Does the arrival of electric vehicles affect price of goods and service in Europe?

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Abstract

This study wants to answer, "Does the arrival of electric vehicles affect price of goods and service in Europe?" Using multiple linear regression estimates on panel data by 12 country are Norway, United Kingdom, France, Germany, Netherland, Sweden, Italy, Austria, Switzerland, Denmark, Spain, and Belgium since 2010 to 2022, Using demand theory. The result show that Consumer price index, Electric price and exchange rate are significant make the arrival of electric vehicles are affect to price of goods and services in Europe that increase at price level. Policy recommendations to the government to make incentive for electric vehicle users are reduce tax for electric vehicle using and support electric vehicle on transportation part such as free charging at public stations and road toll exemptions.

Keywords: Price level; Electric vehicle; Price of goods and services

1. Introduction

Price of goods and service depend on two sections are internal factor including: production cost, financial resources, positioning strategy, pricing strategy and external factors including: economics, market demand, competition, target customers' finances, seasons (My, 2023). The price of oil is one of the factors that affect product prices for both manufacturing products and agricultural products because of transportation costs (Kilian, 2013).

In Europe have import oil from Russia but since 2022 the Russia and Ukraine war new lead Europe reduce import oil from Russia about 82 % (Jones, 2023) and the Europe changed to import oil from The United States instead of Russia, causing The United States are

Europe's number one exporter of oil (Bounfour & Luthi, 2023). However, since the import of oil from US, the price of oil started to rise significantly, with oil price increase from 9 to 12 US dollars per barrel, three to four times higher than before the war (Eurostat, 2023). Causing the consumer price index increase from 120.61% from 127.78% in 2022 (Ycharts, 2023) Because the United States has been affected by the war in Russia and Ukraine, the average price of a gallon of gas has risen by 5 cents overnight to $4.065, and the price has increased more than 42 cents within a week As a result, the price of oil in the Europe continues to increase, and the price of products also increases (White, 2022).

Electric vehicles are part of transportation to solve the problem of the consumer price index increasing after the Europe imported oil from the United States, which will affect most of transportation sector in 2021.In figure 1 show Europe recorded an increase of EV in transportation sector compare with 2020 such as Finland increased 136%, Croatia increased 127%, and Italy increased 122%, while Czechia increased 12% and Spain increased 15% (Eurostat, 2023b) in addition the Europe has a policy for electric vehicles to reduce greenhouse gas emissions from 40% of total Europe to zero (Parliament, 2023). In the case of from Finland has incentives and legislation to make people more interested in using electric vehicles by the government a tax deduction of €170 per month from the taxable value (income tax) of BEVs in 2021–2025. The employer can pay for charging electricity at the workplace or a public charging point to the company car driver with limited car benefits or the employee driving their own car. It is tax-free for the driver. The benefit depends on whether the employer wants to pay for it and the vehicle tax, which is paid at the time of purchase (Commision, 2021). (Johansson-Stenman, 2003)

