Constraints on the ecological transition in private transport: a micro analysis of ownership and purchasing behaviour in Tuscany

Damiano Baldaccini[1,3], Patrizia Lattarulo[2], Maria Grazia Pazienza[3], Leonardo Piccini[2], Corrado Pollastri[4]

[1] Università degli Studi di Milano Bicocca
[2] Istituto Regionale per la Programmazione Economica della Toscana
[3] Università degli Studi di Firenze
[4] Ufficio Parlamentare di Bilancio

Italian Vehicle Fleet

- Access to an extensive transport network is an essential component of individuals' quality of life and may be understood as an individual right that expands citizens' set of **capabilities** **[Lucas, 2012; Todd, 2014; Titheridge et al., 2014; Dorantes & Murauskaite-Bull, 2023]**.

- Italy is characterized by a pronounced **modal imbalance** in favour of private mobility. This modal imbalance corresponds to one of the highest, and steadily increasing, numbers of motor vehicles per capita in Europe **[ACEA, 2025]**.

- The overall set of **externalities** arising from accidents, emissions, congestion, and noise amounts to 3% of GDP and accounts for 15% of public expenditure and 43% of healthcare expenditure in Tuscany **[IRPET, 2012]**.

- The European Climate Law establishing climate neutrality by 2050, requires significant investments and sector-specific measures. The EU Sustainable and Smart Mobility Strategy stresses urgent emission reductions in transport **[Regulation (EU) 2021/1119]**.

Objective and Methodology

- **Objective:** This work analyses vehicle ownership and purchasing behaviour through the lens of **transport-induced poverty** emerging from the sustainable mobility transition.

- **Methodology:** Exploiting three **administrative micro-level datasets**, we estimate regression models, two Logistic Regressions and a Multinomial Probit, to capture heterogeneous effects across individuals and socioeconomic groups.

- **Results:** The results allow us to identify population groups at risk of being **left behind** during the sustainable transition, highlighting the most critical socioeconomic and structural dimensions of transport vulnerability.

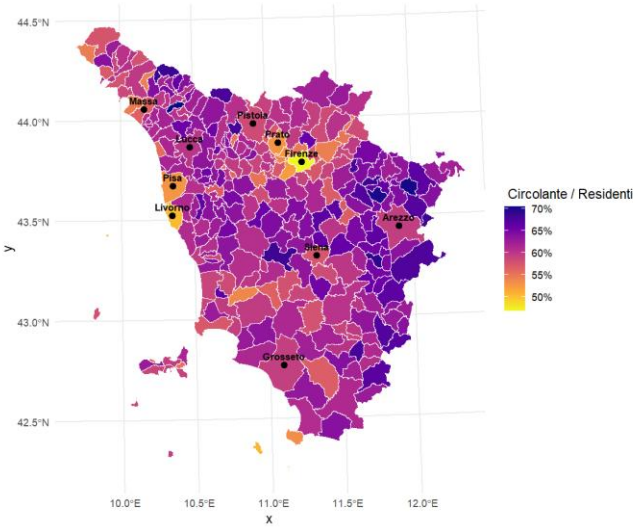
Transport-induced poverty

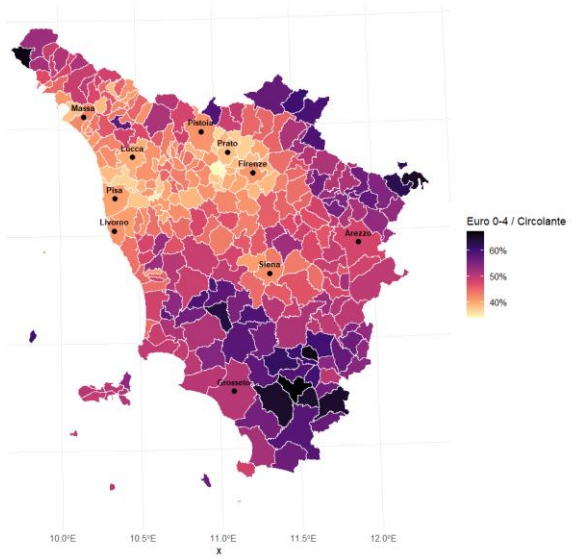
- High reliance on private vehicle ownership, especially in areas with limited public transport options **[Lucas, 2016; van Dülmen et al., 2022]**.
- Low adoption rates of electric and hybrid vehicles despite incentives **[JRC, 2022; Alberini & Vance, 2025]**.
- Economic barriers limiting access to cleaner, energy-efficient transport modes **[Litman, 2017; Dorantes & Murauskaite-Bull, 2023]**.
- Energy costs of vehicle use disproportionately affect low-income households **[Dorantes & Murauskaite-Bull, 2023; Carrieri et al., 2024]**.
- Need for targeted interventions to increase affordability and accessibility of sustainable mobility options **[World Bank, 2025]**.

