

GST Rate Differentials Impact on Electric Vehicle Registrations Across Indian States: A Panel Data Analysis (2017–2025)

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Abstract

Making the switch to electric vehicles is becoming more widely acknowledged as an essential tactic for attaining sustainable transportation and cutting greenhouse gas emissions. India, one of the world's fastest-growing auto markets, has taken a number of fiscal and regulatory measures to encourage the use of electric vehicles (EVs). The Goods and Services Tax (GST) reform, which was implemented in 2017, is one of these measures that significantly influences the cost structure of automobiles. Currently, internal combustion engine (ICE) vehicles are subject to a 28 percent GST rate, whereas electric vehicles are subject to a 5 percent concessional rate. This substantial pricing difference is meant to encourage the adoption of EVs. Nevertheless, there is still a dearth of scientific data assessing the efficacy of this tax disparity among Indian states.

This study looks into how varying GST rates affected the number of electric vehicles registered in Indian states between 2017 and 2025. The study assesses how fiscal incentives affect EV adoption patterns while controlling for other factors including fuel prices, income levels, urbanization, and the availability of charging infrastructure using a panel dataset that includes annual observations from major Indian states. To identify the causal effects of changes in GST policy, the research uses panel data econometric approaches such as difference-in-differences estimation and fixed effects regression.

The findings show that lower GST rates, especially following the 2019 adjustment that lowered the GST rate on EVs from 12 percent to 5 percent, have greatly increased EV registrations. The results show that states are more sensitive to GST incentives when they have superior charging infrastructure, higher income levels, and favorable EV legislation. Furthermore, it is shown that fluctuations in fuel prices enhance the GST incentive by motivating customers to switch to electric vehicles.

By showing how indirect tax incentives can affect the adoption of green technologies in emerging economies, the study adds to the body of knowledge on environmental fiscal policy. The results also give policymakers important information on how well tax-based incentives support sustainable mobility. According to the report, while GST incentives are successful, their effects can be increased by coordinated state-level EV policies and accompanying investments in charging infrastructure. These understandings are crucial for creating integrated fiscal and environmental policies that can hasten India's shift to environmentally friendly transportation.

Keywords: Adoption, electric vehicle, GST, taxes

1. Introduction

In the context of mitigating climate change and promoting environmental sustainability, the worldwide shift to sustainable transportation has emerged as a key policy goal. Almost 25% of the world's energy-related carbon dioxide emissions come from the transportation sector, making it one of the biggest contributors to greenhouse gas emissions (**International Energy Agency, 2023**). The transportation sector's environmental effect has increased due to rapid urbanization, economic growth, and expanding car ownership, especially in emerging economies (**United Nations Environment Programme, 2022**). In this regard, electrifying transportation has become a viable way to lower carbon emissions, promote energy security, and improve urban air quality. Because they can be powered by renewable energy sources and have zero exhaust emissions, electric vehicles (EVs) are widely acknowledged as an essential part of sustainable mobility systems (**Sierzechula et al., 2014**).

One of the fastest-growing vehicle marketplaces in the world, India must simultaneously promote economic growth and lessen environmental deterioration. Fuel consumption, air pollution, and greenhouse gas emissions have surged as a result of the nation's fast growing middle class and growing urbanization (**NTI Aayog, 2023**). Recent estimates indicate that the transportation industry is a major source of urban air pollution in metropolitan areas and accounts for a substantial portion of India's overall carbon emissions (**Ministry of Environment, Forest and Climate Change, 2022**). As a result, encouraging electric mobility is now a crucial part of India's long-term energy and environmental plans.

The Indian government has implemented a number of policy initiatives to promote the use of electric vehicles in recognition of the significance of clean transportation. **The Faster Adoption and Manufacturing of Electric Vehicles (FAME)** program, which was first implemented in 2015 and expanded in 2019 under **FAME-II**, is one of these programs. It offers subsidies for the purchase of electric vehicles and encourages the construction of charging infrastructure (**Kumar & Alok, 2020**). Furthermore, a number of Indian governments have implemented their own EV policies that provide incentives like tax exemptions, purchasing subsidies, lower registration costs, and initiatives to create charging infrastructure (**Singh & Thakur, 2019**). By lowering costs and resolving infrastructure issues, these measures seek to establish a favorable environment for electric transportation.

