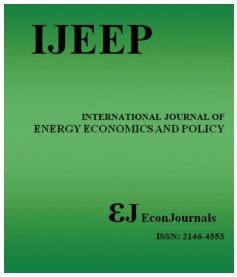

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2025, 15(2), 90-95.

The Impact of Carbon Tax Policies in Achieving the Ambitious Target of Net Zero Emissions 2060 in G20 Countries

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Received: 20 September 2024 **Accepted:** 11 January 2025 **DOI:** https://doi.org/10.32479/ijeep.18100

ABSTRACT

This research aims to explore the impact of carbon tax policies on reducing carbon emissions in G20 countries in achieving the ambitious target of Net Zero Emissions by 2060. This research uses the Pearson correlation test method and content analysis, the time period studied is 4 years. Based on data analysis, it is known that there is a negative and significant relationship between carbon taxes and carbon emission levels in G20 countries. These results support the hypothesis that carbon taxes are an effective policy instrument in reducing carbon emissions, where increasing carbon taxes has the potential to encourage substantial reductions in emissions. The effectiveness of carbon tax policies is influenced by the level of industrialization, commitment to environmental policy, and national strategy. Countries with higher carbon tax rates and consistent policy implementation, such as Japan and South Korea, have achieved more significant emissions reductions than countries with lower tax rates or limited implementation. This research emphasizes the importance of integrating carbon tax policies with a comprehensive climate change mitigation strategy, including investment in low-carbon technologies, increasing energy efficiency, and transitioning to renewable energy so that it can become an effective tool in directing the global economy towards environmental sustainability and achieving long-term climate targets long term, including Net Zero Emissions by 2060.

Keywords: Carbon Tax, Pigouvian Tax, Carbon Emissions, Net Zero Emissions 2060, G20, Pearson Correlation Test
JEL Classifications: Q54, Q58, Q48, H23, Q52, Q56, F64

1. INTRODUCTION

In global efforts to overcome the increasingly real and urgent impacts of climate change, the concept of Net Zero Emissions by 2060 has become one of the main commitments adopted by many countries, including G20 member countries. This commitment not only reflects moral and political responsibility towards sustainability but also shows awareness that without coordinated efforts the impacts of global warming will be increasingly difficult to overcome (Milne and Roberts, 2023). Currently, the world is facing serious challenges related to climate change caused by increasing carbon emissions which have a negative impact on the environment and the global economy (Jackson and Brown, 2022).

Governments in various countries realize that increasing carbon emissions can trigger national economic losses and worsen climate conditions. To overcome this risk, policies are needed that are not only effective in reducing emissions, but are also able to ensure sustainable funding for climate change mitigation (Zhang and Wu, 2020). One of the policies adopted by the government is the imposition of a carbon tax which is designed as an economic instrument to internalize the external costs of carbon pollution. This tax aims to change the behavior of society and industry towards more environmentally friendly economic activities (Hargreaves and Gaskins, 2023).

Based on data compiled by the Emission Database for Global Atmospheric Research in 2020, Indonesia was ranked 10th as

the largest carbon emitting country in the world (EDGAR, 2020). In response to this challenge, the Government of the Republic of Indonesia has demonstrated its commitment to achieving Net Zero Emissions by 2060, including through commitments in the Paris Agreement in 2015 and the implementation of Low Carbon Development as regulated in Presidential Regulation Number 18 of 2020 concerning Medium Term Development Plans 2020-2024.

This research aims to evaluate the impact of carbon tax policies on reducing emissions in G20 countries, including Indonesia, by considering current conditions and future projections (Smith and Adams, 2022). Apart from that, this research also maps the relationship between carbon taxes and reducing the amount of carbon emissions in G20 member countries that have implemented this policy (Thompson and Collins, 2023). This study not only provides insight into the effectiveness of carbon taxes as an emissions control instrument, but also contributes to the global discourse on sustainable climate change mitigation strategies (Nguyen and Wilson, 2021). A carbon tax theoretically offers a solution to address the negative externalities of carbon emissions. Therefore, an in-depth understanding of how these policies operate in various contexts in G20 countries, as well as the impacts they produce, is crucial to determining whether carbon taxes can serve as an effective instrument towards Net Zero Emissions by 2060 (Johnson and Lee, 2023).

