**UNIVERSITÀ DEGLI STUDI DELLA TUSCIA**

**DEPARTMENT OF ECONOMICS, ENGINEERING SOCIETY AND BUSINESS ORGANIZATION**



**ECONOMETRIC PERSPECTIVES IN CIRCULAR ECONOMY**

**TOPIC:**

**HANOI’S MOTORBIKE BAN FOR SUSTAINABLE WELL-BEING**

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| **Supervisor :** | **Prof. Luca Secondi** |
| **Student performs:** | **Pham Nhat Minh Tran** |
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**Civitavecchia – 2025**

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Futhermore, I declare that this work on *“Hanoi’s Motorbike Ban for Sustainable Well-being”* has not been submitted previously, in whole or in part, for any degree or qualification at this or any other institution.

I take full responsibility for the truthfulness and originality of this reseach work.

**Declarant**

**Pham Nhat Minh Tran**

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# **ABSTRACT**

Rapid urban growth, as seen in cities like Hanoi – the capital of Vietnam, is outstripping the development of formal infrastructure needed to support the increasing population. The situation is worsened by the rise of informal transportation systems that appear in spontaneously developed urban areas. Motorbikes serve as the main means of transportation for most people in Hanoi. To provide context, data from 2024 indicated 2.9 million units sold, marking a 4.9% compared to the previous year ([MCD Team, 2025](https://www.motorcyclesdata.com/2025/04/15/vietnam-motorcycles/)). A proposed solution involves banning motorbikes from specific areas. Nevertheless, given their widespread current use, a future ban’s effectiveness will require public backing. Consequently, this project aimed to create statistical model of transport attitudes and behaviors regarding a potential ban, enabling to predict the effects of different transport policies and understand the reasons behind travel choices.

The model along with other exploratory analysyes were presented in project using Jupyter Notebook – an open source scientific computing platform developed in Python, R, and Julia.

# **CHAPTER 1: INTRODUCTION**

## **Urgency of the study**

Hanoi, a city deeply reliant on motorbike for daily transportation, faces growing environmental and urban challenges. The proposed motorbike ban is a critical policy measure aimed at improving air quality, reducing congestion, and fostering a more sustainable urban landscape. The necessity of this research lies in serveral key areas:

Environmental Impact: Hanoi struggles with severe air pollution, much which stems from motorbike emissions. A transition away from motorbikes could significantly decrease carbon emissions and improve public health.

Traffic Congestion & Urban Planning: The overwhelming number of motorbikes contributes to traffic inefficiencies, slowing economic productivity and reducing overall quality of life. The ban encourages a shift toward public transport, cycling, and pedestrian-friendly infrastructure.

Public Adaptation & Economic Considerations: The ban affect millions of residents who depend on motorbikes for daily mobility. Evaluating alternatives, affordability, and implementation strategies is essential to ensure a smooth transition without disrupting livelihoods

By addressing these urgent concerns, the research contributes to the broader discourse on sustainable urban mobility, environmental health, and inclusive policy-making. A thorough evaluation will help determine the feasibility and long-term impact of Hanoi’s motorbike ban, ensuring that sustainability goals align with public well-being.

## **Research scope**

The research subjects were clearly defined as travel behavior by means of transport and views on the motorbike ban.

Scope:

* In terms of space: Research limitations in the Hanoi capital area
* In terms of time: Data collected from October to December 2023

## **Significance of the study**

With this study, policy-maker can evaluate the residents’ response if the law is enacted and what factors should be focused on to achieve the sustainable urban development and improving residents’ lives.

## **Overview of selected dataset**

The dataset provided by Open Science Framework is collected for the purpose of assessing social behavior in transportation mode choice. To reduce complexity, the core important variables are selected as follows:

|  |  |  |
| --- | --- | --- |
| **Variable name** | **Type** | **Description** |
| opinion\_ban | Binary | What is your opinion about motobikes ban policy? |
| freqpweek | Numeric | Frequency of your transport behavior |
| freq\_car | Numeric | How many times do you use a car per week? |
| dist\_to\_pub | Continuous | What is the distance to the nearest bus or train stop from your home location |
| own\_car | Numeric | Number of cars in your families |
| own\_motob | Numeric | Number of motorbikes in your families |
| own\_bike | Numeric | Number of bikes in your families |
| own\_ebike | Numeric | Number of ebikes in your families |
| aware\_ban | Categorical | Have you ever heard of the plan to ban motorbikes from a section of Hanoi central business district? |
| vehic | Categorical | Which vehicle do you use for transport purpose? |
| fut\_veh | Categorical | Do you plan to own another vehicle in the near future, and what is that vehicle? |

Figure 1: Variables Table

Eleven variables correspond to eleven columns in the dataset, containing approximately 20,000 observations about transport behavior of Hanoi residents. Most of the data represented is categorical or numeric.

