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GAUGING GREENHOUSE EMISSION THROUGH CBA, TRADE, FDI, AND POPULATION GROWTH

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ABSTRACT

Introduction: Greenhouse gas emissions have a massive effect on the thinning of the earth's ozone layer, nowadays the industry is obligated to be as responsible for the process and output as possible in order to reduce carbon dioxide emissions (CO2). This study examines the implications of consumption-based accounting, trade, and foreign direct investment on greenhouse gas emissions from the least five emitters of different fuel types, according to the World Research Institute Indonesia, which are Japan, Brazil, Indonesia, Iran, and Canada from 2000 until 2020.

Methods: The study employs a panel data regression using Random Effect Model-Hausman Test.

Results: The findings show that foreign direct investment has a strong negative association with lowering greenhouse gas emissions. The greater the investment, the cleaner the air and atmosphere. Trade has a negative correlation with greenhouse gas emissions, this reflects increasing environmental consciousness among producers and/or increasing pressure for environmentally friendly operations from oversea. Since natural assets could convey their full economic potential on a sustainable ground. The population had a role in lowering carbon emissions as well. The results of the consumption-based emission regression show a significant positive relationship, which can clearly exacerbate climate change conditions. It is not astounding, given that CBA accounts for emissions throughout a product's or service's complete lifecycle.

Conclusion and suggestion: This study advances the grasp of greenhouse gas emissions and the factors that influence others in the five lowest emitters. It is the first study towards using greenhouse gas emission data as the dependent variable, rather than consumption-based accounting data, which has been used in most previous studies.

INTRODUCTION

The environment has already been affected by global climate change, and environmental degradation is one of the biggest problems facing modern society (Muhammad & Khan, 2021). In large part because of greenhouse gases caused by human activity (Sarkodie & Strezov, 2019) such as burning fossil fuels like natural gas, oil, and coal. These gases trap heat from the sun's rays within the atmosphere, raising the average temperature of the Earth This increase in global temperature is referred to as global warming (Geographic, 2022), which carbon dioxide (CO2) accounts for over 75% of worldwide greenhouse gas emissions. Scientists are much confident that global temperatures will continue to rise for decades. The Intergovernmental Panel on Climate Change (IPCC), which covers over 1,300 experts from the United States and other countries, predicts a 2.5 to 10-degree Fahrenheit temperature rise over the next century (NASA, 2022). Climate change differ from location to place. A desert, for example, has an arid climate since it receives minimal rain or snow throughout the year and for tropical climates, which become hot and humid (Diffenbaugh, 2020).

Several economies conduct studies related to global warming (Al-Ghussain, 2019; Nordhaus, 2007; Pearce, 1991). These authors show that the strength of consumer goods is significantly correlated with carbon emissions, indirectly implying that trade also affects greenhouse gas emissions. On the one hand, trade has boosted the flow of commodities and services while also broadening economic activity (Schneider, 2005). Khan et al. (2020) contends that international commerce contributes to environmental damage by allowing governments to relocate polluting industries to other countries. Nonetheless, commerce raises countries' economic levels, which can be used to ameliorate environmental degradation in the latter phases. Smooth trade is undoubtedly backed by capital, the majority of which comes from foreign direct investment (Bin & Jianmao, 2000). As a result, FDI contributes to carbon emissions. Furthermore, FDI should be more focused on raising public awareness about investments that can prevent pollution, such as selecting companies that are already eco-friendly or have technology innovation and adoption of new technologies aimed at lowering greenhouse gas emissions (Omri et al., 2014). The public have responsibility in this situation, because as the population rises, so does public awareness of the need to maintain the environment (S. Wang et al., 2017). In contrary, population growth can also be detrimental if individuals do not even care about the environment and worsen it by consuming excessive amounts of gas (Dong et al., 2018).

