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Inter- and intrajurisdictional commuters in China: How do they differ in socioeconomic, residential and travel characteristics?

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Abstract: Interjurisdictional commuting is increasingly prevalent in China, yet the socioeconomic and mobility disparities between interjurisdictional and intrajurisdictional commuters remain underexamined. This study investigates the socioeconomic, residential, and travel-related differences between interjurisdictional and intrajurisdictional commuters in four cities—Guangzhou, Shenzhen, Foshan, and Dongguan—using cellphone data of 15.2 million users on October 18, 2023. As commuters are not randomly assigned across jurisdictional boundaries, propensity score matching was employed to adjust for differences in workplace characteristics before comparing the two groups. The analysis reveals that interjurisdictional commuters are younger, more likely to be male and migrants, and tend to live in low-rent neighborhoods with poorer access to urban amenities. They also experience significantly longer commuting distances, durations, and higher transport costs compared to their intrajurisdictional counterparts. These disparities reflect not only individual choices but also structural challenges, such as housing affordability gaps, fragmented transport governance, and insufficient regional planning. The study contributes to the spatial mismatch and transport poverty literature by highlighting the regional dimension of commuting inequalities in polycentric urban systems. It underscores the need for integrated transit planning in peripheral cities, and targeted support for long-distance commuters. These findings offer policy-relevant insights for fostering equitable mobility in rapidly urbanizing regions.

Keywords: Interjurisdictional commuters, propensity score matching, cellphone data, spatial mismatch, transport inequality

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1 Introduction

The association between commuting and socioeconomic disparities is well established in Western urban studies. Two key frameworks—spatial mismatch (Gobillon et al., 2007; Ihlanfeldt & Sjoquist, 1998; Kain, 1968;) and transport-related exclusion (Church et al., 2000; Lucas, 2012)—highlight how disadvantaged populations face systemic barriers to employment due to residential segregation and inadequate transport access. Drawing from these theories, Chinese scholars have explored intra-urban commuting disparities

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under unique spatial dynamics (Ta et al., 2017; Wang & Chai, 2009). A consistent finding is that lower-income or peripheral residents endure longer, costlier commutes. These studies underscore growing transport inequities in Chinese cities and point to the need for more inclusive urban planning and mobility strategies (Chen et al., 2024; Hu et al., 2017; Lin et al., 2016; Ye & Titheridge, 2019; Zhao et al., 2020).

While the challenges of intrajurisdictional commuting are now well-documented, a growing but underexplored issue is interjurisdictional commuting, which refers to crossing city or administrative boundaries to reach one's workplace. Since the 1970s, studies have documented a rise in interjurisdictional commuting driven by successive waves of urban expansion in Western cities (Hu, 1976), driven by urban sprawl, economic decentralization, and regional labor market integration (Merriman et al., 1995; Moss et al., 2012). Scholars have analyzed its spatial patterns and governance implications, arguing that traditional planning approaches—anchored in static residential populations—fail to capture the dynamic daily movement of people across administrative lines (Kwan, 2013; Zandvliet et al., 2008).

In China, interjurisdictional commuting is a newer but rapidly expanding phenomenon. Rising disparities in housing affordability, job distribution, and administrative fragmentation—coupled with the expansion of high-speed rail and intercity transit—have led to growing numbers of residents who live in one city but work in another (Zhang & Ma, 2024; Zhao et al., 2019). Nonetheless, most Chinese commuting studies remain confined to a single jurisdiction, focusing on long-distance or suburban commuting within city boundaries (Song et al., 2007; Sun et al., 2010; Wang & Xu, 2010). The broader frameworks of spatial mismatch and transport exclusion have yet to be systematically applied to interjurisdictional contexts in China.

Yet interjurisdictional commuting compounds existing spatial mismatches with additional challenges: longer travel distances, higher costs, and more limited connectivity. These burdens disproportionately affect lower-income commuters, who are more likely to be priced out of city centers. Despite these real-world consequences, academic research on cross-boundary commuting remains sparse. The lack of theoretical frameworks and empirical analysis impedes policy responses. If municipal governments continue to plan housing and transport in isolation, interjurisdictional commuters risk exclusion from infrastructure investment and institutional support. More importantly, fragmented governance can undermine the efficiency and equity of regional labor markets. Interjurisdictional commuting is thus not only a mobility issue—it reflects deeper challenges of coordination, spatial justice, and institutional design.

This study seeks to bridge this gap by applying the lenses of spatial mismatch and transport exclusion to analyze differences between interjurisdictional and intrajurisdictional commuting in China. Focusing on four major cities in the Pearl River Delta (Guangzhou, Shenzhen, Foshan, and Dongguan)—one of China's most densely populated and economically integrated regions—this study uses cellphone data of 15.2 million users on 18 October 2023, supplemented by travel time and cost estimates derived from Gaode Ditu's API (a Chinese desktop web-mapping service application). By employing Propensity Score Matching (PSM), the analysis controls for workplace characteristics to isolate differences in socioeconomic attributes (e.g., gender and age), residential characteristics (e.g., housing rent), and commuting metrics (distance, time, and cost) between the two groups.

In doing so, this paper contributes to a deeper understanding of how institutional and spatial boundaries shape commuting behavior in Chinese city-regions. As housing and labor markets increasingly transcend municipal boundaries, city-centric planning is insufficient. The findings highlight the need for integrated strategies in transport,

housing, and land use—ones that extend beyond administrative borders to ensure equitable access and sustainable regional development.

