Phân tích mối quan hệ giữa tiêu thụ nhiên liệu & phát thải carbon ở Canada bằng cách sử dụng phân tích hồi quy tuyến tính đa biến và gợi ý cho Việt Nam

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Tóm tắt: *Biến đổi khí hậu là một trong những vấn đề nghiêm trọng nhất hiện nay. Việc sử dụng quá nhiều khí nhà kính gây tổn hại cho chúng ta, dẫn đến những thứ như góp phần gây ra bệnh hô hấp, thời tiết khắc nghiệt và gián đoạn nguồn cung cấp thực phẩm. Bài viết này phân tích mối quan hệ giữa mức độ tiêu thụ nhiên liệu và lượng khí thải carbon tại Canada để khẳng định về tầm quan trọng của các yếu tố ảnh hưởng đến biến đổi khí hậu. Dữ liệu được lấy từ trang web của Chính phủ Canada đối với Canada và Macrotrends đối với Việt Nam. Trong bài viết này, phương pháp phân tích hồi quy bội được sử dụng để xác định mối quan hệ giữa mức tiêu thụ nhiên liệu và lượng khí thải carbon. Phương pháp hồi quy bội cho*

The relationship between fuel consumption and carbon emissions in Canada using multiple regression analysis and recommendations for Vietnam

Abstract: Climate change has been one of the most severe issues nowadays. The overuse of greenhouse gases hurts us, leading to things such as contributing to respiratory disease, extreme weather, and food supply disruptions. This paper is the analysis of the relationship between fuel consumption and carbon emissions in Canada to emphasize on the importance of factors that affect climate change. We get the data from the Government of Canada website for Canada's part and Macrotrends for Vietnam's one. In this paper, the method is to use multiple regression analysis to determine the relationship between fuel consumption and carbon emissions. Multiple regression analysis allows to explicitly control for factors that simultaneously influence the dependent variable. The result is that vehicles, especially the more they are used, make a direct impact on and proportional to carbon dioxide emissions. Therefore, it is necessary to invest in cleaner transportation to reduce the carbon dioxide emissions and enhance people's quality of life in the low-carbon economy. We have the recommendation for Vietnam, specifically, improving the public bus system is one of the suitable options in accordance with Vietnam's infrastructure.

Keywords: Canada, carbon emission, fuel consumption, multiple regression, Vietnam.

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phép kiểm soát rõ ràng các yếu tố mà ảnh hưởng đồng thời đến biến phụ thuộc. Kết quả là các phương tiện giao thông, đặc biệt là càng được sử dụng nhiều, tác động trực tiếp và tỷ lệ thuận đến lượng khí thải carbon dioxide. Do đó, giao thông vận tải sạch cần được đầu tư để giảm lượng khí thải carbon dioxide và nâng cao chất lượng cuộc sống của mọi người trong nền kinh tế carbon thấp. Chúng tôi có khuyến nghị đối với Việt Nam, cụ thể, cải thiện hệ thống xe buýt công cộng là một trong những phương án phù hợp với cơ sở hạ tầng của Việt Nam.

***Từ khóa**: Canada, khí thải carbon dioxide, tiêu thụ nhiên liệu, hồi quy tuyến tính đa biến, Việt Nam.*

1. Introduction

As our world continues to make technological advancements, climate change continues to be an issue we face that affects us daily. The overuse of greenhouse gases has a negative effect on us leading to things such as a contribution to respiratory disease, extreme weather, and food supply disruptions. The World Employment and Social Outlook 2018 estimated that 1.2 billion jobs are directly dependent upon the environment's healthy and sustainable management (International Labour Organization, 2021, 2). From the economic perspective, climate change has an indirect impact on economic development. Putting climate change in the context of economic analysis, climate volatility may force companies to deal with uncertainty in the price of resources for production, energy transport, and insurance (Cho, 2019). When economists examine a cost-benefit analysis, they weigh the consequences of the projected increase in carbon emissions compared to the costs of current policy actions to stabilize and try to decrease the CO2 emissions. Strong policy action to prevent climate change will bring benefits along with more opportunities for the economy to thrive.