Through this paper the authors would like to discuss the greenhouse gas emissions that are influenced by consumption-based accounting, trade, foreign direct investment and population growth. The research object selected is the lowest five emitters based on the World Research Institute Indonesia, namely Japan, Brazil, Indonesia, Iran, and Canada from the period 2000-2020. From the selected countries, it is reflected that the

management of gas emissions is quite good compared to the others. The other sections of the paper are organized as follows: the second section comprised a review of the literature, the third section discussed the data and the method, the fourth section included the results and a discussion, and the fifth section provided as the conclusion of study.

LITERATURE REVIEW

A thorough analysis of the literature on the contribution of consumption-based carbon emissions is provided in this section. The recently released work of (Gao et al., 2019; Jijian et al., 2021; Khan et al., 2020; Liobikienė & Butkus, 2019; Macedo et al., 2021; Muhammad & Khan, 2021; Opoku et al., 2021; Sarkodie & Strezov, 2019; Steininger et al., 2018; S. Wang et al., 2017; Y. Wang et al., 2021) are covered in the literature in this part for carbon emissions, trade, foreign direct investment, and population growth.

Macedo et al. (2021) revealed in his journal that consumption-based accounting, as indicated by net consumers, had a substantial negative association with carbon emissions, with evidence showing British Columbia CO2 fell from 2010 to 2015. Comparatively, Steininger et al. (2018) realized that the growing spatial gap between production and consumption activities as a result of globalization. However, according to a survey of the literature on many comparable journals connected to consumption-based accounting, all previous studies, which the researchers have gathered above, utilize it as a dependent variable to show carbon emission, or just looking at it internationally, therefore this is the first study to use it as an explanatory variable.

Y. Wang et al. (2021), who investigated over 30 provinces on the Chinese mainland from 2004 to 2016, concentrate on FDI to obtain the conclusion that FDI's promotion effect on emissions would grow initially before declining. Manufacturing plays a significant role in China's economic growth. The majority of provinces began introducing industry to spur economic growth in the early days of the introduction of foreign capital, which increased emissions. The governments have, however, expressly incorporated more ecologically friendly foreign capital as FDI has grown in scope. The emissions per unit of output might eventually decrease with the advancement and effects of green technology. In the same way, Sarkodie & Strezov (2019) obtained similar findings that the top five developing-nation carbon emitters—China, India, Iran, Indonesia, and South Africa—increase CO2 emissions when foreign direct investment enters their economies. Many least developed and developing countries are eager to draw foreign direct investment inflows with polluting industries by engaging in inefficient competition, such as lowering their environmental standards despite having subpar environmental management systems and cutting-edge technologies to streamline polluting trends. This is due to the

globalization process and the desire to improve economic development. The analysis found that even while greenhouse gas emissions seem to be declining at a consistent rise in foreign direct investment inflows, there is still opportunity for improvement.

In contrast, Muhammad & Khan (2021) demonstrated that FDI has a positive and statistically significant link with carbon emissions in 170 countries for the period 1990 to 2018, while Jijian et al. (2021) showed a positive but insignificant relationship between FDI and CO2 in 52 BRI nations from 1995 to 2014. It means the greater the investment into a country, the greater its carbon emissions. It might be argued that the nation is not yet capable of managing environmental issues. Opoku et al. (2021), proves that FDI flow metrics have a statistically significant negative association with CO2 emissions, indicating that an increase in FDI flow could potentially ameliorate environmental degradation by reducing carbon emissions, regardless of the measure of CO2 emissions. Although Liobikienė & Butkus (2019) also found a negative correlation between FDI and GHG, but not significant.