The remainder of this paper is structured as follows: the next section reviews the literature; the methodology section introduces the data, the variable measurements, and the modeling approach; the results section presents the empirical analyses; and the last section concludes the study and discusses the policy and theoretical implications.

2 Literature review

2.1 Intrajurisdictional commuting and socioeconomic disparities

The association between intrajurisdictional commuting and socioeconomic disparities is a prominent concern in Western countries. As early as the 1960s, Kain (1968) identified the problem of spatial mismatch between residences and workplaces faced by low-income and minority residents. This disconnection contributes to longer commutes, higher travel costs, and even unemployment among these populations. Since then, the spatial mismatch hypothesis (SMH) has been extensively studied and confirmed in various global contexts. In U.S. cities, for example, decentralization of employment left inner-city Black residents with limited access to suburban job opportunities, contributing to higher unemployment rates (Ihlanfeldt & Sjoquist, 1998; Raphael, 1998). Similar findings emerged in Paris (Aguiléra et al., 2009) and South Africa (Naudé, 2008).

Over time, scholars have expanded the scope of spatial mismatch to consider factors beyond geography. For instance, discrimination and skill gaps—termed "racial" or "skills" mismatch—interact with spatial separation to exacerbate employment disadvantage (Houston, 2005; Stoll, 2005). Meanwhile, limited access to automobiles has emerged as a critical barrier to job access. Taylor and Ong (1995) introduced the concept of "automobile mismatch," showing how car ownership mediates the impact of distance. Even after controlling for mode, distance to jobs remains a strong predictor of unemployment (Zenk et al., 2005), reinforcing the idea that spatial mismatch is a multifaceted issue involving geography, mobility, and socioeconomics (Gobillon et al., 2007).

In parallel, the concept of transport-related social exclusion has gained prominence. This framework highlights how insufficient mobility—due to high costs, poor service coverage, or excessive travel time—prevents full participation in work and society (Church et al., 2000; Lucas, 2012). Early UK studies, such as the Social Exclusion Unit (2003), documented how poor transit access in low-income neighborhoods isolated residents from jobs and services. In the U.S., car ownership strongly predicts employment outcomes among the poor, indicating that without reliable transport, distance becomes an insurmountable barrier (Ong & Blumenberg, 1998). Blumenberg and Manville (2004) emphasized that solving spatial mismatch requires both proximity and mobility: welfare-to-work programs often failed when participants could not reach distant jobs due to inadequate transit options. Currie et al. (2010) found, based on empirical evidence from Australia, that time poverty may serve as a crucial link between transport disadvantage and broader issues of social exclusion and individual well-being.

Both literatures converge on a central insight: improving accessibility—through better transit or housing-job proximity—is essential for reducing inequality. Policy responses vary: some cities invest in transit expansion or fare subsidies; others promote affordable housing in job-rich areas. Covington (2018) found that improved transit modestly narrowed the racial employment gap in U.S. cities. In France, programs offering vehicles and licenses to suburban youth helped overcome job access barriers. Yet scholars caution that transit improvements alone may be insufficient if other systemic barriers persist

(Chapple, 2006; Lucas, 2012). Thus, integrated approaches combining transport and land use policy are increasingly seen as necessary for promoting inclusive urban growth.

Inspired by international research, scholars have turned to intrajurisdictional commuting in Chinese cities (Ta et al., 2017; Wang & Chai, 2009), where patterns differ due to unique mechanisms of spatial transformation. Until the late 1970s, Chinese cities were structured around self-contained industrial townships (Zhou & Ma, 2000). Since then, economic reforms have led to sprawling suburban real estate and the construction of welfare housing for low-income suburbanites. These shifts have made long-distance commuting increasingly common.

Researchers have identified three dominant commuting patterns in China: reverse commuting from central cities to suburbs, lateral commuting between suburban new towns, and commuting from suburbs to city centers. The latter pattern dominates due to most Chinese cities' monocentric structure (Lin et al., 2015; Song et al., 2007; Sun et al., 2010; Zheng & Zhang, 2007; Zhou et al., 2014). In highly decentralized regions such as Beijing and Shanghai, lateral commuting between suburbs has rapidly increased (Li, 2010; Meng, 2009; Wang & Xu, 2010; Xue et al., 2007). For example, in Beijing, lateral commuting between inner suburban towns accounts for up to 50% of commutes (Xue et al., 2007). Reverse commuting has also emerged, with workers traveling from city centers to outer industrial zones (Zhao et al., 2013).

Building on general commuting pattern analyses, recent studies in China have focused on how commuting intersects with socioeconomic disparities. Researchers have examined how factors like income, education, age, and urban form produce unequal commuting experiences in Chinese cities. Several studies documented systematic commuting differences across social groups. For instance, Lin et al. (2016) showed that in Beijing's polycentric development, improving jobs–housing balance and transit access in suburban centers particularly reduced commuting times for low-income workers. Similarly, a nationwide analysis found that higher-income urban residents tend to have longer commutes than lower-income residents, especially in larger and more sprawling cities (Zhu et al., 2017). Hu et al. (2017) found that Beijing's spatial and economic changes in 2000–2010 stratified job access between education groups, often disadvantaging the less-educated population. These findings highlighted socioeconomic status and urban structure as key influences on commute length and hinted at a burden falling on disadvantaged groups (Fan et al., 2014). Another strand of studies cast their focus on inequalities in job accessibility and quality of life. Low-income commuters reported lower commute satisfaction (Ye & Titheridge, 2019), and longer daily commutes were shown to significantly reduce overall life satisfaction (Zhu et al., 2019). An explicit equity perspective also emerged around this time. Li et al. (2019) reported that longer commutes significantly erode individuals' perceived social equity, an effect not offset by higher income (a "commuting paradox").