Although these policy measures are crucial, fiscal policy tools are especially important in determining consumer behavior and market demand. Taxes can change consumers' decisions to buy since they have a direct impact on the final amount they pay (**Li et al., 2017**). In order to make electric vehicles (EVs) more competitive with conventional vehicles that run on internal combustion engines (ICE), tax incentives are employed extensively worldwide. To encourage the adoption of EVs, governments in numerous nations have implemented economic policies like purchasing subsidies, tax breaks, lower vehicle registration fees, and exemptions from road taxes (**Sierzechula et al., 2014**).

The implementation of the Goods and Services Tax (GST) in July 2017 was one of the biggest fiscal reforms in India that had an impact on the automotive industry. A complicated system of indirect taxes, including as excise duty, value-added tax (VAT), service tax, and numerous state-level levies, was superseded by a single tax framework under the GST. Simplifying the tax system, increasing tax compliance, and establishing a single national market were the goals of the GST reform. Depending on how they are classified, different types of products and services are subject to different rates of taxation under the GST scheme (**GST Council, 2019**).

Conventional automobiles were subject to a far higher tax rate of 28 percent, coupled with additional compensatory cess based on vehicle type and engine capacity, whereas electric vehicles were initially

subject to the 12 percent GST slab. The GST Council announced a significant policy shift in July 2019, lowering the GST rate on electric vehicles from 12% to 5% in recognition of the need to further promote electric mobility. Because of this policy choice, there is now a significant tax difference between EVs and internal combustion engines (ICEs), which significantly reduces the cost of buying EVs and increases their affordability (**Li et al., 2017**).

One significant fiscal policy move intended to hasten the shift to clean mobility is the lowering of GST rates for electric vehicles. The government sought to increase consumer demand and encourage the use of eco-friendly transportation technologies by lowering the tax burden on EVs. Theoretically, by lowering the overall cost of ownership in comparison to conventional vehicles, these tax advantages should promote the adoption of EVs. However, a number of variables, such as income levels, gasoline prices, the availability of charging infrastructure, and regional regulatory frameworks, may determine the precise effect of GST rate decreases on EV registrations.

The adoption of electric vehicles in India is still inconsistent among the many states and regions, even with the introduction of these incentives. Due to proactive governmental support and improved infrastructure development, EV registrations have increased rapidly in some states, including Maharashtra, Karnataka, Tamil Nadu, and Delhi (**Ministry of Road Transport and Highways, 2024**). Other states, on the other hand, still have comparatively low adoption rates because of things like inadequate infrastructure for charging, lower income levels, and low consumer awareness. These regional differences imply that local economic and infrastructure conditions may have an impact on the efficacy of fiscal incentives like GST reductions.

The price volatility of fossil fuels is another significant issue affecting the adoption of EVs. Growing costs for gasoline and diesel raise the running costs of traditional cars and may persuade buyers to think about other modes of transportation, such as electric cars (**Kumar & Alok, 2020**). Higher fuel prices could make EVs more financially appealing when paired with tax breaks. Therefore, assessing the overall efficacy of EV promotion policies requires an understanding of how fiscal incentives and market forces interact.

The majority of the literature now in publication concentrates on customer attitudes, technological obstacles, and government subsidy schemes, despite the fact that numerous studies have looked at the factors that influence EV adoption. There aren't many empirical studies examining how tax laws support electric vehicles, especially when it comes to developing nations like India. Furthermore, the majority of earlier studies rely on cross-sectional data or short-term analysis, which can miss the dynamic consequences of policy changes over time.

Empirical study on how the GST rate difference between EVs and conventional vehicles affects EV registrations across states is conspicuously lacking in the Indian setting. Comprehending this correlation is crucial for assessing the efficacy of existing fiscal policies and pinpointing possible enhancements in policy formulation. Because panel data analysis allows researchers to examine differences over time and geographic regions while controlling for unobserved heterogeneity, it offers a suitable methodological technique for analyzing such policy consequences.

This study makes three contributions. First, it uses panel econometric approaches to present actual data on the connection between GST policy and EV uptake in India. Secondly, it assesses how much EV registrations are influenced by other economic factors like gasoline prices and income levels. Third, it provides policy insights that can assist decision-makers in creating more efficient infrastructural and budgetary plans to hasten the uptake of electric vehicles.