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Figure 2: Traffic density map in central districts of Hanoi

# **CHAPTER 2: DATA ANALYSIS**

## **2.1. Data Visualization**

### ***2.1.1. People opinion on travel modes***

* At the vehicle ownership:

A graph of a number of vehicles

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Figure 3: Vehicle ownership / Household

Motorbikes dominate Hanoi areas due to affordability and maneuverability while cars are witnessed a low proportion due to high costs, parking limitations, and road conditions. In addition, e-bikes indicate a shift toward eco-friendly transport.

* Bus opinion distribution by ban attitude:

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Figure 4: Bus opinion distribution by ban attitude

People who are neutral on buses are also quite likely to not agree with the ban. In contrast, who thinks buses are good most likely to agree with the ban.

* Car opinion distribution by ban attitude:

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Figure 5: Car opinion distribution by ban attitude

People who are neutral on cars are likely disagree with the ban while people who thinks cars are very good strongly agree with the ban.

* Motobike opinion distribution by ban attitude:

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*Figure 6: Motobike opinion distribution by ban attitude*

People who thinks that motorbike are good tend to disagree with the ban.

### ***2.1.2. Descriptive analysis***

Core variable: **opinion\_ban**. This is a binary variable indicating whether a respondent disagree (0) or agree (1) a motorbike ban policy.

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Figure 7: Boxplot of four variables with opinion\_ban

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Group | Mean | Median | Mode | Std Dev | Skewness |
| own\_car | 0 | 0.45 | 0.00 | 0 | 0.57 | 1.25 |
|  | 1 | 0.92 | 1.00 | 1 | 0.63 | 0.74 |
| own\_motob | 0 | 1.84 | 2.00 | 2 | 1.04 | 1.33 |
|  | 1 | 1.80 | 2.00 | 2 | 0.74 | 1.01 |
| own\_bike | 0 | 0.49 | 0.00 | 0 | 0.75 | 2.31 |
|  | 1 | 0.74 | 1.00 | 0 | 0.77 | 0.88 |
| own\_ebike | 0 | 0.36 | 0.00 | 0 | 0.64 | 2.17 |
|  | 1 | 0.31 | 0.00 | 0 | 0.56 | 2.30 |

**own\_car**: Those who support the ban tend to own more cars (Mean = 0.92) than those who oppose it (Mean = 0.45). The distribution for both groups is skewed right (positive skewness).

**own\_motob**: Motorcycle ownership is slightly higher among opponents, but both groups have similar medians and modes. The higher skewness in the support group indicates a more concentrated distribution.

**own\_bike**: People who support the ban tend to own more bikes on average (Mean = 0.74 vs. 0.49). Opponents show a highly skewed and peaked distribution, suggesting that most own no bike.

**own\_ebike**: Both groups mostly don't own e-bikes (Median = 0), but opponents have a slightly higher average ownership. High skewness indicates strong right-skewed distributions with rare higher values.

## **2.2. EDA**

### ***2.2.1. Objective***

This analysis aims to explore the relationship between ownership of various types of vehicles and individuals’ opinions on a proposed ban, represented by the binary variable **opinion\_ban** (0 = disagree , 1 = agree).

### ***2.2.2. Correlation Analysis***

Examine the correlation between **opinion\_ban** (0 = disagree , 1 = agree) and each of the following variables: **own\_car, own\_motob, own\_bike, and own\_ebike.**

The hypothesis is given:

|  |  |
| --- | --- |
| **H0**: | There is no association between opinion\_ban\_code and the selected variable. (r=0) |
| **H1**: | There is a association between opinion\_ban\_code and the selected variable. (r≠0) |

The results are:

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All selected variables have p – value < 0.05. Therefore, reject null hypothesis, there is evidence of a association. **own\_car** has a moderate positive correlation with **opinion\_ban**, **own\_motob** has a very weak negative correlation also with **own\_bike** and **own\_ebike.**

### ***2.2.3. Hypothesis testing***

Since the count variables (**own\_**) are not normally distributed (as seen from boxplots), the test used is Mann – Whitney U test (non – parametric test) instead of a t – test to compare the medians between the two groups (Disagree and Agree)

General Hypotheses for each variable:

|  |  |
| --- | --- |
| **H0**: | There is no difference in the distribution of vehicle ownership between the two opinion groups. |
| **H1**: | There is a difference in the distribution of vehicle ownership between the two opinion groups. |

The results are:

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For all tested variables, reject the null hypothesis at the 5% significane level, indicating that vehicle ownership significantly differs between individuals who support and those oppose the ban.