In the 2020s, researchers began leveraging new data and methods to capture more nuanced disparities. Cellphone data from Beijing revealed fine-grained patterns of long commutes concentrated among peripheral, disadvantaged groups (Zhao et al., 2020). Likewise, a space–time accessibility study in suburban Guangzhou found stark gaps in access to services between different socioeconomic groups (Chen & Yeh, 2021). Research on China's planned new towns further showed that high-income suburban residents often commute farther (usually by car), while lower-income residents rely on slower public transit and face greater commuting difficulties if local jobs are lacking (Li & Zhao, 2022). Most recently, Chen et al. (2024) applied explainable machine learning to massive mobility data and discovered a new generational divide: younger workers tend to have much longer commutes than older workers in Beijing, reflecting an emerging age-related disparity in commuting. Overall, a consistent finding is that disadvantaged groups

in urban China – whether defined by lower income, lower education, or peripheral location – experience longer and more burdensome commutes, underscoring ongoing transport inequities in Chinese cities, and indicating a need for more inclusive transport policies.

While spatial mismatch and transport exclusion are now well-documented, a growing but understudied issue is interjurisdictional commuting—crossing city or administrative boundaries to reach work. As metropolitan regions become more polycentric, workers often live in one jurisdiction and work in another. Next section will review existing literature to explore the emerging challenge of interjurisdictional mobility and its relation to spatial mismatch and transport exclusion.

2.2 Interjurisdictional commuting: Compounding spatial mismatch and transport exclusion

Since the 1970s, studies have documented a rise in interjurisdictional commuting driven by successive waves of urban expansion in Western cities (Hu, 1976). Such commuting encompasses not only movements between central and peripheral counties but also travel across peripheral counties (Sööt et al., 2006). Scholarly interest in this topic has developed globally. Hu (1976) was among the first to examine the socioeconomic characteristics and spatial distribution of intercounty commuters in Oklahoma. Moss and Qing (2012) documented "super commuters" who reside beyond metropolitan boundaries but work in central counties. Merriman et al. (1995) studied excess commuting in the Tokyo metropolitan area, observing substantial flows between different cities. In Australia, Wilkinson and Butt (2013) explored commuting patterns between small towns and regional centers beyond metropolitan influence. Wang and Hu (2017) further investigated the characteristics and determinants of interjurisdictional commuters' choices in U.S. contexts.

While these studies have improved our understanding of the patterns and correlates of interjurisdictional commuting, other researchers have critiqued traditional planning paradigms for their jurisdictional rigidity. Zandvliet et al. (2008) noted that conventional planning focuses on resident populations rather than daytime or mobile populations, which include interjurisdictional commuters. Kwan (2013) emphasized that a region's economic, environmental, and social performance hinges more on where and when people are active than on their administrative residency.

Meanwhile, interjurisdictional commuting has received limited attention in China despite the rise of long-distance commuting until recently. A new wave of spatial change has unfolded over the past decade. Urban growth has increasingly crossed administrative borders, driven by intercity transit expansion and high-speed rail development. Many workers now live in smaller neighboring cities for lower housing costs or better living conditions while maintaining jobs in core cities (Chen, 2025). Some large municipalities have even created residential "enclaves" by leasing land from nearby jurisdictions. Concurrently, enterprises have relocated R&D operations from city centers to surrounding hinterlands. These changes have led to a growing cohort of interjurisdictional commuters.

Recent studies are beginning to acknowledge this shift. For instance, cellphone data from 2018 revealed approximately 57,000 commuters traveling daily across Shanghai's jurisdictional boundaries, with most living in nearby prefecture-level cities such as Suzhou and Nantong. Zhao et al. (2019) identified an area beyond Beijing's administrative boundary where over 5% of the population commutes to the city center daily. Zhang and Ma (2024) observed similar patterns: high housing costs in the core push workers to peripheral cities, resulting in lengthy inter-city commutes in Beijing-

Tianjin-Hebei corridor. Nevertheless, much of the existing literature in China focuses solely on commuting flows, neglecting the characteristics of origins and destinations. These characteristics are critical for understanding the motivations and constraints that influence interjurisdictional commuting.

Interjurisdictional commuting compounds spatial mismatch with additional challenges. These include crossing incompatible transit systems, encountering uneven service quality, and lacking integrated fare structures. Poor workers may be unable to afford the time or money such commutes require, exacerbating exclusion (Wang & Hu, 2017). Despite its growing relevance, few studies have systematically examined the equity impacts or planning implications of interjurisdictional commuting. One exception is Aguiléra et al. (2009), who found that reverse commuters in Paris—central residents working in suburbs—often relied on cars due to insufficient transit links. In China, similar patterns emerge as job growth in adjacent cities outpaces transport integration (Chen, 2025). Yet such studies are rare, and the broader academic conversation still lacks frameworks to address commuting across city lines.

This research gap has real-world implications. If cities plan housing and transport only within their own borders, cross-boundary commuters may be excluded from infrastructure investment and policy consideration. This undermines the ability of regional economies to function efficiently and equitably. Interjurisdictional commuting is not merely a matter of longer distances—it reflects deeper issues of governance fragmentation, housing affordability, and mobility inequality. More scholarly attention should be paid regarding how regional coordination, integrated transit networks, and cross-border housing strategies can mitigate these burdens and foster greater access to opportunity.

