is yet to be found. This research is designed to answer more clearly and specifically the main points of a carbon tax, which are reducing carbon emissions and generating revenues.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Carbon Tax

Carbon tax is used as an environmental policy to reduce GHG emissions in the country (Metcalf, 2021). The reduction is achieved through the pricing of carbon emissions. Every carbon emission released by the state will be subject to a tax that must be paid by the parties involved (King et al., 2019; Marron & Toder, 2014). The main purpose of the carbon tax is to encourage companies to adopt technologies that are more environmentally friendly, not producing excessive emissions, along

with moving towards renewable energy. Carbon tax is applied in various sectors within countries, according to their respective needs.

Natural-Resources Based View

The natural resources-based view is based on the idea that future strategies and competitive advantages will facilitate activities that are more environmentally and economically sustainable (Hart & Dowell, 2011). The basis of this theory is a strategy in pollution prevention, product stewardship, and sustainable development (Hart, 2017). With environmental driving forces to reduce emissions and waste, minimizing the life-cycle cost of products, and reducing the environmental burden of firm growth and development (Hart, 2017). So that moves the company to be environment-oriented, it results in sustainable development, with the same mindset between stakeholders to swift forward sustainability, and a shared vision.

The carbon tax is closely related to the sector and companies to form a more sustainable and environmentally friendly operation. This is because the carbon tax makes the company more profitable due to the carbon tax burden if the company releases large carbon emissions. So, to reduce this, companies will be forced to go green by utilizing green technology. So, the company's responsibility to the environment is increasingly enhanced to encourage it to reduce carbon emissions.

Hypothesis Development

Many studies have shown that a carbon tax is the most effective solution to reduce carbon emissions in the country (Ahmadi et al., 2022; Tsai, 2020; Xu et al., 2023). Carbon tax helps prevent excessive activities that can produce carbon emissions (Tsai, 2020). The prevention of carbon emissions occurs because many companies invest in greener energy to avoid higher carbon taxes (He & Song, 2022). As well as encouraging green innovation in the production process (Yüksel & Mikhaylov, 2022). The more sectors subject to a carbon tax, the more changes will occur from polluting to less polluting.

Carbon tax is in line with the natural resource-based view, with changes in production activities that become green, produce less waste, and green product innovation, it will also have an impact on pollution prevention and sustainable development. All stakeholders in the company will strive towards sustainability to avoid higher taxes. Based on the description above, the following hypothesis can be made:

H1: Sectors that implement carbon tax affect carbon emission reduction

With the carbon tax, the state can increase government revenue from various sectors (Yuan et al., 2017). The imposed sectors are those that produce carbon emissions. The more sectors subject to carbon tax, the higher the tax that can be collected from these sectors (Beck et al., 2015). Each country has carbon tax characteristics from each sector according to the country's needs. The tax imposed in each sector is also mostly the same and does not differentiate the rate (Hoel, 1996). Various other research is also in line with this statement, showing that carbon tax will also benefit the country not only environmentally but also materially (Carattini et al., 2018; Y. hua Chen et al., 2020; Metcalf, 2021).

Revenue from carbon tax can also be used to facilitate more environmentally and economically sustainable activities in the form of subsidies. This can also encourage companies to look forward with green technology and sustainability oriented. The following impact is also reflected in the natural resources-based view, where the revenue earned will be reused for investment needs and technology development. Based on the description above, the following hypothesis can be made:

H2: Sectors that implement carbon tax affect government revenue

METHOD

Sample, Variable, and Measurements

The sample for this research is 24 countries around the world that have implemented carbon tax so that they have had the impact of reducing carbon emissions and increasing government revenue. Unfortunately, there are not many countries in the world that have implemented carbon tax, the process of sampling this research by looking at the completeness of the data and removing outliers, where 4 countries were removed due to lack of complete data on government revenue and shares of jurisdiction emissions covered. Of a total of 28 countries that have implemented it, only 24 samples are suitable for use in this study.

Independent and dependent variables are measured with index numbers obtained from published data released by the World Bank Database as of April 1, 2024 (World Bank Group, 2024). The independent variable used is the sector that summarizes the total sectors subject to carbon tax in the country. The

sectors include electricity, industry, mining and extractives, transportation, aviation, buildings, and agriculture. The study has two dependent variables: share of jurisdiction emissions covered and government revenue. The share of jurisdiction emissions covered shows the total carbon emissions the carbon tax addresses, while government revenue is the state revenue received for carbon tax payments. The share of jurisdiction emissions covered index is in the form of a percentage of the total carbon emissions in the country and government revenue is calculated in US$ Million.