Main Criticalities

- **Size**
  - Italy has the **second largest** vehicle fleet in the European Union (roughly 40 million vehicles) and the **highest number** of vehicle per 1,000 inhabitants (694) **[ACEA, 2025]**.
  - In Tuscany we observe 744 vehicles per 1,000 inhabitants **[ACI, 2025]**.
- **Average Age**
  - The **average age** of vehicles in Italy is 12.8 years, compared to 12.5 years at the EU level **[ACEA, 2025]**.
  - Consequently, vehicle lifespans are extended, a phenomenon particularly characteristic of the more **peripheral** areas **[ACI, 2025]**.

Spatial Distribution





A higher number of motor vehicles per capita is observed in the more **peripheral** areas of the region.
Euro 0-4 old and polluting vehicles- are highly concentrated in peripheral areas

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Data

Car property tax

- **Individual Level Data**
  - Age
  - Gender
  - Citizenship
  - EURO 0-6
  - Fuel Type
- **Municipal Level Data**
  - Substitution Rate
  - Charging Station
  - Urbanization Level as a proxy for service accessibility (Istat)
  - Distance from Florence

Income

- **Income Measure**
  - We use the declared income from 0 to 150K
- **Income Distribution**
  - Quartile of income distribution of those who have at least one vehicle.

ISEE

- **Household**
  - Number of family members as a proxy for demand for car ownership
  - Role in declaration as a proxy for secondary vehicle

Regression Models

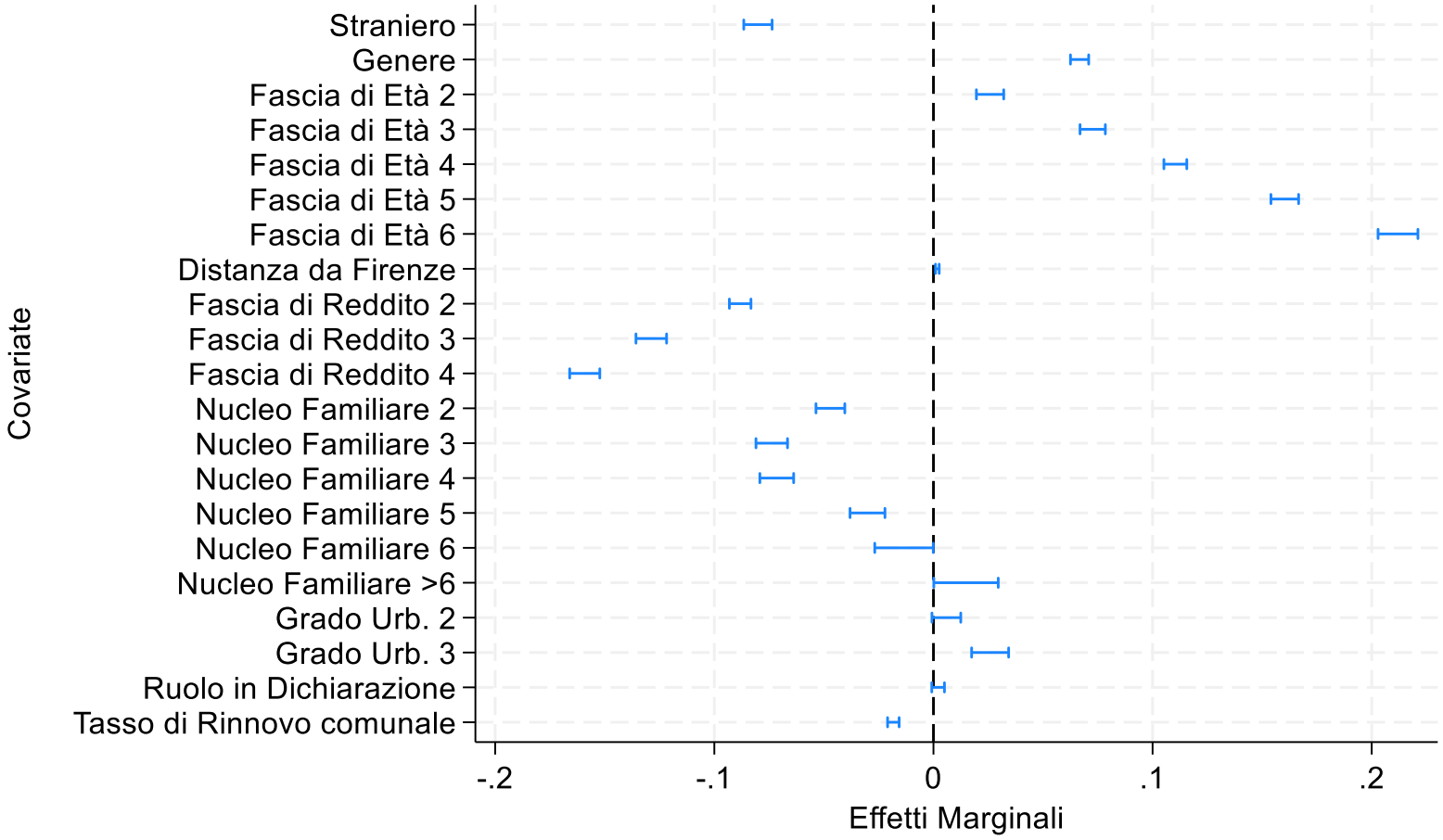
Leveraging the availability of a dataset with individual-level information, we analysed **ownership** and **purchase** dynamics using regression models

