

Operationalizing Mileage Depreciation: A Market-Weighted Hedonic Framework for Used Vehicle Pricing

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Abstract

Secondary automobile markets rely heavily on accumulated mileage as a primary determinant of value, yet a significant methodological gap exists between the econometric estimation of mileage effects and their operationalization in large-scale pricing systems. This paper addresses this challenge by proposing a statistically grounded framework for constructing stable, interpretable, and market-representative depreciation schedules.

Building on the hedonic pricing tradition, we employ a semi-logarithmic model with trim fixed effects and a quadratic mileage specification to isolate usage-based depreciation from vehicle heterogeneity. We introduce a novel market-weighted aggregation mechanism that pools trim-specific estimates into unified segment-level parameters, allowing for the rigorous treatment of data sparsity and behavioral pricing discontinuities.

The methodology is applied to a cross-sectional dataset of 415,249 used vehicle listings from the Turkish market collected in January 2024. Results demonstrate that the updated parameters capture market dynamics more accurately than existing heuristics, revealing that current schedules systematically undervalue low-mileage inventory and overvalue high-mileage vehicles. Additionally, we identify segment-specific nuances, such as the resilience of luxury diesel vehicles to high-mileage depreciation.

The framework is operationalized through an interactive R Shiny application, demonstrating how rigorous econometrics can be translated into scalable production tools for inventory valuation and revenue forecasting.

Keywords

Hedonic pricing, used vehicle market, mileage depreciation, operational analytics, market segmentation.