It is also noteworthy that contextual differences exist between interjurisdictional commuting in Western countries and in China, which are shaped by distinct transportation systems, spatial planning logics, and patterns of regional integration. In many Western cities, interjurisdictional commuting often involves traveling across counties or metropolitan boundaries in predominantly car-oriented environments. The lack of efficient, affordable, and high-frequency public transport systems makes these trips particularly time-consuming and costly for low-income or transit-dependent populations. As such, interjurisdictional commuting in Western contexts frequently exacerbates spatial inequality, especially in areas with fragmented governance and limited transit investment (Lucas, 2012; Wang & Hu, 2017). By contrast, China's rapid investment in high-speed rail (HSR) and intercity transit over the past two decades has significantly altered the landscape of regional mobility. The development of an extensive and technologically advanced intercity rail network—particularly in mega-city regions like the Pearl River Delta (PRD), the Yangtze River Delta, and the Beijing-Tianjin-Hebei region—has compressed spatial and temporal distances between cities and created new opportunities for interjurisdictional commuting. In theory, this infrastructure provides a potential solution to the challenges of long-distance travel, allowing individuals to live in smaller, more affordable cities while working in nearby economic centers.

However, the effectiveness of intercity rail systems in serving everyday commuters depends not only on their presence but also on their spatial alignment with commuters' actual travel needs. Specifically, if the spatial distribution of intercity rail lines and stations does not align well with where interjurisdictional commuters live, work, and travel, these systems may fail to provide meaningful improvements to accessibility. In such cases, commuters may face long access times to reach the nearest station—often involving indirect travel, bus transfers, or extended walking distances—which can offset the time savings offered by fast rail services. In extreme cases, commuters may not be able to access the intercity rail system at all, effectively rendering the infrastructure

irrelevant to their daily mobility. This mismatch is particularly acute in cases where intercity rail lines prioritize business travel or long-distance passengers over daily commuting needs. In this context, even with high-speed rail or intercity transit available, interjurisdictional commuters may still face long travel durations and complex, multimodal journeys. Interjurisdictional commuting can still impose substantial time burdens—particularly for low-income commuters who are excluded from housing markets in job-rich cities and must rely on imperfect transit access to cross jurisdictional boundaries.

In sum, while decades of empirical work have shown that spatial mismatch and transport exclusion significantly shape urban inequality, the rise of interjurisdictional commuting presents a new layer of complexity that remains insufficiently understood. Bridging this knowledge gap is crucial as city-regions continue to expand beyond traditional boundaries.

2.3 Cellphone data in commuting research: Applications, advantages, and limitations

Cellphone data have become an increasingly valuable resource for understanding commuting behavior at scale. Since most people carry phones daily, anonymized cellphone location traces (e.g., call detail records or GPS pings) allow researchers to observe population-level movement in near real time. These data provide broad coverage and high temporal resolution, offering a compelling alternative to traditional travel surveys, which are costly, infrequent, and often cover small samples (Calabrese et al., 2013).

A core methodological step in cellphone-based commuting studies is identifying home and work locations. Most research adopts time-of-day heuristics, assuming individuals stay home at night and work during the day. For example, locations where a phone is most often recorded between 9 p.m. and 7 a.m. are often labeled as "home," while daytime concentrations between 9 a.m. and 5 p.m. suggest "work" (Pappalardo et al., 2021). Kung et al. (2014) refined this by calculating cumulative time spent in locations during day and night windows, labeling dominant patterns accordingly. These heuristics work well for standard 9-to-5 schedules, but may exclude individuals with multiple jobs, irregular shifts, or inconsistent routines. Nevertheless, studies have validated these methods against known user addresses, showing reasonable accuracy in inferring home–work pairs.

Once home and work are defined, cellphone data enable the generation of Origin–Destination (OD) matrices that detail commuting flows between spatial units. Zagatti et al. (2018), for example, mapped national commuting patterns in Haiti using clustered cellphone records, identifying areas with localized labor markets and job–housing imbalances. Kung et al. (2014) used data from Boston, Lisbon, Riyadh, and Abidjan to analyze commute durations and distances, discovering surprisingly consistent average commute times across different cities despite wide variations in distance. These findings support hypotheses such as Marchetti's constant, which suggests individuals tend to tolerate similar commute durations regardless of context.

Beyond static flows, cellphone data are increasingly used to monitor dynamic changes in commuting over time. During crises such as the COVID-19 pandemic, mobility metrics based on phone records revealed sharp reductions in trip frequency and increases in time spent at home (Huang et al., 2020). This ability to track population-scale mobility in real time gives cellphone data a unique edge in evaluating policy interventions and emergency responses.

Compared with traditional travel surveys, cellphone data offer major advantages in scale, frequency, and timeliness. They can capture millions of trips across entire cities or countries without relying on self-reporting. This is especially valuable in regions where official data are scarce or outdated. By contrast, household travel surveys typically involve a small sample and rely on participants recalling trip details over one or two days, which can lead to underreporting or inaccuracies (Chen et al., 2010).

However, cellphone data come with important limitations. One major drawback is the lack of explicit information about trip purpose, mode of transport, or traveler demographics. Surveys can ask respondents why they traveled, how they traveled, and provide socioeconomic context—none of which is directly available from phone data. Analysts must infer such information indirectly, using location timing or proximity to known land uses. This can lead to misclassifications; for instance, university students may be misidentified as workers if their daytime presence is concentrated on campus (ONS, 2017). Another challenge is spatial accuracy: tower-based data may only pinpoint a user within a few hundred meters, limiting precision in dense urban settings. Sampling bias is another concern. Cellphone data are often drawn from a single carrier's network, which may not represent all population groups equally. Moreover, users with frequent phone use generate more location records, skewing the sample toward certain demographics. Individuals who keep their phones off or avoid app usage are underrepresented.