We are aware of the relationship between fuel consumption and carbon emissions is rather self-obvious, but it is still worth to spend time and approach the relationship in an alternative way. In this paper, the method is to use multiple regression analysis. We use STATA/IC 16 for econometrics to write two models, which are the quadratic function and the interaction terms involving dummy variables. Then, we compare to see which one is the most suitable one to analyze the environment conditions. The purpose of this paper is to examine automobiles will affect and contribute to the increase in carbon dioxide emissions. Fuel consumption values depend directly (and very strongly) on CO2 emissions for a discussion in the context of automobiles' engines (Bielaczyc et al., 2019, 2). Firstly, we focus on Canada's condition of fuel consumption and carbon dioxide emission through the dataset collected from the Government of Canada website. After analyzing the situation in Canada, we relate and suggest some recommendations for Vietnam. Even though Canada and Vietnam are not the same in terms of economic and political system, climate change has both increased every day and the necessity of this research is inevitable.

2. Analysis of Canada's situation of fuel consumption

2.1. Data

We collect the data from the database, specifically from the Government of Canada website. The dataset is on March 24, 2021. The record released was on March 31, 2017, and the data has kept maintaining and updating frequently as needed. The resource name of the dataset is 2021 Fuel Consumption Ratings (2021-03-24). Its Publisher (Current Organization Name) is Natural Resources Canada. Dataset provides model-specific fuel consumption ratings and estimated carbon dioxide emissions for vehicles in Canada in 2021. In this paper, the method is to use multiple regression analysis to determine the relationship between fuel consumption and carbon emissions. Multiple regression analysis contains many observed factors as long as they affect the dependent variable (Wooldridge, 2015, 63). We generate variable names to make them convenient to follow and run the regression. The dependent variable is CO2 emissions. According to the dataset from the Government of Canada website, CO2 emissions are calculated in g/k, and we keep this variable name "co2emissions." The rest of the dataset is the independent variables. Engine size is "enginesize" measured in liter. The number of cylinders is generated to "cylinders." In the group of fuel consumption, we have the amount of fuel that automobiles use in the city (L/100 km) called "*fuelsecity*," on the highway (L/100 km) as "fuelsehwy." We also collect the data of smog level, named "smoglevel." Moreover, the "fueltype" variables, including gasoline and other types, present the qualitative information, and we use STATA/IC 16 to generate the dummy variable, which is "gasoline" because of its important role in our paper to answer the research question. When we collect the data from the dataset in the Government of Canada website, there are 13 variables in total. However, we only use seven variables with one dependent variable "co2emissions" and the rest as six independent variables to run the regression models in this research because the other six do not considerably relate to the efficiency and effectiveness of this paper, such as model of vehicle and transmission.

2.2. Model Specification

2.2.1. Theoretical Background

In this paper, we choose two different

Table 1: Summary Statistics Using STATA/IC 16

Variable	Mean	Standard Deviation	Min	Max
enginesize	3.080863	1.301521	1	6.7
cylinders	5.54259	1.8478	3	12
fuelsecity	12.0741	3.074033	4	20.5
fuelsehwy	8.994749	1.92453	3.9	14.3
co2emissions	251.1669	58.77473	94	410
smoglevel	4.774796	1.706754	1	7
gasoline	0.9556593	0.2059712	0	1

Source: March 24, 2021 https://www.nrcan.gc.ca/sites/nrcan/files/oee/pdf/transportation/tools/fuelratings/2021%20Fuel%20Consumption%20Guide.pdf regression models, which are the quadratic function and the interaction terms involving dummy variables. In the first place, the quadratic function is as our non-linear regression model because it is often used to capture decreasing or increasing the marginal effect of an independent variable (Wooldridge, 2015, 173). In the simplest form, y depends on a single observed factor x, but it does so in a quadratic term:

$y = \beta_0 + \beta_1 x + \beta_2 x^2 + u$

Otherwise, does not measure the change in y with the respect to x, it does not make sense to hold x^2 fixed while changing x (Wooldridge, 2015, 174a), so the estimated equation becomes:

$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x + \hat{\beta}_2 x^2$

In other words, it will help to observe the whole picture of the relationship between variables. The way an independent variable affects the dependent variable is not a constant. It depends on what value of that independent variable is at. We are usually more interested in quickly summarizing the effect of x on y, and the interpretation of $\hat{\beta}_1$ and $\hat{\beta}_2$ provides that summary (Wooldridge, 2015, 174b).