2. LITERATURE REVIEW

2.1. Carbon Tax as a form of Pigouvian Tax

Pigouvian Tax is a tax concept imposed to overcome negative externalities arising from economic activity. Arthur Cecil Pigou first introduced this theory in his work "*The Economics of Welfare*" in 1920 which explained that taxes could be used as an instrument to internalize the social costs of negative impacts that are not reflected in production costs, such as pollution (Becker and Davis, 2022). In this context, carbon tax is one of the real applications of Pigouvian Tax. Carbon taxes are designed to reduce the negative impact of carbon emissions by adding social costs to the price of products or activities that cause emissions (Nordhaus, 2019). The carbon tax is calculated based on the amount of carbon dioxide produced from burning industrial fuels which produce greenhouse gas emissions. Thus, a carbon tax not only functions as a tool to reduce negative externalities, but also as a mechanism that directs the economy towards a more efficient and sustainable allocation of resources (Jia et al., 2021). The carbon tax aims to encourage the use of cleaner and environmentally friendly technology, as well as changing people's economic behavior towards a pattern of green economic behavior (Buchanan et al., 2022). As a product of fiscal law, carbon tax also has a budgetary function by generating state revenue. However, the main substance of this tax does not focus on the income aspect, but rather on the regular end function, namely regulating economic behavior to be more in line with the principles of environmental sustainability (Sato et al., 2022).

2.2. Decline Carbon Emissions as Support for Net Zero Emissions 2060

Carbon emissions are the phenomenon of releasing carbon into the atmosphere that occurs as a result of natural and human activities over a certain period of time and in a certain area. Globally, carbon emissions are influenced by various factors such as economic growth, dependence on fossil energy, and increasing human population (International Energy Agency, 2020). Rapid economic growth often goes hand in hand with increased industrial activity and energy consumption, much of which still relies on fossil fuels. The use of fossil energy such as petroleum, coal and natural gas is a major contributor to carbon emissions, which in turn causes an increase in greenhouse gas concentrations in the atmosphere (Zhao et al., 2023).

Responding to this challenge, the government has taken concrete steps in an effort to reduce carbon emissions as part of a global commitment to curb the rate of climate change. One of the main efforts taken is to set a target of achieving Net Zero Emissions by 2060 and commit to reducing carbon emissions to reach net zero, where the emissions produced will be balanced with the amount of carbon absorbed by nature or through other carbon absorption technologies (He et al., 2023).

3. RESEARCH METHODOLOGY

3.1. Research Scope

This research uses quantitative data which includes carbon tax data and carbon emissions data. Secondary data sources were obtained from the World Bank. This research focuses on G20 member countries during the 2016-2020 period.

3.2. Statistical Analysis

Statistical Analysis is the process of collecting, organizing, interpreting and presenting quantitative data using statistical techniques with the aim of identifying patterns, trends and relationships in the data (Gao et al., 2023). In the context of this research, statistical analysis functions to evaluate the relationship between carbon taxes and carbon emission levels, as well as to test hypotheses regarding the impact of carbon taxes on reducing emissions (Wang et al., 2022).

3.3. Pearson Correlation Test

Pearson Correlation Test was used to identify the relationship between carbon taxes and carbon emission levels. The test results are expected to show a negative correlation, indicating that an increase in carbon tax is associated with a decrease in carbon emissions (Li et al., 2023). Interpretation of this correlation coefficient will provide an understanding of the effectiveness of carbon taxes in reducing carbon emissions and evaluate the success of G20 countries' sustainability strategies to achieve the net zero emissions target by 2060 (Chen et al., 2023).

3.4. Content Analysis

The content analysis method is applied to assess corporate sustainability in order to identify initiatives related to reducing carbon emissions and evaluate their impact on the environment (Bebbington et al., 2022). This process involves collecting and reviewing sustainability reports from various periods and sources to uncover policies, practices and reported results regarding emission reductions (Khan et al., 2021). This content analysis is designed to provide in-depth insight into G20 countries' strategies

for carbon footprint mitigation as well as identify areas that require improvement or further development (Nguyen et al., 2023).

4. RESULTS

4.1. Statistical Analysis

Descriptive Statistical Analysis functions in descriptions that include the mean and median of a set of ordered data. Apart from that, this analysis includes data distribution such as maximum values, minimum values, and standard deviation values as indicators of data distribution in research (Jin et al., 2023).

Based on Table 1, the average value of carbon emissions in G20 countries during the 2016-2020 period is 1.997108 CO_2/kWh with a median value of 2.039102 CO_2/kWh is slightly higher than the average indicating that the distribution of carbon emissions tends to be skewed to the left, with most countries showing emission values close to or above the median value. The maximum value is 2.821087 CO_2/kWh and a minimum value of 0.663988 CO_2/kWh indicates that there are significant variations in carbon emission levels between G20 countries. Countries with the highest emissions show more than four times the lowest emission values due to differences in environmental policies, levels of industrialization, or dependence on fossil fuels.