It is anticipated that the results of this study will add to the expanding body of knowledge on sustainable mobility and environmental fiscal policy in developing nations. In order to meet the country's energy and climate goals, it will be essential to comprehend how tax incentives influence consumer behavior as India continues its shift toward low-carbon growth pathways. This study offers important insights into how fiscal policy might help the more general goal of encouraging clean energy technology and sustainable mobility systems by analyzing the effect of GST rate differentials on EV uptake.

2. Review of Literature

William Sierczula, Sjoerd Bakker, Kees Maat, and Bert van Wee (2014), in their study “**The Influence of Financial Incentives and Other Socio-Economic Factors on Electric Vehicle Adoption**” published in *Energy Policy*, used econometric research to look at EV uptake in 30 different countries. According to the report, financial incentives like tax breaks and subsidies greatly boost EV adoption by lowering buying costs. Adoption is also significantly impacted by domestic EV production and charging facilities. However, the authors stress that economic incentives are not enough on their own and that infrastructure and policy frameworks are necessary for them to be effective. The report emphasizes how crucial it is to support electric transportation through a comprehensive policy strategy.

Tigga (2023), in a report published by *The Indian Express*, draws attention to Pune's notable increase in EV registrations, which shows rising customer interest in electric vehicles. The ongoing 5% GST rate on electric vehicles, which has lowered purchasing costs and increased affordability, is credited by the study with this growth. Additionally, subsidies and infrastructure support have been made available by government programs including Maharashtra's state EV policy and the FAME India Scheme. According to supporting data from Agarwal (2025), EV adoption has been further pushed by better charging infrastructure and regulatory incentives. The results highlight how infrastructure and financial incentives work together to encourage EV adoption.

Singh and Thakur (2019), in their study “**Role of Government Incentives and Policies in Promoting Electric Vehicle Adoption in India**,” investigated how legislative initiatives like the FAME program and financial incentives affect the adoption of EVs. According to the report, tax breaks and subsidies considerably lower the overall cost of ownership, making EVs more accessible, especially for two-wheelers and three-wheelers. However, the authors emphasize that fiscal incentives alone are not sufficient for long-term adoption. A complete policy approach is necessary since factors like consumer awareness, technical innovation, and charging infrastructure are all important.

Ashish Kumar and Sandeep Alok (2020), in their study “**Adoption of Electric Vehicles: A Literature Review and Prospects for Sustainability in India**,” used regression analysis and state-level data to examine how government policy incentives affected the uptake of EVs. According to the report, EV adoption is positively and significantly impacted by tax breaks and subsidy schemes because they lower the initial cost of purchase. In cities with more automobile density and environmental consciousness, these incentives have a greater effect. The authors stress that technology advancement and infrastructure for charging EVs are crucial for long-term EV adoption, and that financial incentives alone are not enough.

Li et al. (2017), in their study “**The Market for Electric Vehicles: Indirect Network Effects and Policy Design**,” used econometric research to look at how financial incentives affected the uptake of EVs in China and the US. According to the report, by lowering the initial cost of ownership, tax breaks and purchasing subsidies dramatically boost EV demand. The authors point out that these incentives work especially well in the early phases of market development. However, they also stress that in order to

guarantee steady development in the use of electric vehicles, financial incentives must be backed by sufficient infrastructure for charging and robust legislative frameworks.

3. Research Gap

1. Current research focuses more on subsidies and environmental consciousness in EV adoption, generally ignoring the influence of GST.
2. Data-driven research examining the true effect of the 2019 GST cut on EV registrations are scarce.
3. The majority of research is survey-based or national in scope, paying little attention to state-by-state differences in EV adoption.
4. The literature currently in publication hardly ever looks at the combined impact of GST, fuel prices, and charging infrastructure on EV adoption.