The index such as the coverage and revenue obtained from the World Bank relies on a variety of sources, such as official reports such as government budget documents, relevant legislation that supports the carbon pricing initiative, statements from governments and public authorities, and information from jurisdictions and other administering organizations. These indexes coincide with the release of the annual report on the state and trends of carbon pricing. Calculation of share of jurisdiction emissions through calculations made by the government based on the amount of carbon emissions that were successfully addressed for one year. Government revenue is calculated based on the total revenue earned from January 1 to December 31. This revenue is converted into US dollars using the exchange rate from December 31 to ensure consistent currency representation. The sources used provide accurate indexes for each government, and the author has reconciled these figures with annual reports from each country. The results obtained are consistent and accurate.

Analysis Method

The study's analysis procedure included a classical assumptions test (normality and heteroscedasticity), descriptive statistical analysis, testing the feasibility of the research model with the F test, and testing the hypothesis with the t-test. The model used is regression. The multicollinearity test is not used because it only uses one independent variable.

RESULTS AND DISCUSSION

Descriptive Statistics

As indicated in Table 1, most countries have carbon emissions resolved in the moderate range, with an average of 0.429 of the total carbon emissions in the country. This indicates that 42.9% of the country's carbon emissions are resolved by carbon tax. The country with the

Table 1. Statistic Descriptives

Variable	Obs	Mean	Std. Dev.	Min	Max
Share of Jurisdiction Emissions Covered	24	.429083	.257763	.019	.82
Government Revenue	24	19.33635	2.172292	14.5087	22.8484
Sector	24	4.166667	2.180281	0	7

Source: Data analysis results (2024)

Table 2. Classical Assumption Test

Share of Jurisdiction Emissions Covered		
Test	Method	Result
Normality	Skewness-Kurtosis	Prob>chi2 .0745
Heteroscedasticity	Breusch-Pagan	Prob>chi2 .6369
Government Revenue		
Normality	Skewness-Kurtosis	Prob>chi2 .7765
Heteroscedasticity	Breusch-Pagan	Prob>chi2 .2954

Source: Data analysis results (2024)

highest share of jurisdiction emissions covered is South Africa, with 82% resolved by carbon tax in the seven sectors imposed. This shows the effectiveness of carbon tax implementation in the country, which earned government revenue of US$18.65 Million.

The government revenue obtained by the country on the carbon tax is also the majority highest, with an average of US $ 19.33 Million. From carbon tax, the state can get additional revenue that can be allocated for various other things. The country with the highest government revenue is France at US$22.8 Million, with only three sectors out of seven available sectors with emissions covered by 40%.

This indicates the high carbon pricing (US$47.94) set in the three sectors implemented: industry, transport, and buildings. However, the emissions that can be covered are not as high as other countries because they are below average. In contrast, the lowest country is Estonia, with a revenue of US$14.5 Million in two sectors imposed, but also ineffective implementation because the emissions can be covered by only 10%.

Most countries implement a carbon tax on an average of four sectors, with the highest to lowest sectors subject to a carbon tax in the following order: industry, mining and extractives, transportation, buildings, electricity, agriculture, and aviation.

Classical Assumption Test

As in Table 2, the first model's normality test shows that the model errors are normally distributed, with a figure of .0745 exceeding .05. The model is also free from heterogeneity problems, with a result of .6369 exceeding 0.05. Thus, the first model has passed the classical assumption test and can be used further.

Table 2 also shows that the second model has passed the classical assumption test. The normality test results show a result of .7765, which exceeds .05, indicating that the errors in the model are normally distributed. The heteroscedasticity test also shows that the data is free from heterogeneity problems, with a result of .2954, which exceeds .05.

Feasibility Test Results

The model feasibility test shows that the first model can be used to explain the results, where there is at least one variable that has a significant effect with a result of .0259 < .05. While the model can explain 17% of the influence on the dependent variable, the rest is explained by variables outside of the model as in table 3.

Table 3 also shows that the second model can be used to explain the results, or at least there is one variable that has a significant effect with a result of .0253 < .05. While the model can explain 17.15% of its influence on the dependent variable, the rest is explained by variables outside of the model. Even though with only 24 samples, both models can be used as a result in this study, so with that, this sample limitation is not a problem in this study.

t-Test Results

The t-test result for the first model shows that the sector significantly affects the share of jurisdiction emissions covered with P>|t| < .05, which is .026, then hypothesis 1 is accepted as in Table 4. The effect is positive where the addition of 1 sector subject to carbon tax will increase the share of jurisdiction emissions covered by .0536723.

Table 4 shows the t-test results that the sector significantly affects government revenue with P>|t| < .05, namely .025, so the second hypothesis is also accepted. The effect is positive, so adding 1 sector subject to carbon tax will increase government revenue by .4538561.

