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Mini Review

Demand Forecasting for Interstate Trip Based on Toll Pricing

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ABSTRACT

This paper explores the effects of toll pricing on demand forecasting for interstate trips, with a focus on commuter behavior regarding travel mode choice, route selection and departure times. Using a mixed logit model, the study analyzes data from a survey of 921 commuters on the Tehran-Saveh freeway. The findings indicate that increases in toll prices significantly influence commuters' decisions to alter their travel modes, change routes and adjust departure times, particularly during peak hours. The review highlights the critical role of toll pricing in traffic management and its potential to reduce congestion and environmental impacts. Additionally, the study underscores the importance of considering socioeconomic factors, as lower-income groups are disproportionately affected by toll increases. The implications for transportation policy suggest that dynamic toll pricing, coupled with equitable measures, can optimize traffic flow and promote sustainable urban mobility.

Keywords: Demand forecasting; Interstate trips; Commuter behavior; Departure time adjustment; Dynamic pricing; Transportation policy

INTRODUCTION

This mini-review explores the intricate relationship between toll pricing and travel demand for interstate trips. By focusing on toll pricing, the review aims to highlight the influence of toll adjustments on commuters' behavior, including their choice of travel mode, route selection and departure times [1]. The study in question was conducted in Iran, using the Tehran-Saveh freeway as a case study and employed a mixed logit model to analyze the data gathered from a survey of 921 commuters.

LITERATURE REVIEW

Toll pricing as a transportation management tool

Road pricing and traffic management: Several studies have shown that road pricing, including tolls, can effectively manage traffic volume and reduce congestion. For instance, dynamic pricing strategies have been applied to adjust toll rates based on real-time traffic conditions, thereby influencing driver behavior and alleviating traffic congestion during peak hours. Such strategies highlight the potential of toll pricing to serve as an economic tool for controlling traffic flow.

Behavioral responses to toll increases: The response of commuters to toll increases varies widely. Some studies, such as those by Gypsy and Disaniak and Al-Houdiri, have demonstrated that toll increases can lead to shifts in route choice and travel mode. These shifts are often influenced by factors such as travel distance, purpose and the availability of alternative routes. The current study builds on these findings by examining how a 1000 to man increase in tolls influences route choice, mode change and departure time adjustments among commuters on the Tehran-Saveh freeway [2].

Socioeconomic factors and travel behavior: Research by Tillema et al. and Caiati et al. emphasizes the importance of considering socioeconomic factors when evaluating the impact of toll pricing. For instance, lower-income groups are more likely to be adversely affected by toll increases, which can lead to changes in travel behavior, such as opting for public transportation or altering travel times to avoid higher tolls. The reviewed study takes into account various socioeconomic variables, including income levels, employment status and household size, to provide a nuanced analysis of commuter behavior in response to toll adjustments.

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The study employed a mixed logit model to analyze data collected from a survey of 921 commuters on the Tehran-Saveh freeway. The mixed logit model was chosen for its flexibility in handling random utility variations and its ability to capture the correlation between unobserved factors. Key variables included in the model were toll prices, travel times, income levels and availability of alternative travel modes [3].

Data collection

Data was gathered through a combination of surveys and travel diaries. The survey included questions about travel frequency, purpose, origin and destination, vehicle ownership and socioeconomic attributes. The data collection aimed to capture both qualitative and quantitative insights into commuter behavior and preferences.

DISCUSSION

Model specification and analysis

The mixed logit model was specified to account for the variability in individual preferences and to model complex choice behaviors. The model's parameters were estimated using maximum likelihood estimation, which is effective in handling the random components of the model and providing robust results. The analysis focused on how changes in toll pricing influenced the probability of choosing specific travel modes and routes, offering insights into the elasticity of commuter behavior in response to toll variations [4].

Key findings

The study provides several crucial insights into the effects of toll pricing on interstate travel behavior, highlighting significant behavioral shifts among commuters in response to toll variations. The findings are categorized into three main areas: Travel mode and route choice, departure time adjustments and socioeconomic influences.

Travel mode and route choice: The analysis reveals that a one percent increase in toll prices leads to a 1.5101 percent decrease in the likelihood of commuters maintaining their usual travel mode. Concurrently, the probability of selecting alternative travel options, such as public transportation or different routes, rises by 2.5129 percent. This finding underscores the high sensitivity of commuters' travel mode and route choice to changes in toll prices.