### ***2.2.4. Multicollinearity***

Using Variance Inflation Factor (VIF) to detect independent variables that are too highly correlated with each other. From there, propose measures to optimize the model.

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Figure 8: VIF Table

Generally, no variable has a VIF > 10, so there’s no servere multicollinearity. However, some variables have VIF > 5, indicating moderate to high multicollinearity, which might affect the stability of regression coefficients.

## **2.3. Developing a regression model**

### ***2.3.1. Binary Logistic Regression***

**Binary logistic regression** is similar in principle to linear regression – it models an outcome as a function of one or more predictors. The main distinction, however, is the form of the outcome. In linear regression, the outcome is a continuous variable, taking on values over a range of possible values. In binary logistic regression, the outcome is binary: a categorical variable with exactly two possible values.

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Where:

* P = the probability that a case is in a particular category
* X = Independent variables.
* B = the coefficient of the predictor.

The odds ratio (OR), estimates the change in the odds of membership in the target group for a one unit increase in the predictor. It is calculated by using the regression coefficient of the predictor as the exponent (Agresti, 1996).

### ***2.3.2. Results table***

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Figure 9: Regression coefficients outcome

Dependent variable: **opinion\_ban** (0 – disagree, 1 – agree).

Number of observations: 19,807.

McFadden’s R – squared is 0.301709 => Reasonable explanatory power for social science data.

Likelihood ratio test: p – value: 0.000 => The model overall is statistically significant.

Variables with p - value < 0.05 are considered statistically significant predictors and to better intepretation results, it needs odds ratio transformation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Coefficient | Odds Ratio | p-value | Interpretation |
| freqpweek | −0.0469 | 0.9542 | <0.0001 | Walking more often slightly decreases the odds of supporting the ban. |
| freq\_car | 0.2998 | 1.3494 | <0.0001 | More frequent car use increases the odds of support by ~35%. |
| own\_car | 0.7485 | 2.1135 | <0.0001 | Car owners are more than twice as likely to support the ban. |
| own\_motob | −0.1295 | 0.8785 | <0.0001 | Motorcycle owners are less likely to support the ban. |
| own\_bike | 0.3493 | 1.4184 | <0.0001 | Bicycle owners are more likely to support the ban. |
| own\_ebike | −0.3570 | 0.6996 | <0.0001 | E-bike owners are ~30% less likely to support the ban. |
| aware\_ban\_no | 0.7873 | 2.1974 | <0.0001 | People aware of the ban (but not in favor) are more than twice as likely to support it. |
| aware\_ban\_yes | 1.8811 | 6.5615 | <0.0001 | People who support the ban are over 6.5 times more likely to support it. |
| vehic\_bus | −0.4029 | 0.6682 | 0.0153 | Regular bus users are less likely to support the ban. |
| vehic\_moto | −0.4193 | 0.6576 | <0.0001 | Motorbike users are less likely to support the ban. |
| fut\_veh\_car | −0.4291 | 0.6513 | 0.0011 | Planning to buy a car reduces the odds of supporting the ban. |
| fut\_veh\_moto | −0.3606 | 0.6974 | 0.0067 | Planning to buy a motorcycle also decreases odds of support. |
| fut\_veh\_no | −0.6613 | 0.5163 | <0.0001 | Not planning to buy any vehicle reduces support by ~48%. |

From the above results tables, the chart of variables with their impact:

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Figure 10: Variables with the largest impact

Generally:

|  |  |
| --- | --- |
| Variable | Impact |
| aware\_ban\_yes | Very strong positive |
| fut\_veh\_no | Strong negative |
| fut\_veh\_car | Strong negative |
| fut\_veh\_moto | Strong negative |
| own\_car | Strong positive |

### ***2.3.3. Marginal effects (Slopes – slope to the mean)***

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Figure : Marginal Effects table