Secondly, we use the interaction term to capture the impact of a particular variable on the dependent variable that would differ across the two dummy variable groups. It is helpful to reparameterize a model so that the coefficients on the original variables have an interesting meaning (Wooldridge, 2015, 178). Consider a standard model with two explanatory variables and an interaction term:

$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2 + u$

In this type of model, the two regression models have the different intercept, which shows the different starting point on the vertical axis of the two lines.

We primarily expect the result to support our research about the relationship between fuel consumption and the emission of carbon dioxide leading to environmental pollution as a whole. Basically, from our perspective and our understanding, gasoline should be more harmful than other fuel types, including diesel fuel and Ethanol-85 (E85) that automobiles consume. Diesel fuel and E85 are better for the environment because they fewer volatile components than gasoline, which means fewer gas emissions from evaporation (West, 2021). As a result, in this research, we want to examine how automobiles' fuel consumption have influenced carbon dioxide emission.

2.2.2. Application

The first model is the quadratic function:

$\widehat{co2emissions}$ = 7.98 + 0.88 enginesize + 1.01 cylinders + 15.11 fuelsecity - 0.13 fuelsecity^2 - 9.48 fuelsehwy - 1.80 smoglevel - 3.95 gasoline

In the non-linear model, the key coefficient in the quadratic term would be the variable of the amount of fuel used in the city. We choose this key coefficient because of the meaning of the coefficient of the interaction term. It is the difference in the impact of the variable on the dependent variable between the two groups, specifically in this case, the impact of the amount of fuel used in the city on the carbon dioxide emission between two groups of fuel consumption.

When we want to describe its relationship between the dependent and independent variables, we talk about the complete picture rather than a part of it or only one number due to the constant. In the specific case of our research, it will be worth examining how the amount of fuel consumed affects carbon dioxide emissions. In addition to the fuel consumption, we test whether the amount of fuel used in the city has a significant impact on carbon dioxide emission or not. As we mention above, we try to observe the whole picture instead of looking at only a part of it as the linear regression model does.

In addition, the model with the interaction terms involving dummy variables is:

$\widehat{co2emissions}$ = 40.20 - 0.60 enginesize + 0.4 cylinders + 11.27fuelsecity - 17.81 gasoline + 0.95 fuelsecity.gasoline + 9.46 fuelsehwy - 1.70 smoglevel

As specifically applied in our research, we want to capture the different effects of the fuel used in the city on the carbon dioxide emissions between fuel types (gasoline and the other types) by incorporating the interaction term. Besides, the two regression functions have different slopes. We will have the carbon dioxide emission as the dependent variable. On the right-hand side of the model, we want to interact between the amount of fuel consumed in the city and the dummy variable of gasoline consumption. Therefore, we will see the impact of the amount of fuel used in the city on different types of fuel that leads to the emissions of carbon dioxide.

2.3. Evaluation

We propose the quadratic function and interaction term involving dummy variables to analyze the impacts of automobiles' fuel consumption on the carbon dioxide emissions in Canada in March 2021. For the quadratic regression function, we have "co2emissions" as the dependent variable and the independent variables are "enginesize," "cylinders," "fuelsecity," "fuelsehwy," and "smoglevel" and we have the quadratic term, which is . The "gasoline" variable is also the dummy variable in the regression function. The quadratic function captures the increasing or decreasing marginal effects of "fuelsecity," in this case. We run this quadratic regression by squaring one of the independent variables, which will be "fuelsecity" here. In the second model, the interaction term model is used to further explain the effect of the amount of fuel used in the city on carbon dioxide emissions in Canada between different fuel types. The interaction terms model will help explain whether "fuelsecity" (independent variable) and gasoline (dummy variable) varies with one another. Again, the "co2emissions" is the dependent variable and the independent variables are "enginesize," "cylinders," "fuelsecity," "fuelsehwy," and "smoglevel." To run the interaction term model, we multiply two variables together ("fuelsecity" and "gasoline") and we have the interaction term which is "fuelsecity_gasoline." The interaction term captures how an independent variable varies and affects a dummy variable (gasoline).