The average carbon tax of 22.47883 shows the general rate applied in G20 countries during the 2016-2020 period. This tax functions as an instrument to control carbon emissions by putting a price on CO_2 emissions. The median value of 23.59859 shows that some G20 countries set carbon taxes above the median value, while some others set it below the median value. This shows that the distribution of carbon taxes tends to be skewed towards the higher side. The maximum value of carbon tax is 26.80889 and the minimum value is 12.79140, indicating that there is quite large variation in the implementation of carbon tax policies in G20 countries. Countries with the highest carbon taxes set rates more than double those of the lowest reflecting differences in the commitment to emissions reduction policies and economic strategies of each country.

4.2. Pearson Correlation Test

Pearson Correlation Test used to measure the strength and direction of the linear relationship between the Carbon Tax variable (X) and the carbon emissions variable (Y).

The Pearson Correlation Test Hypothesis is as follows (Kumar and Jain, 2022):
$P < 0.05$ then H_0 is rejected and Ha_a is accepted.
$P > 0.05$ then H_0 is accepted and Ha_{is} rejected

Based on the results of the Pearson correlation test shown in Table 2, there is a negative relationship between the carbon tax variable (X) and carbon emission reduction (Y) with a correlation coefficient value of −0.304561. This value indicates the existence of a moderate and statistically significant relationship between the two variables. In other words, when carbon taxes increase, carbon emissions tend to decrease. This negative correlation shows that carbon tax policies have the potential to be effective

Table 1: Statistical analysis

Statistical classifications	Carbon tax (X)	Carbon emissions (Y)
Mean	22.47883	1.997108
Median	23.59859	2.039102
Maximum	26.80889	2.821087
Minimum	12.79140	0.663988

Source: 2024 research results

Table 2: Pearson correlation test

	Correlation	
Probability	X	Y
X	1,000000	

Y	−0.304561	1,000000
	0.0079	-----

Source: 2024 research results

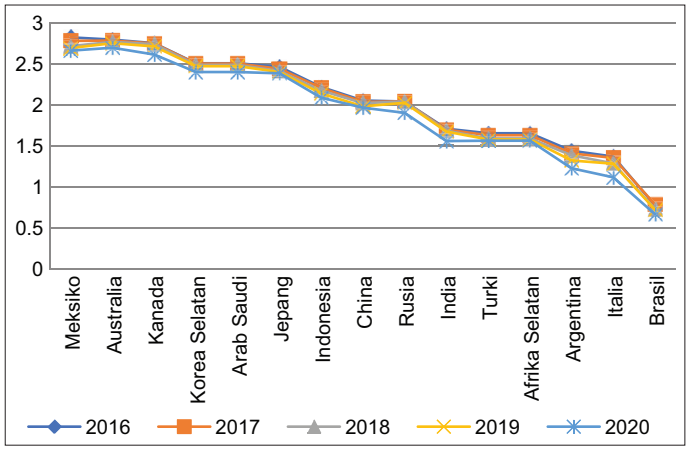
in reducing emission levels, which is one of the main goals in climate change mitigation efforts. The probability value (P-value) obtained is $0.0079 < 0.05$, indicating that at the 5% significance level ($\alpha = 0.05$), the null hypothesis (H_0) states that there is a relationship between carbon taxes and reducing carbon emissions.

5. DISCUSSION

5.1. The Effect of Carbon Taxes on Reducing Carbon Emissions in G20 Countries as a Strategy to Achieve Net Zero Emissions 2060

Based on the results of research conducted on G20 countries during the 2016-2020 period, it was found that there is a negative and significant relationship between carbon taxes and carbon emissions. Figure 1 illustrates this trend, showing how G20 countries with higher carbon taxes experienced a more significant reduction in carbon emissions compared to those with lower taxes. This research confirms the theoretical view that carbon taxes are an effective instrument in reducing carbon emissions, showing that countries that impose higher carbon taxes succeed in reducing their carbon emission levels more effectively compared to countries that impose lower carbon taxes (Metcalf and Stock, 2021). This policy plays an important role in mitigating climate change. In the context of the G20, where countries are the main contributors to global

Figure 1: Trend in Reducing Carbon Emissions in G20 Countries for the 2016-2020 period



emissions, the implementation of a carbon tax has a substantial impact in reducing the carbon footprint (Stern and Stiglitz, 2022).