In sum, cellphone data have expanded the analytical toolkit for studying commuting by enabling large-scale, high-resolution, and real-time observation of daily mobility. When applied carefully, with attention to methodological caveats, they offer valuable insights into commute flows, accessibility disparities, and responses to policies. In particular, given its large scale and extensive coverage, cellphone data allows us to capture commuting patterns of populations that are often underrepresented in traditional travel surveys, such as interjurisdictional commuters. This methodological approach plays a crucial role in addressing the research questions and adds value to the academic discourse on interjurisdictional commuting. This study leverages the advantages of cellphone data to identify a comprehensive and representative sample of interjurisdictional commuting trips within the study area by combining them with other information, such as commuting times and cost by different modes, derived from Gaode Ditu through API.

3 Methodology

3.1 Study area

A case study is conducted on four adjacent Chinese cities that vary in sizes. These four cities, namely Guangzhou, Shenzhen, Foshan and Dongguan, are located in southern China (Figure 1). They together constitute an important part of the Pearl River Delta (PRD) region, one of the largest mega-city regions in China (Yeh & Chen, 2020). Guangzhou and Shenzhen are the most prosperous cities in the PRD region with a population of 18.68 million and 17.56 million, respectively, according to the Seventh National Population Census of China in 2020, qualifying them as mega cities based on the classification of the United Nations (UNPD, 2018). Meanwhile, Foshan and Dongguan are considered medium-sized cities will fewer population compared to Guangzhou and Shenzhen.

The study area is divided into 500-meter grid cells, as the spatial unit, to aggregate the research data, which is described in the next section.

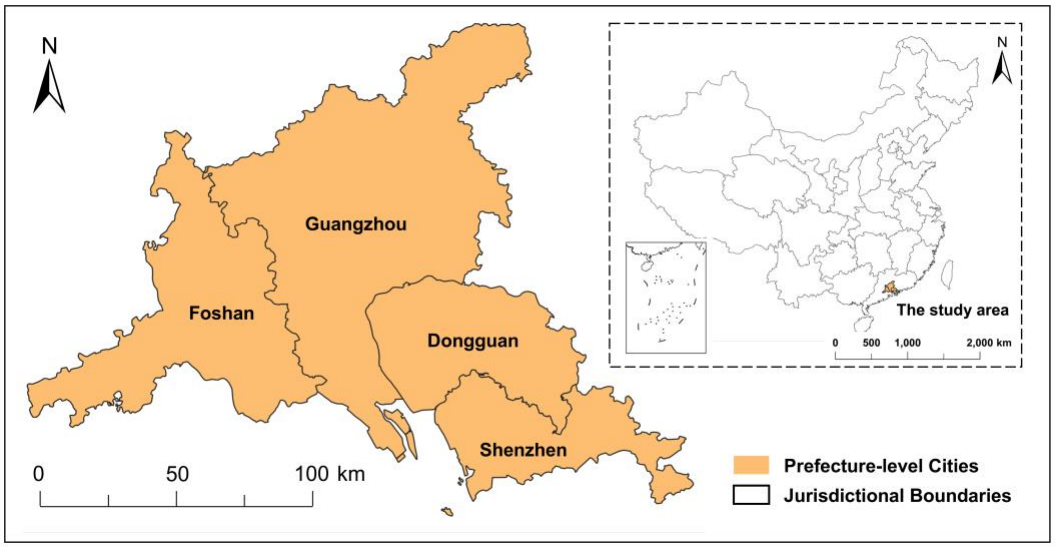

Figure 1. The study area

3.2 Data processing

The cellphone dataset used in this study was provided by China Unicom—one of the major telecommunications operators in China—and covers 15.2 million users in the study area on 18 October 2023. It includes anonymized user identifiers (with phone numbers de-identified to ensure privacy), along with timestamps and the geographic coordinates of the base transceiver stations (BTSs) handling network connections. The spatial distribution of BTSs closely mirrors the layout of urban built-up areas, with an average spacing of approximately 250 meters between stations. User locations were estimated through Voronoi polygons constructed from the BTS coverage areas. A "stay" is defined as a location where the user remains continuously for over 30 minutes. Place types—such as home and workplace—were classified by China Unicom based on patterns of user behavior observed over the preceding six months. A user's residential location was identified as the site with the longest accumulated stay during the overnight period from 9:00 p.m. to 7:00 a.m., while their workplace was inferred from the location with the longest stay between 9:00 a.m. and 5:00 p.m. within the same time frame. In addition to spatial data, the dataset includes several inferred socioeconomic attributes such as age, gender, and born cities, as estimated by China Unicom. All data were aggregated at the level of 500-meter grid cells, which serve as the basic spatial unit of analysis in this study.

Although commuting distances can be identified from cellphone data, it is not possible to directly infer commuting time and cost under different transportation modes. To obtain this information, this study utilized the API of Gaode Ditu (a Chinese desktop web-mapping service application) to batch-query the shortest travel time by private car (including taxis), the minimum cost of traveling by taxi, as well as the shortest travel time by public transportation (including time spent walking or transferring to/from transit stations) and the minimum cost.

In addition to cellphone data, 2023 data on the nighttime light, POIs and average housing rent, aggregated at the 500-meter grid cells, are used to capture the spatial characteristics of the residential and workplace grid cells involved in the commuting trips. The nighttime light data are retrieved from an open-access dataset published by Chen et al. (2020). Data on the average housing area and housing rent in 2023, including the total rent and the unit rent per square meter, are obtained from Lianjia, which is a real estate information website. The POI data from 2023 are extracted from Gaode Ditu. Four types of POIs are used in this study: enterprises, retail facilities, schools, and hospitals. Specifically, "enterprises" consists of manufacturing and service sector enterprises; "retail facilities" consists of local vegetable markets, convenience stores, supermarkets, and shopping malls; "schools" consists of primary and secondary schools; and "hospitals" represents local clinics and major hospitals.

