Who Meets Whom: Income Stratification in Urban Co-Presence

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Headline Summary. Human spatial mobility is not only movement between places; it also organises who becomes co-present with whom. Yet the income composition of co-presence (who actually shares urban space with whom as people move through the city) remains poorly understood. Using mobile location data for 975,952 users across England and Wales, this study reconstructs co-presence at the neighbourhood level and shows that co-location events are spatially concentrated in a small number of high-connectivity venues, strongly income-stratified across all distance bands, and systematically asymmetric in the travel burden they impose on lower-income residents.

Extended Abstract.

Background and Motivation. Social segregation matters because it shapes the everyday field in which social relationships are formed. It affects who people encounter repeatedly, who becomes familiar, who is deemed trustworthy, and who can provide access to information, support, and opportunity. In mobile cities, this field is not fixed by residential location alone. It is also produced by human spatial mobility: the repeated movements through workplaces, retail spaces, schools, and transport hubs that bring some people into co-presence while keeping others apart. We define this intermediate layer as *actual co-presence*: the physically observed sharing of urban space by residents of different neighbourhoods at the same time.

Co-presence is not the same as friendship, conversation, or exchange. It is the physical occasion that makes these forms of interaction possible. This matters because social networks are not formed at random. Homophily is a central organising principle of social life, and people are more likely to form ties with similar others [1]. If daily mobility mostly brings similar people into co-presence, the pool from which weak ties and bridging relationships can form is already narrow, regardless of residential proximity. Income segregation can therefore be reproduced through mobility before a social tie is ever recorded.

Despite this importance, the income structure of actual co-presence remains under-studied. Urban theory has long treated streets, public spaces, and transport hubs as settings where different social groups can encounter one another [2]. Recent mobility research, however, shows that movement alone does not guarantee cross-income mixing [3]. The key question is therefore not only where people go or how much they travel, but whom their mobility actually brings them into co-presence with, and whether these realised co-location events cross or reinforce income boundaries.

Methodology: A Neighbourhood Co-Presence Network. We study this layer by constructing a co-presence network from anonymized mobile location data covering 975,952 users in England and Wales from October to December 2021. Two users are recorded as co-located only when they remain within 100 metres of one another for a minimum of five minutes of overlapping dwell time, excluding pass-through trajectories. Co-location events are linked to inferred home neighbourhoods and aggregated at the Lower Layer Super Output Area (LSOA) level ($n = 32{,}844$). Nodes are home neighbourhoods; weighted edges record the total number of co-location events between residents of two neighbourhoods. For each event, we also record home-to-home distance, income-quintile gap, and the travel-distance imbalance between the lower- and higher-income participants. Income rank is derived from the 2019 Index of Multiple Deprivation for England and the equivalent Welsh index, each mapped to LSOA quintiles (Q1 = most deprived; Q5 = least deprived).

Key Findings: The Income-Stratified Geography of Co-Presence. This procedure identifies 437,800,439 co-location events forming 33,799,928 unique neighbourhood-pair ties across 31,811 active neighbourhoods. Three patterns stand out. First, co-location events are spatially concentrated: the top 5% of venues by event volume account for the majority of cross-neighbourhood co-presence.

High-connectivity nodes (city centres, rail terminals, airports, and major stadiums) draw residents from broader geographic catchments and more income-diverse neighbourhoods than routine spaces, where co-presence is overwhelmingly local and within-quintile.

Second, co-presence is strongly income-stratified across all distance bands. The income quintile of a neighbourhood's co-presence partners closely tracks that neighbourhood's own quintile. Within the 0–5 km band, same-quintile co-presence reaches approximately 0.50, compared with 0.20 under random mixing, a 2.5-fold excess. Longer trips increase income diversity but do not eliminate stratification: even at distances above 50 km, same-quintile co-presence remains elevated relative to the random baseline. Third, cross-quintile co-location events carry an asymmetric travel burden. In Q1–Q5 pairings, the most income-unequal combination, lower-income residents travel a median of approximately 2 km further than their higher-income co-present partners to reach the shared venue. Cross-income co-presence is therefore not only rarer than within-quintile co-presence; it also demands disproportionately greater travel effort from lower-income residents.

Conclusion and Implications. This study makes the income structure of urban co-presence observable at city scale. Residential data describe where income groups are located; social network data describe ties after they have formed. Co-location data capture the structural layer between these two: who actually shares urban space with whom, and under what conditions of income (dis)similarity and travel asymmetry. This makes the physical preconditions of tie formation, and their unequal distribution, empirically tractable for the first time at the scale of an entire national urban system.

The findings challenge a common planning assumption. Greater mobility and more connected urban spaces do not automatically produce income mixing. What determines the social composition of co-presence is not the volume of movement but the income geography of the venues that movement converges on. Policies aimed at social integration therefore need to ask not only whether shared destinations exist, but whether those destinations actually bring residents of different income quintiles into co-presence, and whether the travel burden of cross-income co-location falls disproportionately on lower-income residents. Next steps include stratifying co-presence by time of day and venue type, quantifying the role of repeated co-location in tie formation, and conducting representativeness checks to connect these mobility-derived co-presence patterns to theories of boundary maintenance and stratified social exposure.

References

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