- **Model 1**: Own at least one EURO 0-4 vehicle (old and polluting vehicles, urgent need for renewal)
- **Model 2**: Purchase an Electric/Hybrid Electric vehicle (who purchases green vehicles)
- **Model 3**: Multinomial Probit for fuel choice (infrastructure and municipal determinants)

We consider 2021 data.
We compute cluster-robust standard errors at the municipal level.

Model 1 – Average Marginal Effects

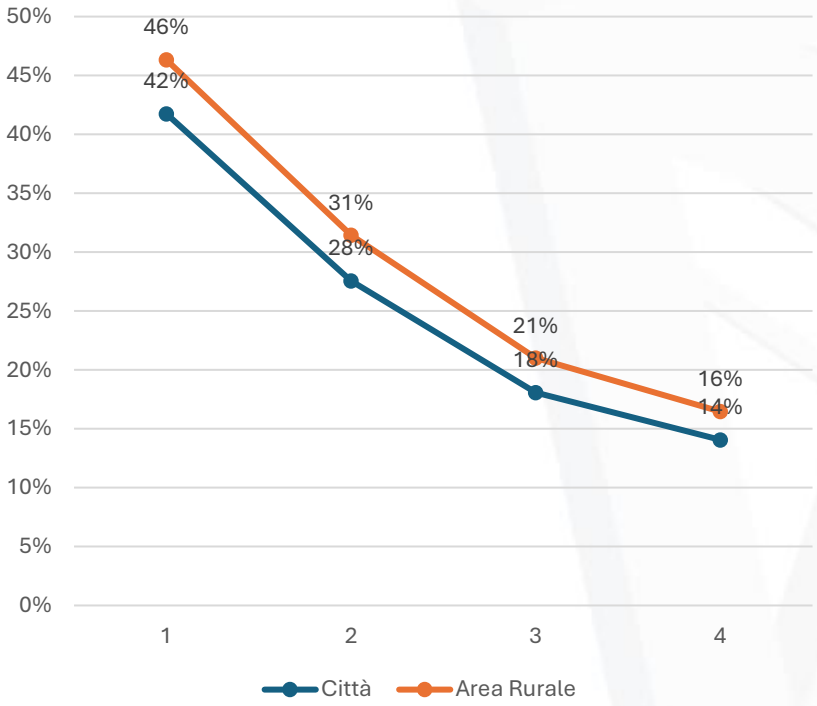
Y = 1 if the owner has at least one EURO 0-4 vehicle