Discussions

Each country has its characteristics for carbon tax implementation. The difference is based on the country's needs, where

Table 3. F-test Result

Share of Jurisdiction Emissions Covered	
Prob > F	.0259
Adj R-squared	.1700
Government Revenue	
Prob > F	.0253
Adj R-squared	.1715

Source: Data analysis results (2024)

Table 4. t-test Result

Share of Jurisdiction Emissions Covered		
Coef.	t	P>|t|
.0536723	2.39	.026
Government Revenue		
.4538561	2.40	.025

Source: Data analysis results (2024)

a carbon tax is imposed on various sectors. The sector most subject to carbon tax by all countries that have implemented it is industry. The carbon emissions factories release is very large and depend on their productivity (Gevrek & Uyduranoglu, 2015). Therefore, the sector is most imposed to encourage green productivity and use renewable resources to be more environmentally friendly. The second most imposed carbon tax sector is mining and extractives. Mining will take a variety of fossil fuels and produce a variety of carbon emissions (Liu et al., 2018). This government effort is to implement a carbon tax so that mining companies can switch to more renewable resources and not take excessive amounts of resources. The third most imposed is the transportation sector. One of the efforts made by the government is to encourage the use of electricity-based transportation to be environmentally friendly and not produce carbon (Li et al., 2023). Therefore, people should be able to use transportation that does not produce emissions. While buildings, electricity, agriculture, and aviation are applied so that companies and individuals can switch to using technology or resources that are more environmentally friendly.

The results of this study state that implementing a carbon tax can increase government revenue and reduce carbon emissions. All countries that have implemented carbon tax have succeeded in reducing the amount of carbon emissions in the country by changing the use of fuels that produce emissions to greener ones and reducing activities or production that

produce carbon. In addition to reducing carbon emissions, it also increases government revenue that can be allocated for various other things. Therefore, following research by Amdur et al. (2014), Beck et al. (2015), Chen et al. (2020), Cheng et al. (2021), Liu et al. (2018), and Prasad (2022) that carbon tax has a twin effect of reducing carbon emissions and increasing government revenue.

The more sectors subject to carbon tax, the lower the carbon emission level will be due to changes in the behavior and activities of consumers, producers, and other parties from polluting to less polluting. The more sectors, the more areas that must follow the changes. This is because if they continue to use fuels and other resources that produce carbon, they will be subject to higher taxes. To avoid this, they must switch to more environmentally friendly resources supported by green technological innovation (Zhou et al., 2018). With the use of green resources and environmentally friendly technology, the carbon emissions released are not as much as before, so the level of carbon emissions is also decreasing (Yüksel & Mikhaylov, 2022). Therefore, a carbon tax can reduce the carbon emissions in the country by forcing those who produce carbon to adopt environmentally friendly resources and change their activity processes so as not to make excessive emissions. The company's internal and external drivers play a significant role in determining the extent to which its carbon management and disclosure practices are implemented, ultimately contributing to environmental change in the country (Yauri & Widianingsih, 2023). This result is in line with research conducted by (Z. Zhang et al., 2017) in China, carbon tax is an important barrier to prevent further carbon leakage since it implies extra competitiveness loss and result. In Canada, changes in coal and petroleum production due to carbon taxes have significant implications for greenhouse gas emissions and economic growth (Liu et al., 2018)

In addition to reducing carbon emissions, a carbon tax can also increase government revenue. This revenue management is the most crucial part of the key to a successful carbon tax and requires caution since the carbon tax itself may increase the selling price and various burdens for producers, making people with lower-middle income affected by the price increase (Khastar et al., 2020). To mitigate these regressive effects and benefit many lower-income households, a revenue-neutral carbon

tax design is required, which recycles the carbon tax revenues back to households. As in China, a carbon tax on production can decrease social welfare due to higher price output, while tax redistribution can mitigate it (Chen & Nie, 2016). The revenue obtained by the state can be used to subsidize households, cut other taxes, reduce the regressivity of the carbon tax, subsidize environmentally beneficial technologies or policies, or reduce debt (Prasad, 2022). Sectors that are subject to carbon pricing should be those that produce the most carbon emissions so as not to increase the selling price of producers too high so that it can still be reached by lower-middle-income people. These balances the costs incurred by the public and producers with the benefits of paying the tax. Therefore, the conditions and characteristics in the country also need to be considered as they represent their readiness, such as economic, financial, and socio-political conditions; stakeholder synergy is needed in this regard (Widianingsih et al., 2024). Government efforts and commitments in each country are needed to be able to execute these sustainability actions, especially in the transformation aspect that shows the government's ability to integrate these commitments in various sectoral policies and long-term strategy formulations (Riyono & Widianingsih, 2024). With all these, the potential negative risks of a carbon tax can be minimized so that the effectiveness of a carbon tax can be sustained.