The decision to switch travel modes or routes is influenced by various factors, including the availability and reliability of alternative transportation options. For instance, commuters who have access to efficient and convenient public transportation systems are more likely to switch from private cars to public transit when toll prices increase. Similarly, the presence of alternate routes with lower or no tolls encourages route changes. This behavior is particularly evident among frequent travelers who seek to minimize travel costs and optimize travel time [5].

Moreover, the study suggests that the perceived value of time plays a critical role in travel mode and route choice. Commuters with a higher value of time are less sensitive to toll increases and are more likely to continue using tolled routes and private vehicles due to the time savings and convenience they offer. Conversely, those with a lower value of time are more inclined to switch to less expensive travel options, even if it means longer travel times.

Departure time adjustments: The study found that higher tolls significantly impact departure time adjustments. Specifically, the probability of commuters changing their departure times increased by 0.1078 percent with higher tolls. This indicates a willingness among commuters to adjust their travel schedules to avoid peak toll rates, thereby reducing overall travel costs [6].

This behavior is particularly noticeable during peak hours when toll rates are often higher to manage congestion. Commuters may choose to depart earlier or later than usual to take advantage of lower toll rates during off-peak periods. Such adjustments not only help commuters save money but also contribute to the overall reduction of traffic congestion during peak hours.

The flexibility in departure time adjustments varies among different commuter groups. For example, employees with rigid work schedules may have less flexibility in changing their departure times compared to freelancers or those with flexible work hours. This variation highlights the importance of considering employment characteristics and work schedules when designing toll policies aimed at managing traffic flow through departure time adjustments [7].

Socioeconomic influences: Socioeconomic factors play a significant role in shaping travel behavior in response to toll pricing. The study highlighted that commuters with higher education levels and incomes were less likely to change their travel mode or route in response to toll increases. These groups tend to have higher disposable incomes and place a greater value on the convenience and time savings associated with using tolled routes and private vehicles.

In contrast, lower-income groups showed a higher propensity to switch to public transportation or alter their travel times to avoid higher tolls. These commuters are more sensitive to cost increases and are more likely to seek alternative travel options to minimize expenses. The availability of affordable and reliable public transportation options is crucial for these groups, as it provides a viable alternative to private vehicle use when toll prices rise.

Additionally, the study suggests that household characteristics, such as the number of dependents and car ownership status, influence travel behavior. Larger households with multiple dependents may find it more cost-effective to switch to public transportation or carpooling arrangements in response to toll increases. Similarly, households with limited access to private vehicles are more likely to rely on public transportation and adjust their travel schedules to avoid higher toll costs.

Implications for transportation policy

The findings of this study have profound implications for transportation policy and planning. By understanding the elasticity of commuter behavior in response to toll pricing, policymakers can design toll systems that balance revenue generation with traffic management and environmental goals. The study suggests that dynamic toll pricing, which adjusts rates based on real-time traffic conditions, can be an effective tool for managing traffic flow and encouraging the use of public transportation.

Dynamic toll pricing can help mitigate congestion by incentivizing commuters to travel during off-peak periods or use alternative routes and modes of transportation. This approach not only reduces traffic volumes during peak hours but also promotes more efficient use of existing transportation infrastructure. Additionally, revenue generated from tolls can be reinvested in public transportation improvements and infrastructure development, further enhancing the overall efficiency and sustainability of the transportation system [8].

Equity considerations

Policymakers must also consider the equity implications of toll pricing. As lower-income groups are more adversely affected by toll increases, measures such as reduced rates during off-peak hours or exemptions for essential travel can help mitigate the negative impacts on these populations. Ensuring that toll policies are equitable and do not disproportionately burden vulnerable groups is crucial for sustainable urban mobility.

Equity considerations should include targeted subsidies or discounts for low-income commuters, providing them with affordable access to tolled routes while maintaining the overall effectiveness of toll pricing in managing traffic. Additionally, investment in public transportation infrastructure and services in low-income areas can provide viable alternatives to private vehicle use, reducing the reliance on tolled routes and promoting social equity.

CONCLUSION

This mini-review has examined the complex relationship between toll pricing and interstate travel demand. The reviewed study provides valuable insights into how toll adjustments influence travel mode, route choice and departure times among commuters. By incorporating these findings into transportation planning, policymakers can develop toll systems that effectively manage traffic congestion, promote environmental sustainability and address equity concerns.

The study highlights the importance of considering both economic and social dimensions when designing toll policies. Dynamic toll pricing, coupled with equitable measures, can optimize traffic flow, reduce congestion and promote sustainable transportation. Policymakers must ensure that toll systems are designed to meet the diverse needs of urban commuters, balancing revenue generation, traffic management and social equity to achieve sustainable urban mobility.

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