To evaluate the models with the same dependent variable, in this case, it is "co2emissions," we use standard error of regression (SER or Root MSE)

$$\hat{\sigma} = \sqrt{\frac{1}{n-k-1}.\ (SSR)}$$

The quadratic model:

$$\hat{\sigma} = \sqrt{\frac{1}{857-7-1}.\ (65780.5817)} = 8.802$$

The interaction term involving dummy variables model:

$$\hat{\sigma} = \sqrt{\frac{1}{857-7-1}.\ (67647.7142)} = 8.926$$

$\hat{\sigma}$ indicates how far the data points from the regression line on average. The small the $\hat{\sigma}$, the better model fits the data. Therefore, according to the results above, the quadratic function is the best model fits the data. According to the quadratic model, both *fuelsecity* and *fuelsecity*^{2} variables are individually significant because their p-values are both less than $\alpha = 0.05$. In the quadratic function, we use the test exclusion restrictions to test whether a group of variables has no effect on the dependent variable once another set of variables has been controlled.

$\widehat{co2emissions}$ =7.98 + 0.88 enginesize + 1.01 cylinders + 15.11 fuelsecity - 0.13 fuelsecity^2 - 9.48 fuelsehwy - 1.80 smoglevel - 3.95 gasoline

H_0: $\beta_{fuelsecity} = \beta_{fuelsecity^2} = 0$

H_1: At least one of above $\beta_j \neq 0$

(a) Estimate Unrestricted Model (above):

$$R^2_{ur} = 0.9778$$

(b) Estimate Restricted Model (without *fuelsecity* and *fuelsecity*^{2})

$$R_r^2 = 0.9415$$

(c) F Statistic

$$F_{stat} = \frac{\frac{0.9778 - 0.9415}{2}}{\frac{1 - 0.9778}{857 - 7 - 1}} = 694.11$$

(d) The critical value: $F_{(2,849,0.05)} = 3$

(e) Conclusion: Reject H_0. Therefore, *fuelsecity* and *fuelsecity*^{2} are jointly significant at 5% level.

The idea of using F-statistic is to compare how much improvement we would see by including two variables *fuelsecity* and *fuelsecity*^{2} that are being restricted. Thus, if including the additional two variables have made the R-square going from restricted R squared to unrestricted R squared with a big improvement, which will give us a large F statistic, in this case, the F-statistic is 694.11. With every additional variable to the model, R-squared will increase rather than decrease. Therefore, unrestricted model obviously would have a higher R-squared than the restricted model because the unrestricted model has two more variables than the restricted model. Thus, the improvement in the R-squared by the inclusion of those two variables is considerably large, so this would be a sign that these two variables are very useful in terms of explaining the dependent variable in the model.

Additionally, we examine whether any of the assumptions are violated. We checked for this by examining whether our preferred model, the quadratic model, suffered from multicollinearity, heteroscedasticity, etc. To determine if there is a concern for multicollinearity, we will get the Variance Inflation Factor (VIF) for the slope coefficients in our quadratic model. The formula for VIF is:

$$VIF = \frac{1}{1 - R_j^2}$$

We can also solve for it through STATA by creating our quadratic regression first, then the command will be "vif" and enter for the results of vif of the various slope coefficients. Our finding suggests that the independent variables "*fuelsecity*" and "*fuelsecity*^{2}" (the squared variable) had high VIF's (larger than 10) of 45.61 and 45.24, respectively. This indicates that multicollinearity should be a concern. However, these two independent variables are jointly significant, so we can forget this multicollinearity. Multicollinearity does not violate any OLS assumptions though since it is not perfect collinearity. Another way to check if the model violates any of the assumptions is to check for heteroskedasticity, where the error terms do not have constant variance. Since our preferred model is the quadratic regression model, we used the white test to detect forms of heteroscedasticity. The command for this was "estat imtest, white", where the null hypothesis and the alternative hypothesis:

H_0 = homoskedasticity

H_1 = heteroskedasticity is present

The result is:

Chi2(33) = 221.94

Prob > chi2 = 0.0000

Since the p-value = 0 which is less than α = 0.05, so we reject the null hypothesis, meaning there is some form of heteroskedasticity in the quadratic model. In the presence of heteroskedasticity, the OLS estimator is still unbiased, however, OLS estimates are no longer BLUE. The standard errors are biased when heteroskedasticity is present leading to bias in test statistics and confidence intervals. We deal with this by checking for outliers and measurement errors, checking if any important variables were omitted, respecify model, or use the robust standard errors. We checked our data for outliers, the measurement errors, and for any omitted variables, but none of these were the case. We tried various ways to respecify our model such as using log and changing up the variables, but this seemed to have made our models worse. Thus, we will report the robust standard errors to fix our heteroskedasticity in the result part. No other assumptions were violated, so we were able to proceed with our data using our robust standard errors.