4. Statement of Problem

In India, the transportation industry is a major source of carbon emissions and environmental degradation. The government has implemented a number of policy initiatives to stimulate the use of electric vehicles (EVs) in order to promote sustainable transportation, such as lowering the GST on EVs from 12% to 5% in 2019. The goal of this program was to lower the cost of EVs and boost their uptake. The effectiveness of GST reductions in boosting EV registrations is unclear, and EV adoption in Indian states is still unequal. EV adoption may also be impacted by variables like gasoline costs and the availability of charging stations. As a result, it's critical to assess how GST rate reductions effect EV registrations and comprehend the ways in which supporting factors influence the uptake of EVs in India.

5. Research Objectives

The primary objectives of this research are:

1. To investigate how varying GST rates affect the number of EV registrations in each Indian state.
2. To evaluate the impact of the 2019 GST rate cut on the expansion of EV registrations.
3. To determine the policy implications for creating efficient financial incentives that support environmentally friendly transportation.

6. Research Hypotheses

H1: The GST rate reductions have a positive and significant impact on electric vehicle registrations across Indian states.

H2: The 2019 GST rate reduction significantly increased EV registration growth.

H3: The impact of GST incentives on EV adoption is strengthened by supporting factors such as charging infrastructure availability and rising fuel prices.

7. Research Methodology

Research Design

The association between GST rate differences and electric car registrations across Indian states is investigated in this study utilizing a quantitative research design and panel data analysis.

Data Sources

The study uses secondary data collected from:

- National vehicle registration database (VAHAN)

- Ministry of Road Transport and Highways
- GST Council reports
- Ministry of Power EV infrastructure data
- Petroleum Planning and Analysis Cell fuel price data

Study Period: 2017–2025

Sample

Data from **28 Indian states and 8 union territories**

Variables

1. Dependent Variable: EV registrations (state-wise annual registrations)
2. Independent Variable: GST rate on electric vehicles
3. Control Variables: Fuel price, Charging infrastructure count, State GDP per capita, Urbanization level

Econometric Model

Fixed effects panel regression:

$$EV_Registrations_it = \beta_0 + \beta_1 GST_Rate_it + \beta_2 FuelPrice_it + \beta_3 ChargingInfra_it$$

Where:

i = State

t = Time

Statistical Tools

- Panel regression
- Fixed effects model
- STATA / R software

8. Data Analysis and Results

Table 1: Variables Used in Hypothesis Testing

Variable	Type	Measurement	Expected Relationship
EV Registrations	Dependent Variable	Number of electric vehicles registered across states	—
GST Rate (%)	Independent Variable	GST rate applied on electric vehicles	Negative (lower GST increases EV adoption)
Fuel Price (₹/Litre)	Independent Variable	Average annual petrol price	Positive
Charging Infrastructure	Independent Variable	Number of EV charging stations	Positive

Interpretation

This table defines the variables used in the study. EV registrations represent the level of EV adoption, while GST rate, fuel price, and charging infrastructure represent policy and market factors influencing adoption.

Hypothesis 1 (H1)

H1: GST rate reductions have a positive and significant impact on electric vehicle registrations across Indian states.

Table 2: Regression Results for H1

Variable	Coefficient	Std. Error	t-value	p-value
GST Rate (%)	-2105.34	455.21	-4.62	0.000
Constant	32,480.22	2,105.66	15.42	0.000
Observations	288			
R ²	0.43			

Source: Author's compilation based on data from VAHAN Dashboard (Ministry of Road Transport and Highways), GST Council reports (2019).

Interpretation

The coefficient of GST rate is **negative (-2105.34)** and statistically significant ($p < 0.01$). This indicates that a **1% reduction in GST rate leads to an increase of approximately 2,105 EV registrations** across states.

The R² value of **0.43** suggests that GST rate explains **43% of the variation in EV registrations**.

The results confirm that fiscal incentives such as GST reductions significantly influence EV adoption.

Hypothesis 2 (H2): The 2019 GST rate reduction significantly increased EV registration growth.

Table 3: Impact of GST Reduction (Before and After 2019)

Period	Average EV Registrations	GST Rate (%)
2017–2018 (Before GST reduction)	6,540	12
2019–2021 (After GST reduction)	14,320	5
Growth Rate (%)	119%	—

Source: Author's calculation based on government datasets.

Interpretation

The table shows that **average EV registrations increased from 6,540 before the GST reduction to 14,320 after the policy change**, representing a growth of **119%**.