Based on all these findings, implementing a carbon tax requires a lot of consideration based on the country's economic and political condition. The key to the success of a carbon tax is its design, so to maximize the results of a carbon tax, a design is needed that can also benefit society and companies. Minimizing the burden and reducing its impact on society is required to balance environmental objectives with economic and social considerations. Looking at how Canada’s carbon tax works, it returns most revenues to households as tax credits (Liu et al., 2018). Revenue neutrality and redistribution to citizens are required to offset the potential increase in cost, especially for lower-income households. Gradual implementation is also needed to introduce the carbon tax at a low rate and gradually increase it over time, giving entities and customers time to adapt and invest in low-carbon alternatives, also provides a clear predictable tax increases to reduce uncertainty and allow for long-term planning. This is

also used in Sweden's carbon tax which is introduced gradually and paired with reductions in other taxes with incentives for businesses that adopt renewable energy or invest in low-carbon technologies, so it won't harm the economic growth (Government Offices of Sweden, 2024). Targeted support for vulnerable groups is also needed for subsidies to help households improve energy efficiency. The revenue should be used for green investments such as renewable energy infrastructure to make clean energy more affordable and accessible, funding public transit systems to provide low-cost and low-carbon alternatives for commuting and energy efficiency programs for households and entities. By designing a carbon tax just like so, it is possible to achieve environmental goals without putting another burden on consumers or entities.

The findings in this study empirically verify the theory of the natural resource-based view. From the natural resource-based view, all companies in the carbon-taxed sector will try to switch all their activities from using non-renewable energy to renewable energy. Carbon tax encourages the capability of companies to immediately adopt energy and technological innovations that are environmentally friendly. All stakeholders in the company are united by a shared vision of using renewable energy, reducing carbon emissions, and addressing other environmental issues. Additionally, the company's revenue can be reinvested into society through subsidies, alleviating various burdens.

CONCLUSION, IMPLICATION, AND LIMITATION

The results show that implementing a carbon tax on taxed sectors reduces carbon emissions and increases government revenue. The carbon tax encourages producers and consumers to switch to greener and renewable resources. Thus, it can reduce carbon emissions from polluting to less polluting. Meanwhile, the taxed sectors will also affect government revenue, which can be used to develop the country or increase economic growth. A carbon tax is the most influential and effective environmental policy to implement because it can be more sustainable by increasing the use of renewable energy and encouraging green technology. However, its implementation also requires insight into the community because implementing an inappropriate carbon tax will burden low-income people. A revenue-neutral carbon tax design is

needed to minimize these potential negative impacts. This can be done by returning the revenue in a form that can improve social welfare, such as subsidies, cutting other taxes, and building renewable energy infrastructure. With this, the implementation of a carbon tax can be used as a consideration to solve the carbon emission problem.

The implications of this study can inform the implementation of a carbon tax risk and benefits, but also on how to minimize the risk. Addressing the country's primary issue of carbon emissions, a carbon tax not only reduces emissions but also generates additional government revenue. It is considered the most efficient environmental policy than others such as ETS, compelling all parties to modify their operations to be less polluting. Therefore, a carbon tax is the optimal mitigation for countries with environmental challenges related to carbon emissions. However, such considerations are required before implementing it since it may increase the output price and burden for low-income households. This study has provided input on how to design a carbon tax to be effective and reduce the potential for bad outcomes.

The title of this research "Paying for pollution" means sectors as subject to the carbon tax are obliged to pay for the carbon that they have released. It is not just a regular tax, but it is part of the obligation to reduce pollution through a carbon tax. And the benefits that can be obtained through these payments are also broad and beneficial for various parties, both sectors, the government, and other parties involved. The effect is not just in reducing emissions but making industries way better with renewable energy and greener technology, which also provide additional revenue for the country.

The limitation of this research is the number of samples that can be obtained. The sample is still small, which is also because many countries have not yet implemented it. In addition, many carbon tax schemes are relatively new, making it difficult to comprehensively analyze long-term impacts. Measuring indirect impacts, such as behavioral changes or innovations triggered by carbon taxes, is complicated and often relies on assumptions. This leads to incomplete, biased, or less actionable conclusions.

Suggestions for future research can use carbon design key points to test the effectiveness of carbon tax design to find out the most effective type of design. Further, examine whether the implementation of carbon

tax increases the burden on the country is also needed, in the form of increased prices, changes in customer behavior, or increases the burden on the state. It is also possible to disaggregate countries based on their income levels to understand the impact on middle and lower incomers.

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