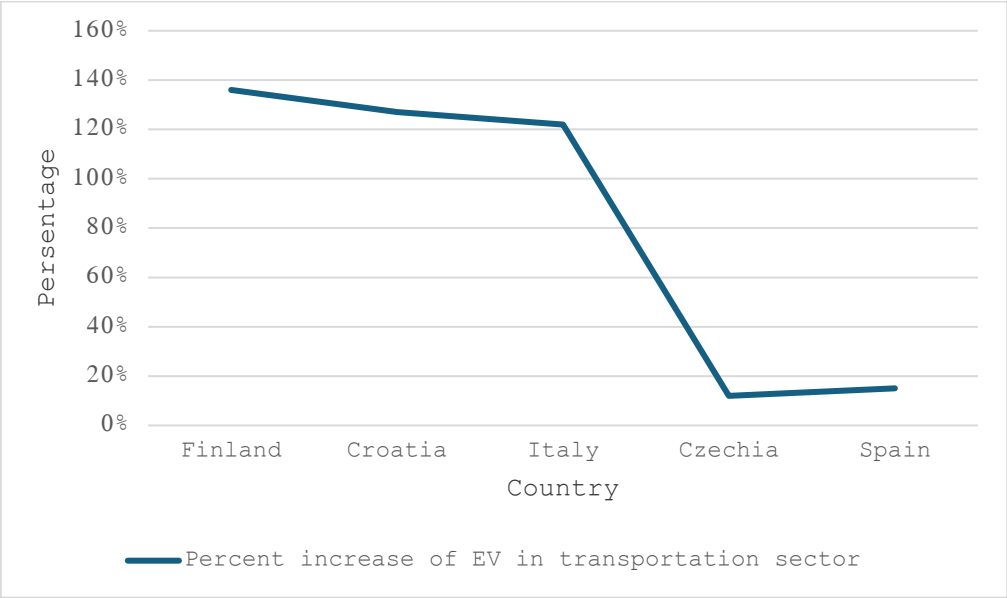

Figure 1 Europe recorded an increase of EV in transportation sector compare with 2020
Source: Eurostat, 2023

Electric vehicles have become important in transportation due to rising oil prices. Europe is interested in electric vehicles as they affect the price of goods and help reduce greenhouse gas emissions. In figure 2 show top 12 country have grown of number of electric passenger car are Norway, United Kingdom, France, Germany, Netherland, Sweden, Italy. Austria, Switzerland, Denmark Spain and Belgium (Yanatma, 2023) in 2021 compare 2022. In 2003 Fredrik Carlsson and Olof Johansson-Stenman found case in Sweden price of oil and electric vehicles have results that are no different because electric vehicles have a high battery cost and a high maintenance cost but since 2022 found that electric vehicles can reduce greenhouse gas emissions for 2.0 gigatons CO2-eq(2000 million ton) and case in the world EV can help reduce transportation cost and help reduce produce price(Chen Tang, 2022; Hossein Ranjbar, 2022).It will be interesting to see in if Europe benefit from electric vehicle.

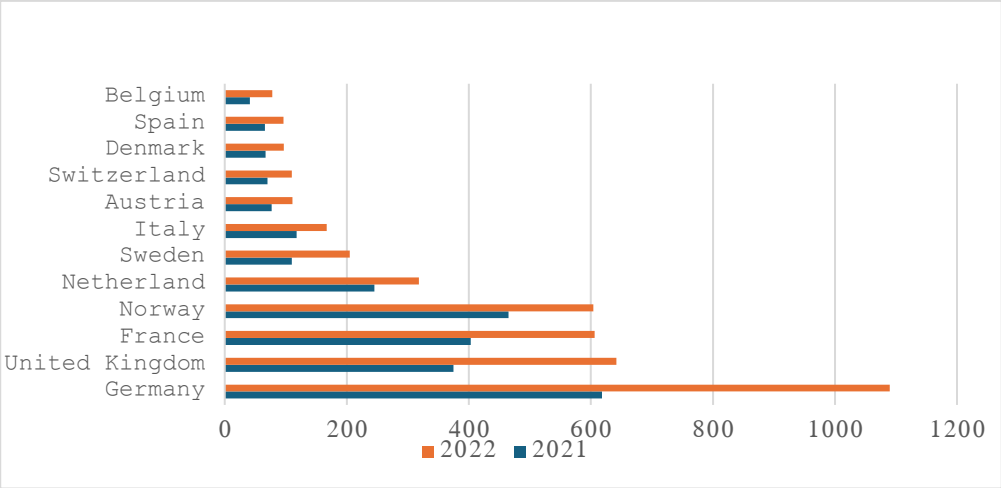

Figure 2 Grown of number of electric passenger cars in Europe 2021 to 2022
Source: Euro News, 2023

In this study we want to find electric vehicle can affect to price of goods and service in Europe because Europe has objective in 2030 Europe can reduce greenhouse gas emissions make Europe take electric vehicle to part of transportation instead gasoline car but gasoline car is one of factor to affect price of goods and services. For this reason, Europe take electric vehicle to part of transportation instead gasoline car this study we want to know when Europe take electric vehicles to part of transportation that will make effect to price of goods and services in Europe measure by price level index for study price of goods and services in Europe has effect.

2. Research Objectives

2.1 To examine the impact of the arrival of electric vehicles on the prices and costs of goods and services in Europe.

2.2 To analyze the factors influencing price changes in goods and services associated with the introduction of electric vehicles in the European market.