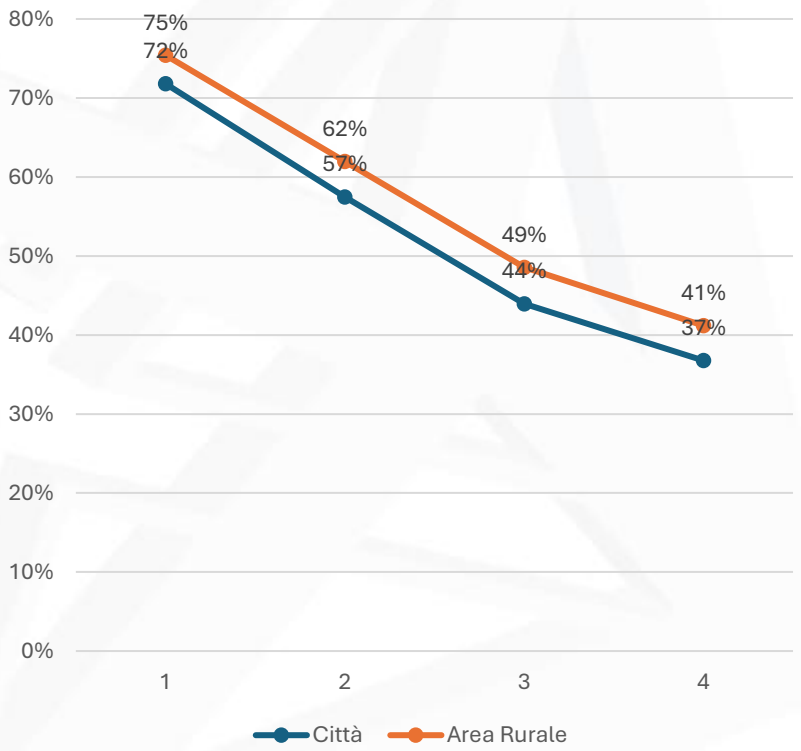
The two main drivers behind the behavior of continuing to own an older vehicle are **Age** and **Income**.

Predicted Probabilities

Man, Italian citizen and single



Age Level: 30-40

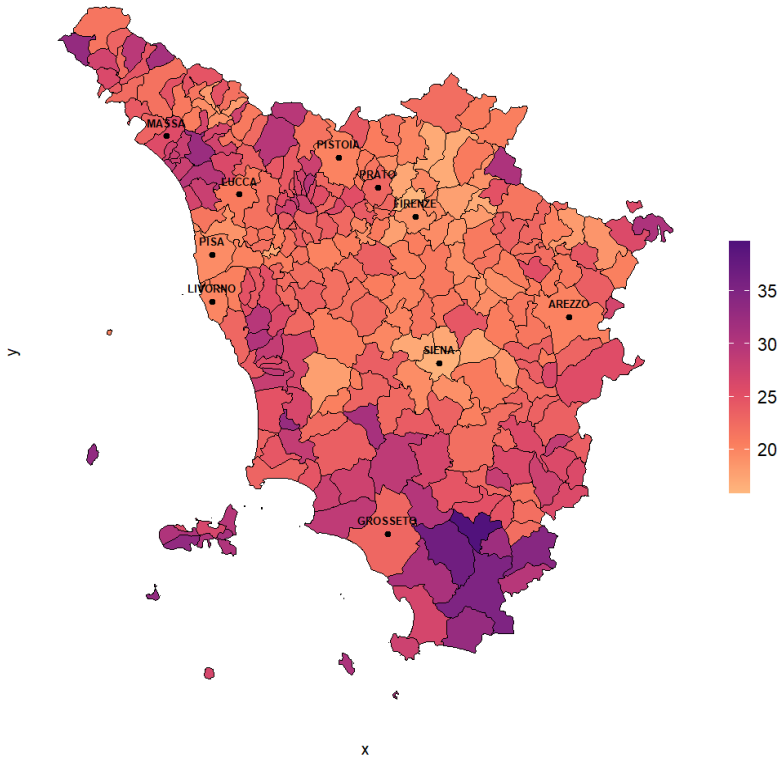


Age Level: > 70

Income Level: 1(0-12.186), 2 (12.186, 21.220), 3 (21.220-29.759), 4 (>29.759)