The definitions of the variables based on the aforementioned datasets are presented in the next section.

3.3 Defining the variables

In this study, the sample unit is a pair of home (trip origin) and workplace (trip destination) grid cells connected by commuting trips. A series of variables are defined to capture the socioeconomic, residential, travel and workplace characteristics of inter- and intrajurisdictional commuting trips. The definitions of the variables are specified below.

(1) Socioeconomic characteristics, i.e., "age," "male%" and "migrants%," are estimated by China Unicom and included in the cellphone data. "Age" refers to the average age of commuters between the home and workplace grid cells. "Male%" refers to the percentage of males among the commuters. "Migrants%" refers to the percentage of migrants, who were not born in cities of the study area, among the commuters.

(2) Residential characteristics refer to the accessibility of facilities, as well as the average housing area and housing rent (including the total rent and the unit rent per square meter), in the home grid cells. The data of housing area and rent are directly obtained from Lianjia. The accessibility of facilities (including retail facilities, schools, and hospitals) is measured using the enhanced two-step floating catchment area (E2SFCA) approach. Building on the conventional 2SFCA approach, the enhanced approach uses weights to differentiate between the travel distance zones (Luo & Qi, 2009). First, the catchment of facility location j is defined as an area within 20 km. Within each catchment, ten travel distance zones, with minute breaks of 0–2 km, 2–4 km, 4–6 km, 6–8 km, 8–10 km, 10–12 km, 12–14 km, 14–16 km, 16–18 km, and 18–20 km (zones 1–10), are computed. All the demand locations (k) within the catchment of facility location j are identified. The supply-to-demand ratio (R_j) of facility location j is calculated, as follows:

$$R_j = \frac{S_j}{\sum_{k\in\{d_{kj}\le D_r\}} P_k W_r} \tag{1}$$

where P_k represents demand for the facilities in grid cell k, that is, the population of k, derived from the gridded population data; S_j is the supply at location j (i.e., the number of facilities derived from the POI data); d_{kj} is the travel distance between k and j, and D_r is the rth travel distance zone within the catchment; and W_r is the distance weight of the rth travel distance zone, which captures the distance decay, calculated from the Gaussian function, as follows:

$$G\big((m,n),r\big) = \frac{e^{-1/2\times(d_{mn}/D_r)^2} - e^{-1/2}}{1 - e^{-1/2}}, \qquad d_{mn} \le D_r \tag{2}$$

where d_{mn} is the travel distance between locations m and n, D_r is the rth travel distance zone, and e is the base of the natural logarithm.

Second, all the facility locations (j) within the catchment of demand location i are identified. Their supply-to-demand ratio (R_j) is summed to calculate the accessibility of the facilities (A_i) in demand location i, as follows:

$$A_i = \sum_{j\in\{d_{ij}\le D_r\}} R_j W_r, \tag{3}$$

where d_{ij} is the travel distance between i and j. The same distance weights derived from the Gaussian function are applied to the different travel distance zones to account for the distance decay.

(3) Travel characteristics include the travel time by private car (including taxis), the minimum cost of traveling by taxi, as well as the shortest travel time by public transportation (including time spent walking or transferring to/from transit stations) and the minimum cost. These data were obtained through the API of Gaode Ditu. Specifically, we conducted API queries at three distinct time periods to capture intra-day variability: 8:00 a.m. (morning peak), 11:00 a.m. (off-peak), and 6:00 p.m. (evening peak). For each origin-destination pair, we collected travel time and cost estimates at all three time points and used the average value in our final analysis. This approach helps mitigate the influence of short-term temporal fluctuations and provides a more representative estimate of typical commuting conditions.

(4) Workplace characteristics include nighttime light value (reflecting economic vibrancy in the grid cells) as well as manufacturing sector and service sector job opportunities in the workplace grid cells. Opportunities of manufacturing (and service) jobs are estimated based on the number of employments from the cellphone location data multiplied by the proportion of manufacturing (and service) enterprises among all the categories, which is derived from the POI data.

The modeling approach based on the aforementioned variables is described in the next section.

3.4 Modeling approach

To address potential confounding in the comparison between interjurisdictional and intrajurisdictional commuting trips, this study employs Propensity Score Matching (PSM), a widely used quasi-experimental technique for mitigating selection bias in observational studies (Oakes & Kaufman, 2017; Rosenbaum & Rubin, 1984). Since commuters are not randomly assigned to work in or outside their residential jurisdictions, a direct comparison between the two groups may be statistically biased due to systematic differences in workplace characteristics. PSM is a widely used statistical technique for dealing with nonrandom assignment in program evaluations (Oakes & Kaufman, 2017), to minimize selection bias and facilitate reliable comparisons. It allows for the construction of a counterfactual scenario by pairing each interjurisdictional commuter (treatment group) with an intrajurisdictional commuter (control group) who exhibits

similar observed characteristics at the workplace level. In PSM, each observation in a treatment group is matched with a nearly "identical" observation in the control group (Cao et al., 2010; Rosenbaum & Rubin, 1984). This "matching" process resembles an actual experiment, with the random assignment of a treatment. A composite score (propensity score) is used to consolidate all the characteristics identified in the quasi-experiment and match the multiple characteristics between the control and treatment groups (Rosenbaum & Rubin, 1984).