The implementation of higher carbon taxes will not only trigger behavioral changes at the producer and consumer level, but also accelerate innovation in clean energy technologies. Manufacturers in countries with high carbon taxes are adopting more technologies that reduce carbon emissions, such as capture and storage (CCS) technology, renewable energy, and increased energy efficiency (Gollier and Tirole, 2023). On the other hand, consumers will be encouraged to choose products and services that are more environmentally friendly, such as electric vehicles or solar energy for households. This innovation will ultimately accelerate the transition from a fossil fuel-based economy to a low-carbon economy, in line with the global commitment to achieve Net Zero Emissions by 2060 (Kumar et al., 2022). This is in accordance with environmental economic theory which states that the internalization of the social costs of pollution through taxes can significantly influence economic decisions, leading to better environmental outcomes and thereby contributing to achieving emissions reduction targets (Harrison and Rubinfeld, 2023).

Mexico is a country in Latin America that implemented a carbon tax in 2014, with relatively low rates. This tax focuses on the energy and transportation sectors. The impact of the carbon tax in Mexico is still limited, but there has been a moderate reduction in emissions due to increased energy efficiency and the adoption of green technologies in the industrial sector. Mexico has set a target to achieve Net Zero Emissions by 2060 with a strategy that includes increased use of renewable energy, energy efficiency, and environmental policy reform (González et al., 2022).

Australia has experienced a moderate reduction in emissions due to increased use of renewable energy, especially solar and wind. However, dependence on coal exports remains a major challenge. Australia has committed to achieving Net Zero Emissions by 2060, with a focus on developing low-carbon technologies, although consistent and comprehensive policies are still needed (Hughes and Gale, 2022).

Canada implements a national carbon tax with gradually increasing rates. This policy is accompanied by a mechanism to return the majority of tax revenues to the community. Since the implementation of the carbon tax, emissions have been seen to decrease, especially in the transportation and energy sectors. Carbon taxes encourage the transition to electric vehicles and increased energy efficiency. Canada has set a target to achieve Net Zero Emissions by 2060, with measures such as major investments in renewable energy, carbon capture and storage (CCS), and energy policy reform (Murray and Rivers, 2021).

South Korea had an emissions trading system (ETS) similar to a carbon tax in 2015, as part of efforts to reduce carbon emissions. This policy covers various sectors, including energy, industry and transportation. Since the implementation of the ETS, South Korea has seen significant reductions in emissions in the sectors covered by the scheme, mainly through increased energy efficiency and the adoption of low-carbon technologies. South Korea is committed to achieving Net Zero Emissions by 2060, with a strategy that includes developing renewable energy, electrifying the transportation sector, and reducing the use of fossil fuels (Hutfilter et al. (2023).

Saudi Arabia is starting to introduce environmental policies, including a carbon tax, but these policies are still in their early stages and rates are low. The impact of the carbon tax policy is still not significant, but Saudi Arabia is trying to reduce emissions through economic diversification and investment in renewable energy. Saudi Arabia has set a target to achieve Net Zero Emissions by 2060, with a strategy that includes developing renewable energy, reducing domestic oil use, and increasing energy efficiency (Al-Mulali et al., 2023).

Japan implemented a carbon tax progressively, starting in 2012. This tax applies to sectors with high emissions such as industry and transportation. The carbon tax has driven emissions reductions in Japan, primarily through increased energy efficiency and the adoption of low-carbon technologies such as CCS and electric vehicles. Japan has set a target to achieve Net Zero Emissions by 2060. This strategy includes large investments in renewable energy, increased energy efficiency, and the development of new technologies such as hydrogen and CCS (Takahashi et al., 2023).

Indonesia is starting to introduce a carbon tax policy with a focus on the energy and industrial sectors. This policy is still in the early stages of implementation and requires stronger support. Emission reduction in Indonesia is still limited, with heavy dependence on coal as the main energy source. However, there are efforts to increase the use of renewable energy and energy efficiency. Indonesia is committed to achieving Net Zero Emissions by 2060. This strategy includes developing renewable energy, reducing deforestation, and increasing energy efficiency (Sari et al., 2023).