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

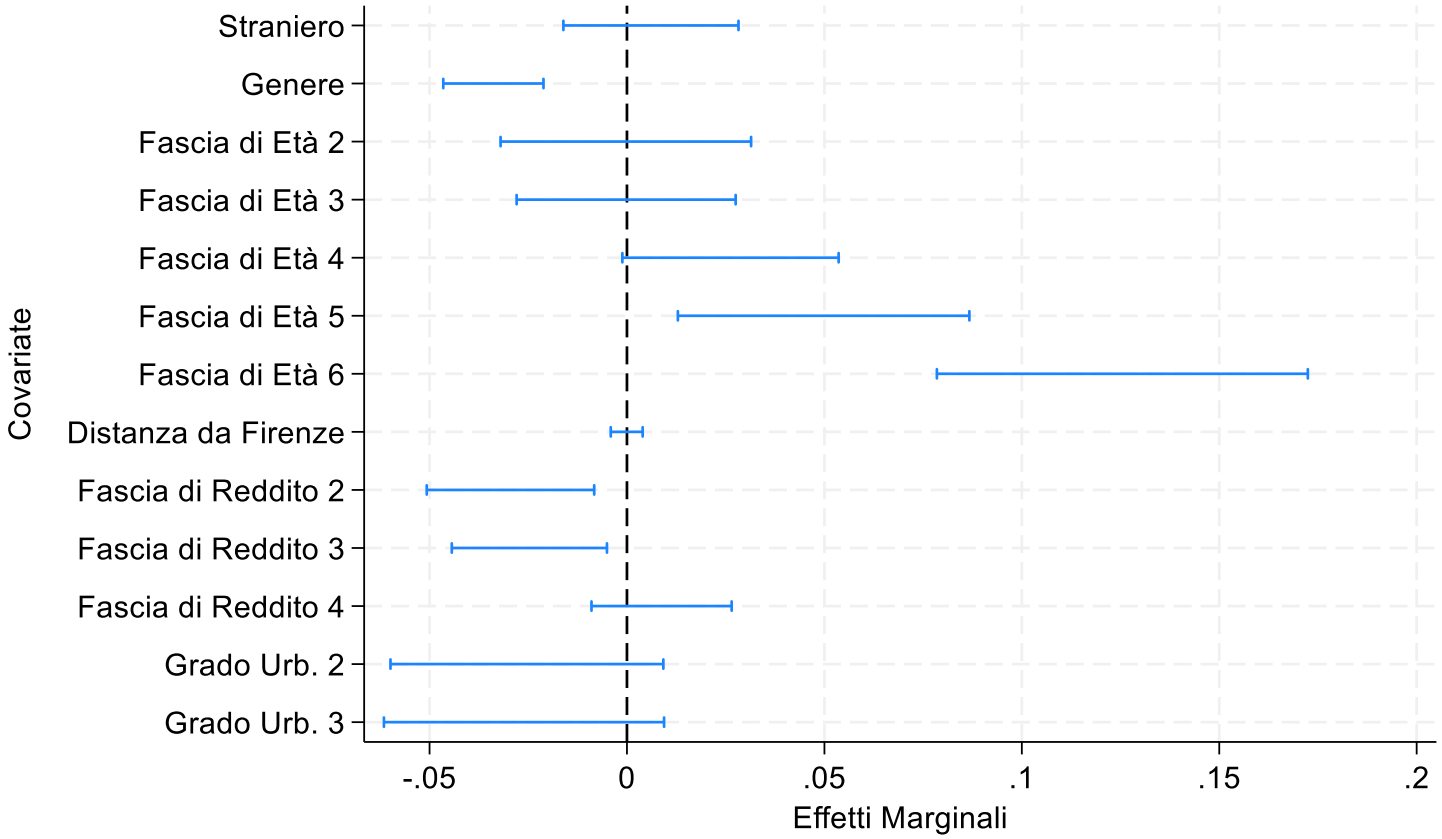
Where are the individuals at risk?
First Quartile of Income



In areas with a higher **concentration of old and polluting** motor vehicles per capita, the vehicle fleet is also more **difficult to replace**. These challenges are particularly pronounced in the most peripheral areas, including the province of Grosseto in the southern part of the region.