In this study, a PSM analysis is conducted to compare the socioeconomic, residential and travel characteristics of the inter- and intrajurisdictional commuting trips by controlling the workplace characteristics. The analysis represents a scenario in which the matched inter- and intrajurisdictional commuters work in the same areas, because they have nearly identical workplaces. The outcome variables are a series of socioeconomic, residential and travel characteristics of the residential grid cells, namely, male%, age, migants%, average housing area housing rent (including the total rent and the unit rent per square meter), accessibility of facilities, commuting distances, commuting time by transit and by cars, as well as commuting cost by transit and by taxi. Several variables, namely, nighttime light value as well as manufacturing sector and service sector job opportunities, are adopted to represent the workplace characteristics and are thereby controlled as covariates in the model.

In the PSM model, the propensity score is the conditional probability of whether a commuting trip is an inter- or an intrajurisdictional commute. This probability is predicted using a binary logit regression model. Matching is implemented using one-to-one nearest neighbor matching without replacement, ensuring that each treatment unit is paired with the most similar available control unit. A caliper width of 0.02 is applied to restrict matches to control units with propensity scores sufficiently close to those of the treated units, thereby improving match quality. This study employs "PSMATCH2" in STATA 14.0 to conduct the PSM (Leuven & Sianesi, 2003) and "PSTEST" to examine whether the workplace characteristics are balanced between the matched inter- and intrajurisdictional commuting trips. This study achieves a balance (with a standardized bias of less than 10%; Stuart et al., 2014) by incorporating the variables of nighttime light value as well as manufacturing sector and service sector job opportunities in the workplace grid cells. In the next section, the modeling results report the average treatment effect on the treated (ATT), which indicates the differences between the inter- and intrajurisdictional commuting trips, as well as the corresponding t-statistics.

After matching, standardized mean differences (SMDs) are calculated to assess covariate balance between the treatment and control groups. SMDs provide a scale-independent measure of balance and are not influenced by sample size. An SMD below 0.1 is generally considered to indicate negligible imbalance (Austin, 2009; Stuart, 2010), and all covariates in this study meet this criterion after matching. Furthermore, to examine the robustness of the findings, a sensitivity analysis is conducted by increasing the caliper to 0.05. The consistency of the results under different caliper settings suggests that the estimated treatment effects are stable and not sensitive to small variations in the matching criteria.

4 Results

4.1 General patterns of interjurisdictional commuting trips

Before presenting the results of the PSM analysis, this study analyzes the commuting patterns in the study area. As shown in Table 1, none of the four cities are fully self-contained. Foshan and Dongguan have a lower level of employment self-containment

compared with the other two cities. In Foshan, only 80.9% of the residents are intrajurisdictional commuters. In Dongguan, 87.6% of the residents are intrajurisdictional commuters. Dense interjurisdictional city commuting occurs between Guangzhou and Foshan as well as between Shenzhen and Dongguan. 19.1% of the Foshan residents work in Guangzhou. Over 11.1% of the Dongguan residents work in Shenzhen. Meanwhile, Guangzhou and Shenzhen exhibit a predominant proportion of intrajuristional commuting, with 98.2% and 98.7% of residents working within their respective cities.

The findings highlight the prevalence of interjurisdictional commuting in the study area, particularly between Guangzhou and Foshan as well as between Shenzhen and Dongguan, which necessitates the thorough analysis of the interjurisdictional commuting patterns in the study area. Most important, the findings imply that the interjurisdictional commuting trips tend to originate from the smaller cities (i.e., Foshan and Dongguan) and go toward the core cities (i.e., Guangzhou and Shenzhen) of the region.

Table 1. Commuting trips decomposed by the destination (work) cities

Origin (home) city of commuting trips	**Intrajurisdictional trips**	**Interjurisdictional trips**			
Dongguan	87.6%	12.4%	Trips to Foshan	Trips to Guangzhou	Trips to Shenzhen
			0.0%	1.3%	11.1%
Foshan	80.9%	19.1%	Trips to Guangzhou	Trips to Shenzhen	Trips to Dongguan
			19.1%	0.0%	0.0%
Guangzhou	98.2%	1.8%	Trips to Shenzhen	Trips to Dongguan	Trips to Foshan
			0.0%	0.3%	1.5%
Shenzhen	98.7%	1.3%	Trips to Dongguan	Trips to Foshan	Trips to Guangzhou
			1.3%	0.0%	0.0%

4.2 The socioeconomic, residential and travel characteristics of intra/interjurisdictional commuters

This section presents the results of the PSM analysis that focuses on the commuters' socioeconomic, residential and travel characteristics. The spatial characteristics of the workplace grid cells (i.e., nighttime light value, as well as manufacturing sector and service sector job opportunities) are controlled to compare the residential grid cells. In this way, interjurisdictional commuting trips are matched with intrajurisdictional commuting trips based on the propensity score, which integrates the spatial characteristics of the workplace grid cells. The matched inter- and intrajurisdictional commuters have nearly identical workplace grid cells; thus, it can be assumed that they are working in the same areas.

To assess the effectiveness of PSM, we computed the standardized mean differences (SMDs) for key workplace-related covariates. The SMD measures the difference in means between the treatment and control groups, standardized by the pooled standard deviation. Unlike p-values, which are sensitive to sample size, SMDs provide a sample-size-independent measure of covariate balance and are widely used in matching diagnostics. According to established guidelines (e.g., Austin, 2009; Stuart, 2010), an SMD below 0.1 is generally considered to indicate negligible imbalance, suggesting adequate comparability between groups.