3. Research Methodology

3.1 Data

This study we focus on factor affect to produce price, use panel data of 12 country there are Norway, United Kingdom, France, Germany, Netherland, Sweden, Italy. Austria, Switzerland, Denmark Spain and Belgium collect data by annual year in 13 period since 2010 to 2022.Variable we estimate price level (percentage) as independent variable from Eurostat. And we have 5 dependent variable to estimate specific affect to price level there are consumer price index (percent) and electric price (per kilowatt) from Eurostat, Gasoline price (per litter) from International Energy Agency (IEA), GDP per capita (per dollar) from World bank national and Exchange rate (per dollar) from Organization for Economic Cooperation and Development (OECD).

Variable	Meaning	Units	Sources
PRICE	The average of current price across the entire of goods and services produced in an economy	Percentage	Eurostat
CPI	Overall change in the prices of goods and services that people typically buy over time.	Percentage	Eurostat
GASOLINE	Cost of Gasoline per litter	Current U.S. dollar	International Energy Agency
ELECTRIC	Cost of electric price per kilowatt	Current U.S. dollar	Eurostat
GDPPC	Economic metric that breaks down a country's economic output per person by GDP of nation dividing population of country.	Current U.S. dollar	World bank national
ER	Which one currency will be exchanged for another currency	Current U.S. dollar	Economic Cooperation and Development

Table 1 the variable and definition

3.2 Methodology

3.2.1 Theoretical Model

We study to relationship between cost of eletric vehicles and product price use demand theory by Garrett J. van Ryzin(2012) demand model consider customers to be decision makers because demand is the result of decisions made by many individuals such as the choice to purchase one company's product over another. Wait or buy now, buying more or less, etc (Ryzin, 2012). Following: $Qd_{it} = f(P_{it}, Y_{it}, Prg_{it}, T_{it})$

In demand function Qd is quantity of demand or consumer willing to pay for goods and service at i is country and t is time period can measure by price (P) is price of good and service or change in the price of the commodity at i is country and t is time period, income (Y), price relate goods and service (Prg) is price has relate to good and service such as if pricr of butter incraese will make demand of bread fall at i is country and t is time period and test (T). In this study we can change variable to suits for our research following as $equation\ 2$

$$PRICE_{it} = f(CPI_{it}, GDPPC_{it}, GASOLINE_{it}, ELECTRIC_{it}, ER_{it})$$

Where price level $(PRICE)$ is the average of current prices across the entire of goods and services produced in an economy.Price level can measure quantity of demand or consumer willing to pay for goods and service from Deonir De Toni and Andressa Tormen(2021) they found price level can effect to purchase intention such as high price VS low price has effect to purchase intention (Deonir De Toni et al., 2021). We can instead quatity of demand (Qd) to price level $(PRICE)$ from Garrett J. van Ryzin(2012) demand model measure by consider customers to be decision makers.

Consumer price index (CPI) is Overall change in the prices of goods and services that people typically buy over time. Consumer price index can measure price of goods and service or change in the price of the commodity and can tell inflaion rate in that time by consumer price index base year is 100 such as if consumer price index increase 110 it mean inflation in that time has 10 % at time meanning in that time price of goods and service increase more than previous year around 10 % (Oner, 2022). from report of National Statistical (2022) inflation on moment of Covid-19 pandemic has a lot of effect to price of goods and service increase make quantity of buy goods and service decrease by inflation has increase 8% (Jenkins, 2022). We can instead Price (P) to consumer price index (CPI) for measure change in price can effect to price level.