Hypothesis 3 (H3)

H3: The impact of GST incentives on EV adoption is strengthened by supporting factors such as charging infrastructure availability and rising fuel prices.

Table 4: Regression Results with Supporting Factors

Variable	Coefficient	Std. Error	t-value	p-value
GST Rate (%)	-1780.22	410.33	-4.34	0.000
Fuel Price (₹/Litre)	162.14	36.48	4.44	0.000
Charging Infrastructure	24.72	5.11	4.83	0.000
Constant	11,860.40	2,340.11	5.07	0.000
Observations	288			
R ²	0.65			

Source: Author's calculations based on data from VAHAN Dashboard, GST Council publications, and PPAC fuel price statistics.

Interpretation

The results show that:

- **GST Rate** has a negative and significant relationship with EV registrations.
- **Fuel Price** has a positive and significant impact.
- **Charging Infrastructure** significantly increases EV adoption.

The R^2 value of **0.65** indicates that these variables jointly explain **65% of the variation in EV registrations**.

The results suggest that fiscal incentives such as GST reductions are more effective when supported by favorable market conditions such as high fuel prices and adequate charging infrastructure. These factors collectively strengthen the adoption of electric vehicles.

Table 5: Summary of Hypothesis Testing

Hypothesis	Relationship Tested	Result	Conclusion
H1	GST Rate → EV Registrations	Significant	Supported
H2	GST Reduction 2019 → EV Growth	Significant	Supported
H3	GST + Fuel Price + Infrastructure → EV Adoption	Significant	Supported

Interpretation

All three hypotheses are supported by the empirical analysis. The findings indicate that tax incentives, fuel price trends, and infrastructure development collectively influence EV adoption across Indian states. Regression results indicate that GST rate reductions have a statistically significant positive impact on electric vehicle registrations. States with stronger policy support and better charging infrastructure show higher EV adoption rates.

Fuel price increases also positively influence EV adoption, as consumers seek alternatives to expensive fossil fuels.

9. Findings and Discussion

1. GST Rate Reduction's Significant Effect on EV Adoption

The empirical findings unequivocally show that lower GST rates have a favorable and statistically significant effect on the number of electric car registrations in all Indian states. EVs are now more affordable for consumers thanks to the 2019 GST cut from 12% to 5%. This result lends credence to the theory that financial incentives are a major factor in shaping consumer choices and hastening the adoption of electric vehicles.

2. Fiscal Incentives' Effectiveness in Early Market Stages

According to the study, GST incentives work especially well in the early phases of the EV market's development, when high upfront expenses are a significant obstacle. GST reductions encourage first-time purchasers by lowering the purchase price and bridging the cost difference between electric and conventional internal combustion engine (ICE) automobiles.

3. The Complementary Function of Infrastructure for Charging

The data shows that EV adoption is strongly and favorably impacted by charging facilities. EV registrations are typically much higher in states with more charging facilities. This suggests that the

availability of infrastructure boosts customer confidence and lessens range anxiety, supporting the efficacy of GST incentives.

4. Impact of Increasing Fuel Prices on the Demand for EVs

The adoption of EVs is also significantly influenced by changes in fuel prices. The results imply that when consumers look for more affordable options, rising gas and diesel costs have a favorable impact on EV registrations. The combination of decreased GST rates and growing fuel prices makes EVs even more appealing.

5. Differences in EV Adoption by Region

Significant differences in EV adoption rates between states are noted in the report. Due to improved infrastructure, supportive legislation, and greater income levels, states like Maharashtra, Karnataka, Tamil Nadu, and Delhi have higher EV adoption rates. States with less developed economies and inadequate infrastructure, on the other hand, exhibit slower adoption rates. This suggests that different regions are affected differently by GST incentives.

6. Combined Impact of Non-Fiscal and Fiscal Elements

The findings show that a mix of supporting factors and financial incentives affect EV adoption. Although GST decreases increase affordability, their efficacy is greatly increased when paired with elements like the availability of charging infrastructure and good fuel price conditions.

7. Tax Incentives' Limitations

The analysis demonstrates that tax incentives by themselves are not enough to guarantee the EV market's long-term expansion. While initial demand is stimulated by GST reductions, long-term adoption is contingent upon the establishment of a wider ecosystem, which includes increasing consumer awareness, infrastructure expansion, and technological breakthroughs in battery efficiency.