Variables with p - value < 0.05 are considered statistically significant predictors and presented:

|  |  |  |
| --- | --- | --- |
| Variable | Slope | Interpretation |
| freqpweek | −0.00933 | Decrease the probability of supporting the ban by **0.93 percentage points**. |
| freq\_car | 0.05969 | Increase the probability by **5.97 percentage points**. |
| own\_car | 0.14901 | Increase the probability by **14.9 percentage points**. |
| own\_motob | −0.02578 | Decrease the probability by **2.58 percentage points**. |
| own\_bike | 0.06955 | Increase the probability by **6.95 percentage points**. |
| own\_ebike | −0.07107 | Decrease the probability by **7.11 percentage points**. |
| aware\_ban\_no | 0.13686 | Increase the probability by **13.7 percentage points**. |
| aware\_ban\_yes | 0.39954 | Increase the probability by **39.95 percentage points** (very strong effect). |
| vehic\_bus | −0.08675 | Decrease the probability by **8.68 percentage points**. |
| vehic\_moto | −0.08225 | Decrease the probability by **8.23 percentage points**. |
| fut\_veh\_car | −0.08786 | Decrease the probability by **8.79 percentage points**. |
| fut\_veh\_moto | −0.07526 | Decrease the probability by **7.53 percentage points**. |
| fut\_veh\_no | −0.13526 | Decrease the probability by **13.53 percentage points**. |
| freqpweek | −0.00933 | Decrease the probability of supporting the ban by **0.93 percentage points**. |

### ***2.3.4. Confusion matrix***

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Figure 12: Confusion matrix

True positive (TP = 10,047): Cases where the person actually support the ban, and the model correctly predicts support.

True negative (TN = 5,466): Cases where the person actually opposes the ban, and the model correctly predicts opposition.

False positive (FP = 2,021): Cases where the person actually opposes the ban, but the model incorrectly predicts support.

False negative (FN = 2,273): Cases where the person actually supports the ban, but the model incorrectly predicts opposition.

The model performs reasonably well, with an accuracy 78.3%.

### ***2.3.5. Evaluation***

*Strong resistance from future motorbike and car users*

Individuals who plan to use motorbikes or cars in the future are significantly less supportive of the ban. This likely reflects a perceived loss of mobility freedom and inadequate alternatives.

*Awareness power:*

Both groups who are aware of the ban – whether supportive or not – show significantly higher support than those unaware. This suggests that transparent information campains can positively influence public opinion.

*Transport mode and ownership effects:*

People who walk, own bicycles, or primarily use cars show more support for the ban. In constrast, current of future motobike users are less supportive, highlighting the need to target interventions at the most impacted groups.

*Public transport:*

Variables related to public transport are statistically insignificant. This may reflect dissatifaction with service quality, indicating that public transit improvements are essential.

### ***2.3.6. Recommendations***

To enhance the effectiveness and public acceptability of a motorbike ban, the following recommendations are:

Supporting modal shift for motorbike users such as providing incentives (subsidies) for switching from motorbikes to e-bikes or public transport or implementing pilot programs offering free/discounted mobility passes.

Investing in public awareness by lauching information campaigns to explain the rationale, timeline, and benefits of the ban.

Improving transport alternatives by upgrading public transport infrastructure and expanding infrastructure for cycling and walking.

Phased implementation, starting with central districts, followed by gradual expansion, allowing transition periods with incentives to ease adaptation.

# **CONCLUSION**

This study provides a multifaceted view of how personal mobility patterns, vehicle ownership, and public awareness influence attitudes toward vehicle bans in Hanoi. As a city undergoing rapid urbanization, Hanoi embodies the tension between modern transportation ambitions and the socio-economic complexities of a diverse urban population.

The analysis reveals that individuals who frequently rely on motorcycles and e-bikes—especially those who foresee using them in the future—are significantly less likely to support vehicle ban policies. Conversely, car users and those intending to rely on private cars show greater support for such regulations. This indicates that personal stake in future mobility plays a crucial role in shaping attitudes, possibly reflecting deeper issues of class, accessibility, and transport equity.

Furthermore, the strong positive influence of policy awareness on support for the ban highlights a critical policy lever: knowledge and communication. Citizens who are informed about the ban are significantly more likely to support it, suggesting that public awareness campaigns could play a transformative role in shifting public opinion and ensuring policy acceptance.

To build on these findings, several directions for future research are recommended:

**Qualitative Insights**: Incorporate in-depth interviews or focus groups to understand the emotional, cultural, and practical reasons behind resistance or support for mobility restrictions.

**Spatial and Geographic Analysis**: Explore how attitudes vary across districts or peri-urban zones of Hanoi, especially where public transport is less accessible.

**Policy Simulation Studies**: Use behavioral experiments or discrete choice modeling to forecast how different groups would respond to alternative mobility policies (e.g., subsidies for e-scooters, improved bus routes).

In sum, this study contributes to a deeper understanding of urban transportation governance in the Global South. As Hanoi positions itself as a greener, more livable city, its policies must align not only with global environmental goals but also with the lived realities of its citizens.

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