Gross domestic product per capita $(GDPPC)$ is Economic metric that breaks down a country's economic output per person by GDP of nation dividing population of country. We can instead Income(Y) to Gross domestic product per capita $(GDPPC)$ because Jeffrey H. Bergstrand(1991) found There are positive relationship between the price level and gross domestic product (GDP) per capita (Bergstrand, 1991). In 2020 Javier Cravino and Samuel Haltenhof (2020) can measure Gross domestic product per capita has positive effect to price

level by sectoral differences in intermediate input shares (Haltenhof, 2020). Gasoline price($GASOLINE$) is cost of Gasoline per litter and electric price($ELECTRIC$) is cost of electric price per kilowatt. We can instead price relate goods and service (Prg) to Gasoline price ($GASOLINE$) and Electric price ($ELECTRIC$) because Michael Gelman and Yuriy Gorodnichenko(2016) study about the response of consumer spending to changes in gasoline prices in America they found change in gasoline price has large effect to consumer spending (Michael Gelman et al., 2016) and Dora Gicheva and Justine Hastings(2007) found gasoline price increase make consumer change dinner outside to buy goods from groceries for reduce expenditure (Dora Gicheva, 2007). In 2013 Napoli found Europe take electric vehicle to part of transportation for reduce greenhouse Gas Emission. In part of transportation is price of oil is one of the factors that affect product prices for both manufacturing products and agricultural products (Kilian, 2013) in Europe has take electric vehicle to part of transportation will be electric price has effect to price of goods and service in Europe.

Exchange rate (ER) is which one currency will be exchanged for another currency. We can put exchange rate to demand model because in 1985 Rudiger Dornbusch found the appreciation of the U.S. dollar has a large effect to price changes of different groups of goods (Dornbusch, 1985).

In theory we can put all variables in the independent variable there are consumer price index, Gross domestic product per capita, Gasoline price, Electric price and Exchange rate that effect to price level. We use study does the arrival of electric vehicles affect price of goods and service to measure price of goods and service in Europe will make price of goods and service increase or decrease when Europe take electric vehicle to part of transportation instead gasoline vehicle. Price level can measure price of goods and service in economic such as if previous years has price level 103 % but in this year has price level 105 % its mean in this years has price of goods and service will increase around 2 % from previous years. That make we can use price level for measure price of goods and service in Europe from 2010 to 2022 since Europe has registered electric vehicle in Europe will make effect to price of goods and service in Europe when electric vehicles into transportation part will make price of goods and service will increase or decrease.

3.2.2 Econometric Model

(1) This study we use Mutiple Linear Regression medthod is Panal data to analyze for find what factor will affect to price level by follow research quasion is Does the arrival of electric vehicles affect product prices in Europe to find gap of electric price will have effect to price of product in Europe by similar grown of number of electric passenger cars 12 country are Norway, United Kingdom, France, Germany, Netherland, Sweden, Italy. Austria, Switzerland, Denmark and Spain.

(2) In this study we use one dependent variable and five independent variables there are price level($PRICE$), consumer price index(CPI), Gross domestic product

per capita $(GDPPC)$, electric price $(ELECTRIC)$, gasoline price $(GASOLINE)$, exchange rate(ER) referred to $Equation\ 3$

$$PRICE_{it} = \beta_0 + \beta_1 CPI_{it} + \beta_2 GDPPC_{it} + \beta_3 GASOLINE_{it} + \beta_4 ELECTRIC_{it} + \beta_5 ER_{it} + \mu_{it}$$

(3) Where i is country that we study there are 12 country are Norway, United Kingdom, France, Germany, Netherland, Sweden, Italy. Austria, Switzerland, Denmark and Spain, t is time period since 2010 to 2022, $PRICE_{it}$ is the average of current prices across the entire of goods and services produced in an economy in 12 country since 2010-2022, CPI_{it} is overall change in the prices of goods and services that people typically buy over time in 12 country since 2010 to 2022, $GDPPC_{it}$ is economic metric that breaks down a country's economic output per person by GDP of nation dividing population of country in 12 country since 2010 to 2022, $GASOLINE_{it}$ is price of gasoline per litter in 12 country since 2010 to 2022, $ELECTRIC_{it}$ is price of electric per killowatt in 12 country since 2010 to 2022 and ER_{it} is which one currency will be exchanged for another currency in 12 country since 2010 to 2022 and μ_{it} is error term in $equation\ 4$ we use $PRICE_{it-1}$ (1 year lag) for solve autocorrelation problems.

$$PRICE_{it-1} = \beta_0 + \beta_1 CPI_{it} + \beta_2 GDPPC_{it} + \beta_3 GASOLINE_{it} + \beta_4 ELECTRIC_{it} + \beta_5 ER_{it} + \mu_{it}$$