2.4. Results

The amount of fuel consumed in the city and the types of fuel consumption have an influence on the environmental pollution. With a view of illustrating the result, we talk about the significance of the key coefficients as well as interpret these coefficients in terms of the impact on the carbon dioxide emission as the dependent variable in the quadratic model.

$\widehat{co2emissions}$ = 7.98 + 0.88 enginesize + 1.01 cylinders + 15.11 fuelsecity - 0.13 fuelsecity^2 - 9.48 fuelsehwy - 1.80 smoglevel - 3.95 gasoline

After we run the quadratic model with the robust standard error, the robust standard error produces different t-tests, compared to the original set of regression. Fortunately, the p-values for the robust standard error regression and the original regression tell the same story, the same conclusion in terms of whether the coefficients are significant. Coefficient estimates will not change, but the standard errors and hence the t values are a little different. Based on the original standard errors, *fuelsecity* and *fuelsecity*^{2} variables are significant and based on the robust standard errors, *fuelsecity* and *fuelsecity*^{2} variables are significant as well. At least, by reporting the robust standard errors, the testing on the coefficient is not going to be biased, we are still able to confidently say *fuelsecity* and *fuelsecity*^{2} variables are significant because even if there is heteroskedasticity, but we use the robust standard errors, so heteroskedasticity will not affect the result of the testing.

Because the coefficient of enginesize^2 is -0.13, which is less than 0, so the graph is the inverted U-shape, so $\widehat{co2emissions}$ is a maximum.

The partial (marginal) effect of the engine size on the carbon dioxide emission is

$$\frac{d_{\widehat{co2emissions}}}{d_{fuelsecity}} = 15.1 - 2.(0.13).\text{enginesize} = 0$$

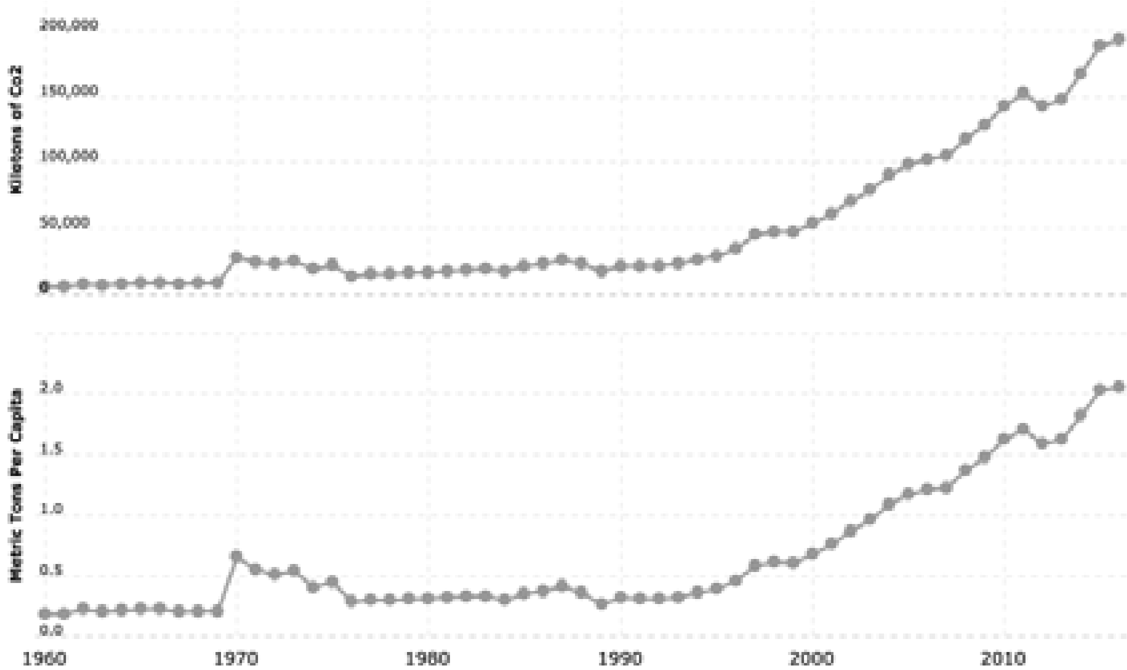
Therefore, *fuelsecity**. The whole picture tells us that as the amount of fuel consumed in the city increases, the carbon dioxide emission increases at a decreasing rate until fuel's consumption in the city reaches the turning point of 58.11 liters per 100 kilometers, after that, the carbon dioxide emission decreases at an increasing rate ceteris paribus.