Khan et al. (2020) identified that exports are inversely correlated with consumption-based carbon emissions whereas imports are favorably associated with consumption-based emissions. Since the G7 economies are highly developed, there is a greater demand for a healthier environment, which results in more production of environmentally secure commodities. Furthermore, imports of energy-intensive goods, which have a favorable influence on energy consumption, result in increased carbon emissions. This is also consistent with Jijian et al. (2021) research findings. However, Liobikienė & Butkus (2019) found statistical evidence of a negative association between trade and GHG emissions, which contradicts the leakage effect, but Opoku et al. (2021) discovered that trade openness has predominantly positive coefficients, showing that increased trade openness generally damages the environment. They also indicated that the influence of population growth is varied, and it relies on the measure of CO2 emissions. In general, population growth is observed to likely raise production-based (territorial-based) CO2 emissions while decreasing consumption-based emissions. S. Wang et al. (2017) also demonstrates that population has a negative and strong relationship with carbon emissions.

RESEARCH METHODS

This study investigates the relationships respectively greenhouse gas emissions (GHG) and their antecedents, such as trade (TRA), foreign direct investment (FDI), and population, inside the case of the five lowest emitters, namely Japan, Brazil, Indonesia, Iran, and Canada. To explain the relationship between our explanatory and dependent variables, panel data regression is our primary estimation method. The regression model for this study is as follows Opoku et al. (2021) and Wang et al. (2017):

$$GHG_{it} = \alpha + \beta_1 CBA_{it} + \beta_2 TRA_{it} + \beta_3 FDI_{it} + \beta_4 PPL_{it} + \varepsilon_{it}$$

where *i* and *t* deputize country (5 countries) and time (2000–2020) variables, successively. The dependent variable is GHG, which stands for degradation of the environment, specifically greenhouse gas emissions that represent carbon dioxide (CO_2), which accounts for roughly three-quarters of all emissions. It has the potential to remain in the atmosphere for thousands of years. GHG is calculated in this study based on the use of coal, oil, gas, cement, flaring, and other industries and it is also calculated in million tons of carbon per year. Coal-fired power plants and cement factories account for the majority of carbon dioxide emissions.

CBA is referred to as Consumption-Based Accounting. Some studies use CBA as a sign of GHG (Gao et al., 2019; Khan et al., 2020; Macedo et al., 2021), but the researcher reveals the two apart by declaring them dependent and independent variables. since the data for the two variables are distinct. Fundamentally, CBA is primarily to blame for the state of the environment; the more emissions are consumed, the more in danger the environment is. CBA is typically equivalent to Production-Based Accounting (PBA) as well, but in this study only CBA is used because PBA would incorporate multicollinearity, given that CBA is sufficiently representative and allows for later trade depiction of production.

Trade (TRA), which is the sum of all exports and imports of goods and services as a percentage of GDP (Jijian et al., 2021), is a measure of trade openness. This metric is used to estimate globalization. The trade is also heavily considered when examining the EKC hypothesis (Liobikienė & Butkus, 2019), which could be used to proxy the leakage phenomenon. However, this phenomenon has not yet been considered in the studies of the EKC hypothesis.

Foreign direct investment (FDI) is only recorded by the researcher in one way—through net inflows into the Balance of Payment (BoP) using the current US dollar. The stock measure calculates the total cumulative value of foreign owned investment or capital in a country because the flow measures are based on current account inflows. Stock resulting from the accumulation of flows may more effectively capture long-term effects, might capture established multinationals, and may have a greater impact on the local economy and, consequently, the environment (Muhammad & Khan, 2021; Opoku et al., 2021).

PPL stands for the number of populations, and it is measured as the total amount of people in million inhabitants. Dietz & Rosa (1994) and Schneider et al. (2011) say that population changes have an effect on the environment, CO_2 pollution is worse in countries with more people. While β_1- β_4 are the estimated parameters, and ε_{it} is the error term.

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Trade and FDI data were obtained from the World Bank, whereas GHG, CBA, and population data were obtained from Oxford Martin. Japan, Brazil, Indonesia, Iran, and Canada were chosen derived on a survey by the World Research Institute (WRI) Indonesia 2020 as the five countries with the lowest emissions among the ten countries that contribute the most to global emissions. Therefore, it can be assumed that the five countries are better at managing carbon emissions than the larger group, as demonstrated by the benchmark variables utilized in this study. The base years 2000 to 2020 were chosen based on data availability.