(4) This study we have five variable are consumer price index, Gross domestic product per capita, gasoline price, eletric price and exchange. First we expect null hypothesis H0 : β_1 = 0 that consumer price index not effect to price level $(PRICE_{it})$, alternative hypothesis H1 : β_1< 0 that comsumer price index has possitive effect to price level$(PRICE_{it})$ because consumer price index can measure inflation rate that can tell if consumer price index increase will make price index will increase. Second we expect null hypothesis H0 : β_2 = 0 that gross domestic product per capita not effect to price level$(PRICE_{it})$, alternative hypothesis H1 : β_2< 0 that gross domestic product per capita has possitive effect to price level $(PRICE_{it})$ because gross domestic product per capita can measure indirectly income per capita that can tell if gross domestic product per capita will increase make income increase that can effect to price index will increase. Third we expect null hypothesis H0 : β_3= 0 that gasoline price not effect to price level$(PRICE_{it})$, alternative hypothesis H1 : β_3 < 0 that gasoline price has positive effect to price level $(PRICE_{it})$ because gasoline is one of factor to effect to transportation cost that will make if gasoline price increase will make price index will increase. Forth we expect null hypothesis H0 : β_4= 0 that electric price not effect to price level$(PRICE_{it})$, alternative hypothesis H1 : β_4 < 0 that electric price has positive effect price level$(PRICE_{it})$ because in the world has take eletric vehicle to part of transportation instead gasoline car because gasoline price has increase a lot and electrice vehicle can reduce greenhouse Gas emission such as some country in Europe and China. Last varaible we expect hypothesis H0 : β_5 = 0 that exchance rate not effect to price level$(PRICE_{it})$, alternative hypothesis H1 : β_5 > 0 that exchange rate has negative effect or depreciated that tell if exchange rate has depreciated will make price index will decrease.

4. Research Findings Summary

We study does the arrival of electric vehicles affects price of goods and service in Europe? by factor affect to price level are consumer price index, Electric price, Gasoline price, GDP per capita and Exchange rate by regression analysis the result show as table 2

Variable	Coefficient	Std. Error	T stat	Prob.
C	-326.2725	2599.569	-0.1255	0.9003
CPI	-0.2958	0.1493	-1.9807	0.0496**
Electric price	27.0413	10.0013	2.7037	0.0077***
Gasoline price	-0.6755	1.9567	-0.3452	0.7305
GDP per capita	5.3535	0.0002	0.2010	0.8409
Exchange rate	-3.5142	1.1934	-2.9446	0.0038***
AR(1)	1.002	0.0114	87.6893	0.0000
R2	0.9725			
Adj.R2	0.9713			
DW	2.1452			

Note: The symbols ***, ** and * are significant at 1%, 5% and 10 % level respectively.

Table 2 Regression analysis result

This table show R2 =0.9725 mean consumer price index, Electric price, Gasoline price, GDP per capita and Exchange rate expian factor can price level to 97 % in this table have 3 variable are singnificant to price level there are consumer pruce index, Eletric price and Exchange rate. First is consumer price index (CPI) has negative effect to price level by 0.2958 and significant at 5% level mean if consumer price index increase 1 % will be price level decrease 0.2958 %.

Consumer price index can describe inflation and can predict use from macroeconomic statistics such as real value of investment to micro-level budgeting such as construction project price forecasts (Marco K. W. Yu, 2010). Consistant with Oyekunle Janet Olufunmike (2019) found that CPI have negative and opposite to economic theory in Sub sahara African Countries because in Sub-sahara African Countries has vary fluctuations in inflation and Jonathan D. Church(2016) found that CPI can has decrease indirectly effect to price of goods and service Products by consumers, businesses, governments, and foreigners but not include import because current CPI does not reflect the fact that consumers can adjust their spending to achieve comparatively low priced goods or services, leading to

excessive increases in the rate of consumer price increases.On the other hand Allen Head, Alok Kumar and Beverly Lapham(2010) found about inflation rate increase will make price will increas because inflation increases, prices become more responsive with higher inflation that make price increase (Allen Head, 2010; Oyekunle Janet Olufunmike et al., 2019).