We evaluated all these models and decided to choose the quadratic model as the preferred one to demonstrate the effect of automobiles' fuel consumption on the carbon dioxide emissions in Canada in 2021. After that, when we check the assumption violation, we detect the presence of multicollinearity and heteroskedasticity in our model. In terms of multicollinearity, although it violates none of the assumptions and OLS estimates are still biased, multicollinearity has many consequences, such as confidence interval being wider and the null hypothesis being harder to be rejected. However, we believe that being able to control the quadratic relationship is more important than having a multicollinearity in the model. In terms of heteroskedasticity, we tried many methods to get rid of it, but heteroskedasticity is still present. Eventually, we report the robust standard error to address the heteroskedasticity.

In conclusion, after testing the coefficients and interpreting the coefficients in terms of the impact on the emissions of carbon dioxide, we realize the huge impact of fuel consumption, in this case, the amount of fuel used in the city, on the amount of carbon dioxide released. The result is that vehicles, especially the more they are used, make a direct impact on and proportional to carbon dioxide emissions.

3. Recommendations for Vietnam

Canada and Vietnam are obviously different in terms of culture, politics, and economics, but it is still worth when Vietnam can draw some lessons and changes from Canada's situation, especially related to environmental issue because it is a universal problem. Unlike the economic pattern of Canada, Vietnam is a developing country with the average income per capita being approximately 4.19 million in 2020. Vietnam's remarkable success in mitigating poverty and promoting economic development over the past decades has been enabled by the rapid growth of supporting economic infrastructure, including transport. This accelerated increase in the mobility of people, goods, and services has benefited both the urban and rural populations (Oh et al., 2019, 23). As a result, the transport sector is becoming a significant and growing contributor to total GHG emissions in Vietnam. Statistically, Vietnam currently contributes 0.6% of the world's total greenhouse gases (GHG) emissions and ranks 27th globally in terms of GHG emissions (Vietnamnet, 2017). Besides, the majority of the Vietnamese's vehicle is motorcycles. Motorcycles are currently responsible for about 80% of travel needs in the city. As of 2019, out of 96 million population in Vietnam, nearly 49 million owned motorbikes (ReportLinker, 2020). However, Vietnam's automobile industry has grown significantly in recent years thanks to the country's fast-growing middle class. Entering to the new situation with many changes, it is better for Vietnam to observe, analyze, and learn from other countries' experiences. From the analyzed result above in Canada, there is a huge impact of the amount of fuel used in the city on the amount of carbon dioxide released. Vietnam carbon emissions for 2016 was 192,667.85, a 2.3% increase from 2015 (MacroTrends). Both automobiles and motorbikes discharge carbon monoxide, carbon dioxide, nitrogen oxide, and sulphury oxide into the atmosphere through exhaust pipes, flue gas stacks,