Table 1. Summary of Variable

Type of variable	Name of variable	Symbol	Unit	Data source
Dependent variable	Greenhouse gas (CO_2) emission	GHG	Million tonnes per year	Oxford Martin
Independent variable	Consumption-based accounting	CBA	Million tonnes	
	Trade	TRA	% of GDP	World Bank
	Foreign direct investment inflows	FDI	Current US$	
	Population	PPL	Million inhabitants	Oxford Martin

RESULT AND ANALYSIS

The result of panel regression indicated that Random Effect Model is the best model to estimate the link of consumption-based accounting, trade, foreign direct investment, and population growth with greenhouse gas emission in the lowest five emitters (Japan, Brazil, Indonesia, Iran, and Canada). The research initially used the Hausman test to determine whether utilizing REM or Fixed Effect Model is the best option (see Table 2). When the correlated random effect-Hausman test's p-value was 0.00, it indicated that alpha was greater than p-value (0.05). Consequently, it may be determined that REM is rejected.

The Chow test was further applied to support the outcomes of the earlier Hausman test. The ideal model is the common effect model if the p-value of the chow test is less than alpha, and the fixed effect model if the p-value of the chow test is greater. The data indicate that CEM is the remarkable estimation, due to alpha was greater than p-value, 0.00 < 0.05. The Lagrange multiplier/Breusch Pagan test is then used in the decision-making process to establish whether CEM is superior to REM (Hsiao, 2007). The final p-value shows the same result as before, that Breusch-Pagan is less than alpha. In other

words, REM is accepted whereas the Common Effect Model is denied. The preceding test demonstrates that REM is the best option for this study's estimation of the greenhouse gas emission model under a variety of conditions.

Table 2. The regression panel determination

Regression	Test	P-value
Random Effect Model	Hausman-test	0.000
Fixed Effect Model	Chow-test	0.000
Common Effect Model	Lagrange-test/ Breusch-pagan	0.000

Seen from the comparison of the three models; REM, FEEM and CEM. Only in the constant negative FEM, population and trade are both positive and significant. Meanwhile, REM and CEM coefficients and symbols are the same. In FEM, it can be interpreted that when 1% of trade and population increase, it will contribute to changes in greenhouse gas emissions by 2.5% and 4% per year, respectively. This implies that rising economic growth may be connected to rising CO2 emissions and consequent environmental degradation (Opoku et al., 2021), and it cannot be separated from population growth, due to population is theorized become an primary determinant, alongside economic activities (Dietz & Rosa, 1994; Schneider et al., 2011).

Table 3. Comparison of panel regression model

Variable	REM	FEM	CEM
Dependent variable: GHG			
Independent variable:			
CBA	4.690 ***	1.760 ***	4.690 ***
	(1.010)	(4.870)	(3.050)
Trade	-11.639 ***	2.555 ***	-11.639 ***
	(0.306)	(0.889)	(0.925)
FDI	-12.476 ***	-5.603 *	-12.476 *
	(2.699)	(3.731)	(8.139)
Population	-3.650 ***	4.000 ***	-3.650 ***
	(7.660)	(1.090)	(2.310)
Constant	1248.9 ***	-152.05	1248.9 ***
	(20.225)	(117.94)	(60.991)
R^2	0.826	0.981	0.826
Number of countries	5	5	5
F-Statistic	0.000	0.000	0.000

After confirming the use of Random Effect Model, the regression results showed as follows; first, consumption-based accounting is positively associated with greenhouse gas emission. On average, a 4.6% increase in greenhouse gas emission is caused by consumption-based accounting. The increased consumption-based accounting of emissions indicates that environmental contamination is spreading rapidly as a result of the increased use of gas. Moreover, emissions from domestic consumption and emissions contained in imports, which allocate emissions to all consumer activities inside a nation. These findings verify the result of Steininger et al. (2018).