Next variable is Electric price has positive effect to price level by 27.0413 and significant at 1% level mean if eletrice price increase 1% will be price level increase 27.0413 %.In this study we get result are possitive because in Europe electric vehicle still unstable compared to gasoline car, in Europe Norway is leading transition to electric vehicles, with a large percentage of new car sales being electric but in 2019 case in china found negative because China has falling battery prices make electric vehicles more economically attractive. This has led to increased adoption of electric cars and bicycles for affordable transportation and China has a large number of electric cars in service, including cars, buses and trucks (Larry E. Erickson, 2019). However, Li Fei and Wu Chaofei (2013) found electric price can affect positive or negative to price because It depends on the structure between production and consumption cost of economic sector structure. Exchange rate has negative effect to price level by 3.5142 and have significant at 1% level mean if exchange rate depreciated will be price level decrease 3.5142 %.Rudiger Dornbusch(1982) found exchange rate are relate price of monies and price of goods if exchange rate depreciated will be increase in domestic real income increase demand for real balances and has effect to fall in domestic prices but in opposite if exchange appreciation will be higher interest rate make pricce will increase (Dornbusch, 1982).

5. Discussion of Research Findings

This study investigates whether the adoption of electric vehicles (EVs) in Europe affects the price of goods and services, particularly in the context of the region's shift from gasoline-powered vehicles to electric vehicles (EVs) as part of its broader effort to reduce greenhouse gas emissions. The research tests five hypotheses to assess the impact of this transition on price levels across various sectors.

Hypothesis 1: Consumer Price Index (CPI) The first hypothesis posits that the Consumer Price Index (CPI) has a negative effect on price levels in Europe due to fluctuations in inflation rates. The results support this hypothesis, as the CPI has shown considerable volatility from 2010 to 2022, contributing to periodic price increases. These fluctuations reflect broader macroeconomic conditions, such as inflation, which directly affect the cost of goods and services in the region. Thus, the adoption of electric vehicles, coupled with inflationary trends, seems to have a compounding effect on the overall price level.

Hypothesis 2: Electric Vehicle Price Impact The second hypothesis examines the relationship between the price of electric vehicles and the broader price levels in the

economy. The results support this hypothesis, indicating that the introduction of electric vehicles does indeed have a positive effect on price levels. This outcome is due to the current instability and structural challenges in the European economic sector, particularly in industries that manufacture or rely on electric vehicles. The high initial costs of EVs, limited infrastructure, and fluctuating demand contribute to the increase in prices of goods and services associated with this transition. However, as the market for electric vehicles matures, this effect may stabilize.

Hypothesis 3: Gasoline Prices The third hypothesis investigates the impact of gasoline prices on price levels. The study rejects this hypothesis, as the findings indicate that gasoline prices do not significantly affect the overall price levels in the economy. This suggests that, despite rising fuel costs, the transition to electric vehicles does not lead to a direct increase in the cost of goods and services, possibly due to the fact that the gasoline price is only one of many factors influencing the cost structure in Europe.

Hypothesis 4: Gross Domestic Product (GDP) per Capita The fourth hypothesis explores the impact of GDP per capita on price levels. The study rejects this hypothesis as well, indicating that GDP per capita does not significantly influence the pricing of goods and services. This result implies that, while higher economic output can lead to higher demand for goods and services, it does not directly correlate with price levels in the context of the electric vehicle transition.

Hypothesis 5: Exchange Rate Finally, the fifth hypothesis addresses the effect of exchange rates on price levels. The study accepts this hypothesis, revealing that a depreciating exchange rate has a negative impact on price levels, leading to a decrease in the cost of goods and services. This effect can be attributed to the reduced cost of imported goods, which may result from a weaker currency and subsequently lower prices in local markets. As electric vehicles become more widespread, this dynamic could further influence the price structures of related goods and services in Europe.

6. Knowledge from Research

This research provides valuable insights into the economic impacts of the adoption of electric vehicles (EVs) in Europe, particularly in relation to the prices of goods and services. The study highlights how the transition from gasoline-powered vehicles to electric vehicles influences various macroeconomic factors such as inflation, sectoral costs, and the pricing structure of goods and services.