China has developed and implemented an emissions trading system (ETS) starting with a pilot scheme in several cities and provinces in 2013 before launching a national ETS system in 2021. This ETS system covers large energy and industrial sectors, aiming to monitor and reduce carbon emissions through allocation quotas and emissions trading. China has seen a significant reduction in carbon emissions thanks to strict pollution control policies and large investments in renewable energy. The country is a global leader in renewable energy capacity, especially in solar and wind power. China is committed to achieving Net Zero Emissions by 2060, with a strategy that includes increasing the use of renewable energy, electrifying the transport sector, and developing low-carbon technologies such as hydrogen and carbon capture. In addition, China has a strategy to reduce carbon intensity per unit of GDP and accelerate the transition from coal to clean energy (Qi et al., 2021).

Russia is starting to implement a carbon tax in several sectors but rates are still very low and implementation is limited. Although Russia remains one of the largest emitters, there are several efforts to improve energy efficiency and reduce emissions in certain sectors. Russia has set a target to achieve Net Zero Emissions by 2060, with a focus on modernizing the energy sector, reducing

dependence on fossil fuels, and improving green technologies (Petrova et al., 2022).

India has started implementing a carbon tax policy in the form of a CESS (levy) on coal since 2010, which aims to reduce dependence on fossil fuels. This tax was strengthened in the 2016-2020 period. Emission reduction in India remains limited due to high levels of economic growth and dependence on coal. However, there has been a significant increase in the use of renewable energy such as solar and wind. India is focusing on increasing renewable energy capacity and energy efficiency as part of its long-term strategy to reduce emissions (Jain et al., 2020).

Türkiye has developed various policies to reduce emissions, including energy efficiency standards and incentives for renewable energy. Emission reductions in Türkiye are still limited due to high levels of economic growth and dependence on coal. However, there is an increase in the adoption of renewable energy, especially in the energy sector (Kaya et al., 2022).

South Africa is starting to implement a carbon tax at a relatively low and gradual rate. This tax is applied in various sectors, including electricity, industry and transportation. The impact of the carbon tax is starting to be seen, with moderate emissions reductions in the energy sector, mainly due to increased investment in renewable energy, although dependence on coal remains high. South Africa has set a target to achieve Net Zero Emissions by 2060, with a focus on the transition from coal to renewable energy, improving energy efficiency, and investing in clean technologies (Lamb et al., 2023).

Argentina began implementing a carbon tax with rates that were initially low but gradually increased. This tax focuses on the energy sector, especially fossil fuels. The impact of the carbon tax in Argentina remains limited, but there is increasing awareness and investment in renewable energy, such as wind and solar power. Argentina has stated a strategy to achieve Net Zero Emissions by 2060, with a focus on developing renewable energy, increasing energy efficiency, and reducing emissions from the transportation sector (Diaz et al., 2023).

Italy has implemented a carbon tax since early 2010 as part of the European Union's efforts to reduce carbon emissions. This tax is applied in the transportation and energy sectors. Italy has succeeded in reducing carbon emissions significantly, mainly through increasing the use of renewable energy and energy efficiency in the transport and building sectors. Italy is committed to achieving Net Zero Emissions by 2060, with a focus on the energy transition, increasing energy efficiency and developing green technologies (Bosi et al., 2023).

Brazil has adopted various policies to reduce emissions, including incentives for renewable energy and efforts to reduce deforestation. Emission reductions in Brazil remain limited, mainly due to continued deforestation in the Amazon. However, there is progress in the use of bioenergy and hydropower as renewable energy sources. Brazil is committed to achieving Net Zero Emissions by 2060, with a strategy that includes reducing deforestation, increasing renewable energy, and increasing energy efficiency in the transportation and industrial sectors (Barros et al., 2023).

6. CONCLUSION

This research confirms that carbon taxes have an important role in reducing carbon emissions, which is a critical step towards achieving Net Zero Emissions by 2060 in G20 countries. Empirical analysis shows that although there are differences in the impact of implementing carbon taxes between countries, overall, this policy is effective in reducing carbon emissions. The success of a carbon tax cannot be separated from supporting policies that strengthen the transition to a low-carbon economy, such as renewable energy subsidies and investment in green technology.

6.1. Suggestions

A carbon tax that is consistently implemented and even gradually increased could accelerate the transition to a low-carbon economy. This is in line with long-term goals such as the Net Zero Emission target by 2060 launched by many countries. However, to achieve sustainability in reducing emissions, carbon taxes need to be combined with other complementary policies, such as investment in renewable energy, support for green innovation, and regulations that encourage energy efficiency in various economic sectors. Therefore, a more holistic and collaborative strategy is needed, involving all stakeholders to achieve long-term success in reducing emissions and mitigating the impacts of climate change globally.

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