Second, trade has a negative relationship with greenhouse gas emissions. When trade grows by 1%, greenhouse gas emissions fall by 11.6 %. This accomplishment demonstrated that these five countries were successful in regulating carbon emissions. It is likely that some corporations have implemented stricter environmental standards. Additionally, advanced technology is strongly influential in reducing emissions (Liobikienė & Butkus, 2019; Y. Wang et al., 2021). On the other hand, Opoku et al. (2021) found that trade openness is determined to have primarily positive coefficients, implying that increasing trade openness generally damages the environment. This essentially said that opening up to trade will eventually ruin the nature.

Third, foreign direct investment is significant and negatively connected with greenhouse gas emission. The rise in foreign direct investment into the country contributed to the 12.4 % drop in greenhouse gas emissions. However, as the amount of FDI grows, governments have deliberately implemented more ecologically friendly foreign capital. Eventually, with the advancement and spillovers of green technology, emissions per unit of output may gradually be minimized (Sarkodie & Strezov, 2019). Comparatively, (Muhammad & Khan, 2021) revealed that foreign direct investment had a positive and statistically significant association with carbon emissions. It can be said that several countries are willing to attract foreign direct investment inflows with polluting industries in the process of globalization and the desire to improve economic development by engaging in inefficient competition, such as eroding their environmental standards, despite having poor environmental management systems and technological advances to streamline environmentally destructive trends (Omri et al., 2014).

Fourth, Population growth is negatively associated with greenhouse gas emission. On average, a 3.6% decline in greenhouse gas emission is caused by population. It indicated that the population had an intrinsic knowledge of the environment, which is followed by individual sensitivity to take care of both private and public projects. Furthermore, government support in the form of environmental policies had a substantial impact. This confirm the previous study by (Dong et al., 2018; Schneider et al., 2011). In contrast, population has a negative and strong link with carbon emissions, according to

Wang et al. (2017). The rising population will degrade the ecosystem by consuming more carbon emissions (Dietz & Rosa, 1994).

Finally, it can be claimed that foreign direct investment plays a vital role in lowering greenhouse gas emissions. realizing foreign direct investment is the key financing that affects all economic activities of a country. As seen from this that Japan, Brazil, Indonesia, Iran, and Canada have been capable of aligning economic activities with the environment. Due to the abundance of natural resources, it can decrease carbon emission (Muhammad & Khan, 2021), given that the country does not need to import any fossil fuel. Therefore, innovation can maximize already-existing natural resources and gas consumption can be reduced. This might be considered the government's accomplishment in publicizing and tightening environmental policies and gaining community support for their implementation. However, more empirical research is needed to through combination quantitative and qualitative to gain a clear classification and a more detail factor influencing carbon emission the most.

CONCLUSION

Japan, Brazil, Indonesia, Iran, and Canada are designated by the World Research Institute Indonesia as the lowest emitter countries based on the 2020 survey. This research will assess the relationship between consumption-based accounting, trade, foreign direct investment, and population growth in these nations for the period 2000-2020 using random effect model, and will be utilized as a resource for reviewing and studying factors that raise or decrease carbon emissions. This is the first study to differentiate between greenhouse gas emission and consumption-based emission variables into response and explanatory variables. According to the data, foreign direct investment had a significantly negative correlation with reducing greenhouse gases. This indicated that the more money invested, the healthier the air and atmosphere will be. Alongside trade, which had an adverse connection with greenhouse gas emissions, this showed more awareness of environmental issues among producers and/or immense pressure from abroad for ecologically beneficial operations. Yet natural assets can deliver their full economic potential on a sustainable basis. Population growth also has a role in reducing gas emissions. The findings of the consumption-based emission regression, on the other hand, demonstrate a significant positive association, which can definitely worsen global warming circumstances. The harmony between the government and society of the five lowest emitting countries is reflected in the results of economic activities that continue to prioritize the environment, as long-term investment materials.

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