1. Impact of Inflation and Consumer Price Index (CPI): The study underscores the significant role of inflation in influencing price levels, with the findings showing that the Consumer Price Index (CPI) is strongly correlated with price volatility in the European market. Fluctuations in inflation rates have a direct effect on the cost of goods and services, especially

as the economy shifts towards a more sustainable future through the adoption of EVs. This suggests that the adoption of electric vehicles occurs within a broader economic context where inflationary pressures are also at play.

2. Electric Vehicle Pricing and Economic Sector Challenges: A key takeaway from the research is the positive relationship between the introduction of electric vehicles and the increase in price levels. This effect is partly attributed to the current instability and structural challenges within the electric vehicle market, such as the high costs of EVs, limited charging infrastructure, and fluctuating demand. As the EV market matures, however, this impact on prices may stabilize. The findings suggest that while electric vehicles are a promising solution for reducing emissions, their initial economic footprint can cause temporary price increases in related sectors.

3. Gasoline Prices and Their Limited Effect on Price Levels: Interestingly, the research found that gasoline prices do not significantly influence the overall price levels in Europe. This indicates that the transition from gasoline to electric vehicles does not necessarily result in a proportional increase in the cost of goods and services, as gasoline prices are just one element in a larger, more complex pricing structure. This insight suggests that while fuel prices are an important consideration, other factors, such as technological advances and government policies, play a more pivotal role in shaping price dynamics in the context of EV adoption.

4. GDP Per Capita and Its Non-Influence on Price Levels: The study also revealed that GDP per capita does not have a significant impact on price levels in the context of electric vehicle adoption. This suggests that, while higher economic output can drive demand for goods and services, it does not directly correlate with price changes during the shift to a green economy. This finding challenges the assumption that higher economic development automatically results in higher prices, particularly when new technologies such as electric vehicles are introduced.

5. Exchange Rate Effects on Price Stability: Finally, the research emphasizes the role of exchange rates in affecting price levels. A depreciating exchange rate is found to have a negative effect on prices, which could lead to a reduction in the cost of imported goods. This could indirectly reduce the cost of goods and services associated with electric vehicle production and infrastructure, offering a potential economic benefit as the market for electric vehicles grows. The interaction between exchange rates and electric vehicle adoption suggests that global economic factors will continue to play a significant role in shaping the prices of green technologies.

In conclusion, the research provides a comprehensive understanding of how the arrival of electric vehicles influences price levels in Europe. It demonstrates that while the transition to EVs presents initial economic challenges, such as increased prices due to technological and infrastructure factors, it also offers long-term opportunities for price

stabilization, especially with supportive government policies. By addressing these challenges, such as providing financial incentives and expanding EV infrastructure, policymakers can help facilitate a smoother transition to a green economy, with a focus on reducing greenhouse gas emissions without sacrificing economic stability.

7. Recommendation

This study examines the economic impact of electric vehicle (EV) adoption in Europe, specifically on the price of goods and services. Based on the findings, the following recommendations are proposed for policymakers, businesses, and future research:

7.1 Policy Recommendations:

1) Promote EV Adoption: Governments should reduce barriers to EV adoption by offering financial incentives like tax cuts and investing in public charging infrastructure. These measures will make EVs more accessible and encourage widespread use.

2) Mitigate Price Hikes: To counter the price increases caused by EV adoption, governments should consider offering subsidies for EV buyers, reducing VAT on EV-related products, and stabilizing the EV market through long-term strategies.

3) Support Green Business Initiatives: Governments should encourage innovation in the green technology sector by offering R&D incentives. This will help lower EV costs and reduce their impact on inflation.

1.2 Business Recommendations:

1) Invest in Cost Reduction: Businesses should prioritize R&D to reduce EV costs and improve efficiency, making EVs more affordable for consumers and reducing price volatility.

2) Expand Charging Infrastructure: Companies should collaborate with governments to expand the EV charging network, increasing consumer confidence and demand for EVs.

7.3 Further Research Recommendations:

1) Examine Long-Term Effects: Future research should explore the long-term price impacts of EV adoption as technology advances and consumer adoption increases.

2) Analyze Regional Variations: Research should consider regional differences in the impact of EVs on price levels across Europe to tailor policies more effectively.

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