Disentangling individual-level from location-based income uncovers socio-economic preferential mobility and impacts segregation estimates

Keywords: spatial networks, human mobility, experienced segregation, urban networks, cities

Extended Abstract

Spatial and social segregation in living spaces have a significant impact on the daily lives of residents, such as social cohesion, mixing, and inequality. Traditional approaches have primarily focused on residential segregation, assigning socio-economic characteristics to individuals based on their home locations. However, these methods overlook individual-level features beyond income and, more importantly, fail to distinguish between location-based and individual-level income [1]. Recent research has emphasized that mobility patterns play a critical role in providing a more comprehensive understanding of spatial and social segregation [2]. Ignoring the potential impact of individual-level information like income, age and gender in the study of mobility mixing may bias our understanding of socio-economic segregation.

In this paper, we map macroscopic behavior into more granular mobility patterns by incorporating mobility data stratified by individual-level income class. We combine a mobile phone dataset of daily mobility flows across Spanish districts, stratified and adjusted by age, gender, and income, with census data on the median income of districts. We build mobility-based socio-economic assortativity matrices for multiple demographic groups and observe the mobility patterns of three income groups in relation to location-based socio-economic (SE) classes.

Our findings show that socio-economic assortativity varies when isolating the mobility of specific income groups, with the middle-income group reporting the highest segregation and the low income group reporting the lowest segregation, in Figure 1A. The analysis of their origin-destination mobility patterns reveals that all groups tend to visit areas with higher residential income than their own, a phenomenon we term preferential mobility. This behavior is heterogeneous across income groups it strongest for the highest-income group and attenuating with income, shown in Figure 1B, and remains hidden in the overall aggregated probability matrix on the left, in Figure 1B, which introduces our Preferential Mobility Index ($R > 0$ indicates upward bias). Our analysis further reveals substantial differences in SE assortativity between weekdays and weekends, with weekends exhibiting higher assortativity, particularly for the elderly class.

Figure 1C reveals the dynamics of assortativity ρ in October 2023 across different genders and age groups. The trend exhibits a weekly regularity, without systematic differences from one week to the next. Weekends show higher levels of assortativity compared to weekdays, meaning higher level of segregation during weekends. Additionally, there is a significant difference in assortativity levels among the oldest individuals, with men particularly displaying higher assortativity than women. Figure 1D illustrates the dynamics of the Preferential Mobility Index R in October 2023 across different genders and income groups, aggregated by weekday. Consistent with the patterns observed in the probability matrices, individuals from the lowest income group exhibit a consistently higher mobility preference towards the wealthiest districts. The same trend is present among middle-income groups, although to a lesser

extent, and it diminishes further among the richest individuals. This effect remains consistent across all weekdays.

Finally, we use a radiation model, which performs well in capturing inter-municipal population mobility, to obtain null estimates of mobility. We show that it best fits the mobility flows of middle-income and middle-aged groups, while performing less effectively for younger and lower-income groups.

Our dual approach, focusing both on assortativity patterns and mobility modeling, highlights that current models fail to adequately capture preferential mobility behavior. Overall, our work suggests that considering the interplay of socio-economic preferential behavior, as well as age and gender gaps, could significantly improve the performance of current state-of-the-art models.

References

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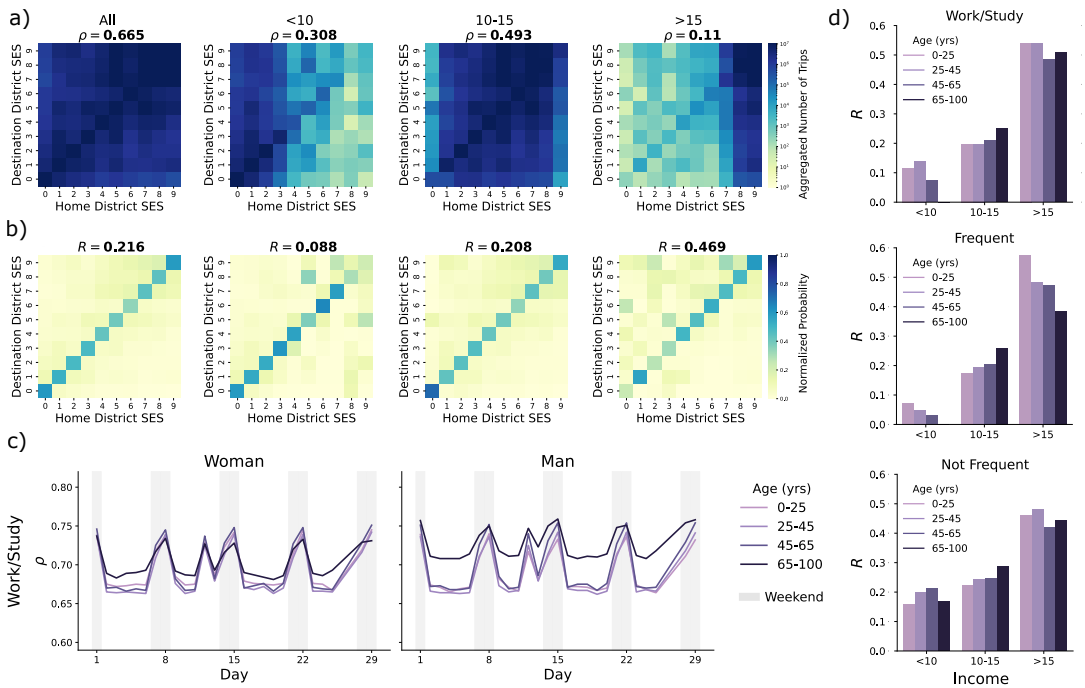

Figure 1: **Assortativity ρ and Preferential Mobility Index R a)** Mobility matrices aggregated over October 2023 across three income groups (< 10, $10-15$, > 15 thousands euros per year). **b)** Probability matrices (normalized by Home District SES) aggregated October 2023 across the three income groups (< 10, $10-15$, > 15 thousands euros per year). **c)** Assortativity ρ dynamics for travels from home to work or school in October 2023 among different genders and age groups (0-25, 25-45, 45-65, 65-100 years). **d)** socio-economic Mobility Preference Index R aggregated by weekdays for travels from home to work or school in October 2023 among different genders and income groups (< 10, $10-15$, > 15 thousands euros per year).