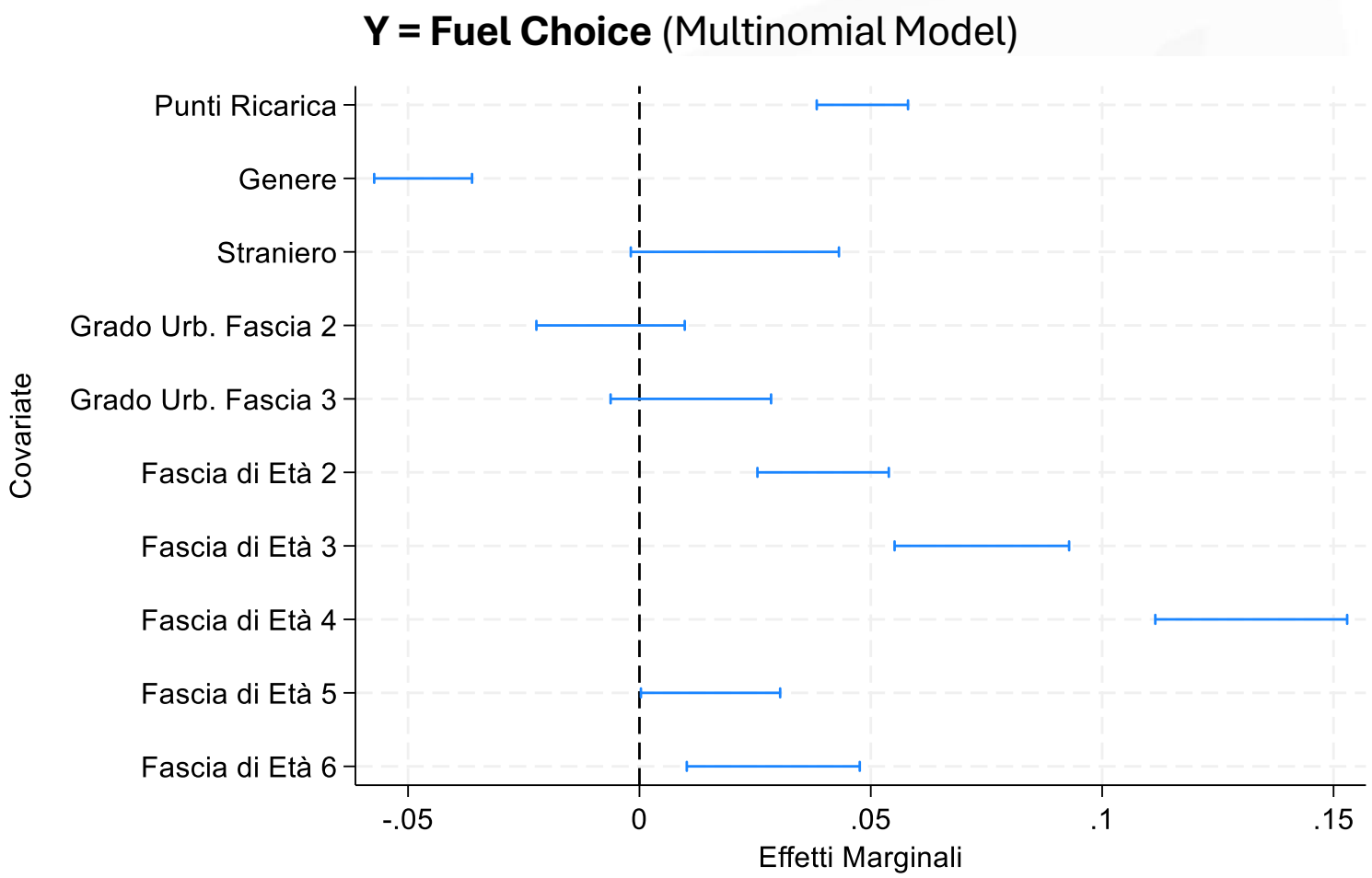
Model 2 – Average Marginal Effects

Y = 1 if the owner purchase an Hybrid/Electric Vehicle or Full Electric



Unlike the retention of old vehicles, the purchase of hybrid and electric cars reflects a choice driven by **age-related economic stability.**

Model 3 – Average Marginal Effects for Electric Vehicles



The availability of **infrastructure** strongly affects the probability of purchasing an electric or hybrid electric vehicle.

Conclusion and Policy Implications

- The availability of individual-level **administrative databases** has enabled a highly precise analysis of vehicle ownership and purchase dynamics in Tuscany.
- The energy transition must address **social risks**: elderly people, low-income families, and residents of peripheral areas dependent on private cars face barriers in accessing sustainable mobility.
- Analysis of this kind can support the **identification** of areas with the greatest criticalities and **groups of individuals** at risk to be left behind, thereby facilitating the adoption of policies that address **both** environmental and social dimensions.

Thanks!

Damiano Baldaccini[1,3]

d.baldaccini@campus.unimib.it

[1] Università degli Studi di Milano-Bicocca

[3] Università degli Studi di Firenze