Source: macrotrends.net/countries/VNM/vietnam/carbon-co2-emissions

Figure 1: Vietnam Carbon Emissions from 1960 to 2021

and propeller nozzles. Even though the economy's carbon intensity is coming down, increasing per capita income drives the demand for mobility (Oh et al., 2019, 23a). This demand leads to continued growth in carbon intensity in the transport sector over the coming decades. Under the business-as-usual scenario, it is estimated that carbon emissions from transport per capita would rise sharply by 2.5-fold between 2014 and 2030 (Oh et al., 2019, 23b). Carbon dioxide emissions stem from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. With the result in Canada above, the amount of fuel used in the city had a major impact on carbon dioxide emissions based on our results. Therefore, it is time to invest in cleaner transportation to, first, reduce the carbon dioxide emissions; second, enhance people's quality of life in the low-carbon economy. Statistically, the transportation sector contributes 25% of Canada's emissions. One of the initial methods is to develop cleaner fuels for automobiles. Furthermore, Canada has implemented some actions to mitigate the pollution by providing over $182 million in funding for electric and alternative-fuel infrastructure, having established light-duty zero-emission vehicles policy sales targets of 10 percent by 2025, 30 percent by 2030, and 100 percent by 2040, and providing a purchase incentive of up to $5,000 on eligible zero-emission vehicles ("Canada's Actions to Reduce Emissions"). Also, Canada has increased the stringency of emissions standards for passenger vehicles and most trucks. From that, with a view of minimizing pollution, Vietnam has applied a tax policy based on engine capacity and fuel use, and incentives of lowering tax on electric vehicles. Tax policies based on engine capacity and fuel type has been applied while taxes have been lowered for electric vehicles (5-15%) (Tang et al., 2020, 55). In 2018, passenger transportation by bus reached 13.7% and 9.38% in Hanoi and Ho Chi Minh City respectively. The consumption proportion of biofuel (E5 gasoline) increased to about 40% of the total gasoline consumption. In August 2017, Hanoi issued Decision No. 5953/QD-UBND approving the scheme: "Strengthening the management of road transport means to reduce traffic congestion and environmental pollution the period of 2017 – 2020 vision 2030" (MCD Team, 2021). Thus, thanks to the approved project, Hanoi may limit and proceed to stop operating motorcycles in the districts by 2030. Following Hanoi, in August 2018, Ho Chi Minh City also issued the project "Strengthening public transport in combination with controlling motor vehicles in Ho Chi Minh City" to reduce the carbon emissions (MCD Team, 2021). Besides, from the lesson of Canada, we realize the huge impact of the amount of fuel consumed on the condition of carbon emissions. We have some recommendations for Vietnam, specifically, improving the public bus system is one of the suitable options in accordance with Vietnam's infrastructure. Moreover, the public transportation system will effectively and efficiently restrict the use of personal vehicles. Worsening traffic congestion has been caused by poor management, short-term planning, and overloading of vehicles on most roads in the city, especially during rush hour. On the other hand, Vietnam deals with many daunting tasks because of the lack of data availability and awareness with car buyers. Also, the challenges exist in the commercial interests of car manufacturers and have technological limits of car manufacturers, mainly following technologies from overseas because it will take a few years of lead time for car manufacturers to meet the standards ("Fuel Efficiency Policy and Measures in Vietnam").

4. Conclusion

As explained, we are focusing on the issue of climate change and how carbon dioxide emissions pertain to it. Greenhouse gas emission, specifically carbon dioxide here, provide negative consequences to our planet though they also provide business opportunities. It is critically significant subject as we continue to face global warming and climate change issues. The focus has shifted into new ways to conserve energy and live sustainably to ensure future generations of a healthy planet. We want to concentrate on the carbon dioxide emissions of automobiles.

Our result in this research is consistent with theory that vehicles, especially the more they are used, make an impact on carbon dioxide emissions. Many suggest alternate options to reduce it, such as riding a bike in the city or using public transportation to cut its use. However, there are some challenges in this research. We lack access to data about the fuel consumption and the level of carbon dioxide emissions in Vietnam to observe the actual situation and come to effective solutions to the issue which require us to continue and conduct more future research. Canada and Vietnam have the different patterns in economics and politics, but carbon dioxide emission is the common problem as a whole. Our results show that models, such as the ones created here, are used to help predict and forecast the effects of carbon dioxide, and other greenhouse gas emissions, on our planet. In turn, this allows policymakers to accurately predict the extent to which our Earth is affected, and the various sectors that are affected. They can then create policies based on their findings. The automobile industry can establish alternative methods of using fuel in the more friendly-environment way to reduce the emissions. Nowadays, there are cars running by electricity, such as Tesla. ■

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