8. Implications of Policy for Sustainable Mobility

According to the findings, governments ought to implement a comprehensive strategy that combines financial incentives with technology assistance and infrastructural development. Accelerating the shift to sustainable mobility requires stable and supportive tax policies in addition to ongoing investment in charging infrastructure.

10. Conclusion

In order to achieve sustainable mobility and lessen environmental externalities in India, electric vehicles are essential. The results of this study demonstrate that GST rate reductions significantly and favorably affect the adoption of EVs, mainly by reducing the initial cost and enhancing affordability. EV registrations have significantly increased across states as a result of the 2019 GST cut, demonstrating the power of fiscal policy to shape consumer behavior.

The study does, however, also show that fiscal incentives are not enough to support long-term growth in the EV industry. Supporting elements like the availability of charging infrastructure and the dynamics of gasoline prices greatly increase the efficacy of GST reductions. Fuel price volatility and persistently high petrol and diesel prices have raised the operational costs of conventional automobiles in recent years, prompting people to switch to electric vehicles as a more cost-effective option.

Furthermore, geographical differences in EV adoption show that the advantages of GST incentives vary by state based on policy execution, income levels, and infrastructural development. Overall, the analysis comes to the conclusion that a thorough and integrated policy framework is crucial, even while GST incentives serve as a powerful initial motivator. The long-term economic argument for

electric transportation is further strengthened by the increasing volatility of fuel prices, which makes EVs both a financially viable and environmentally friendly choice for customers.

11. Suggestions

1. **Stability and Persistence of GST Benefits:** It is essential to keep the electric vehicle concessional 5% GST rate in place. Adoption momentum may be adversely affected by any increase in tax rates.
2. **Fortifying the Infrastructure for Charging:** To lessen range anxiety and encourage widespread EV adoption, the government should greatly increase the infrastructure for public charging in both urban and rural locations.
3. **Fortifying Infrastructure for Charging:** To lessen range anxiety and encourage widespread EV adoption, the government should greatly increase the infrastructure for public charging in both urban and rural locations.
4. **Handling Volatility in Fuel Prices:** Policymakers should deliberately portray EVs as a cost-effective alternative given the regular changes and rising trends in the price of gasoline and diesel. Campaigns to raise awareness should emphasize how using EVs can save money over time when compared to fuel-powered cars.
5. **Alignment of State-Level Policies:** States with poor EV adoption rates are to be urged to implement consistent and encouraging EV regulations, including more infrastructure funding and subsidies.

References

1. Agarwal, R. (2025). *EVs to stay at 5% GST rate as council promotes clean mobility*. Business Standard.
2. Bureau of Energy Efficiency. (2023). *Electric mobility infrastructure development report*. Government of India.
3. GST Council. (2019). *Recommendations of the 36th GST Council meeting*. Government of India.
4. Kumar, A., & Alok, S. (2020). Adoption of electric vehicles: A literature review and prospects for sustainability in India. *Renewable and Sustainable Energy Reviews*, 132, 110043. <https://doi.org/10.1016/j.rser.2020.110043>
5. Li, S., Tong, L., Xing, J., & Zhou, Y. (2017). The market for electric vehicles: Indirect network effects and policy design. *Journal of the Association of Environmental and Resource Economists*, 4(1), 89–133.
6. Ministry of Power. (2024). *Electric vehicle charging infrastructure guidelines and reports*. Government of India.
7. Ministry of Road Transport and Highways. (2024). *VAHAN dashboard: Vehicle registration statistics*. Government of India.
8. Petroleum Planning and Analysis Cell. (2024). *Petroleum statistics*. Ministry of Petroleum and Natural Gas, Government of India.
9. Sierzechula, W., Bakker, S., Maat, K., & Van Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy*, 68, 183–194.
10. Singh, M., & Thakur, R. (2019). Government initiatives and adoption of electric vehicles in India: A study of policy incentives and market response. *International Journal of Innovative Technology and Exploring Engineering*, 8(10), 2076–2080.
11. Tigga, S. (2023). *33,411 EVs registered in Pune this year, clocking a 30% rise*. The Indian Express.