In this study, we examined three workplace-related covariates: nighttime light value, manufacturing sector job opportunities, and service sector job opportunities. The post-matching SMDs for these variables were 0.006, 0.009, and 0.011, respectively—all well below the 0.1 threshold. These results indicate that the matched treatment and control groups are highly similar in terms of their workplace characteristics, thus reducing the risk of confounding bias and supporting the validity of subsequent comparisons (Table 2).

Table 2. Standardized mean differences (SMDs) before and after matching for the three co-variates

Covariate	SMD Before	SMD After
Nighttime light value	0.035	0.006
Manufacturing sector job opportunities	0.079	0.009
Service sector job opportunities	0.088	0.011

As shown in Table 3, the interjurisdictional commuters tend to have a higher proportion of males (61.1%) and migrants (82.3%) as well as be younger on average (31.752 years old) in a significant manner, compared to the intrajurisdictional commuters (48.5%, 69.1%, and 35.758 years old, respectively). They also reside in the grid cells with lower housing rent (3,136.521 yuan per month, or 35.171 yuan per month per m^2) than their intrajurisdictional counterparts (4,802.540 yuan per month, or 67.562 yuan per month per m^2). The average housing area for interjurisdictional commuters is 81.838 m^2, slightly larger than that of intrajurisdictional commuters (78.458 m^2). However, this difference is not statistically significant at the 0.05 level. This finding presents a possible reason for interjurisdictional commuting: the commuters, most likely being young, migrant workers, cannot afford to live where they work owing to their underprivileged income status and thus reside in a different city with affordable housing.

The comparison of home-based accessibility of facilities yields similar results. The accessibility of facilities (0.003) is significantly lower in the residential grid cells of the interjurisdictional commuters compared with that in the residential grid cells of the intrajurisdictional commuters (0.037, see Table 3), thereby suggesting that when the workplace characteristics are controlled, the interjurisdictional commuters tend to reside in neighborhoods with less accessible facilities compared with the intrajurisdictional commuters. This finding further corroborates the aforementioned assumption that, because they cannot afford housing in their workplace city, which tends to be a large city, the interjurisdictional commuters will reside in small cities with a low density and thus will have less access to facilities.

Meanwhile, the PSM model also reveals the travel characteristics of interjurisdictional commuters. When workplace characteristics are controlled for, the commuting distance for interjurisdictional trips is significantly greater than that of intrajurisdictional trips—14.229 km compared to 7.995 km, respectively. Data obtained via API from Gaode Map on travel times and cost further indicate that interjurisdictional commuters spend more time commuting, regardless of whether they drive or use public transportation. Specifically, if commuting by car, then interjurisdictional commuters would spend an average of 49.020 minutes, while intrajurisdictional commuters working in similar workplace locations would only spend 26.489 minutes. If using public transit, then interjurisdictional commuters would spend 99.390 minutes on average, including 32.052 minutes of out-of-station walking time; in contrast, intrajurisdictional commuters in

comparable workplace settings would spend only 47.499 minutes, including 15.110 minutes of out-of-station walking.

In short, after controlling for workplace characteristics, the commuting distance of intrajurisdictional commuters is equivalent to 56.2% of that of interjurisdictional commuters. When traveling by car, the commuting time for intrajurisdictional commuters is 54.0% of that for interjurisdictional commuters. When using public transportation, the commuting time for intrajurisdictional commuters is 47.8% of that for interjurisdictional commuters, with their out-of-station walking time being 47.1% of the latter. These figures indicate that interjurisdictional commuters travel significantly longer distances and spend more time commuting compared to intrajurisdictional commuters working in similar workplace locations. This disparity is even more pronounced when commuting by public transport, particularly in terms of out-of-station walking time. It reflects not only the longer commuting distances faced by interjurisdictional commuters but also the poor connectivity between public transport systems and both origins and destinations during their journeys. In China, public transportation in each city is provided by the local municipal government. During the development process, cooperation with neighboring municipal governments is often neglected, and little attention is paid to cross-city coordination in public transport planning. As a result, the routing of transit lines, station distribution, and intercity connectivity often fall short of meeting the growing demand for interjurisdictional commuting.

In addition, the PSM model also reflects the differences in commuting costs between interjurisdictional and intrajurisdictional commuters. For those commuting by private car, there are considerable costs involved in purchasing a vehicle, and obtaining a license plate typically requires entering a lottery system with a low success rate, adding further uncertainty to the cost. In this study, taxi fares are used as a proxy for the cost of commuting by private car. Model results show that, after controlling for workplace characteristics, interjurisdictional commuters would spend 67.041 yuan per trip if commuting by taxi, and 6.575 yuan if commuting by public transit. In contrast, intrajurisdictional commuters would spend 35.535 yuan and 3.225 yuan respectively—equivalent to 53.0% and 49.0% of the costs incurred by interjurisdictional commuters. Assuming commuters need to travel to work at least 22 days per month (based on an average of 4.35 weeks per month and 5 workdays per week, totaling 22 commuting days or 44 one-way trips), interjurisdictional commuters would spend 2,971.530 yuan per month if taking a taxi for every trip, or 289.3 yuan if using public transportation. These costs are equivalent to 94.7% and 9.2% of their average monthly rental expenses, respectively. The results also indicate that although the availability of public transportation helps reduce the financial burden of interjurisdictional commuting as compared to car-dependent commuting in Western societies (Sööt et al., 2006), interjurisdictional commuting in Chinese cities is associated with a substantial time burden, especially in terms of out-of-station walking time.

This clearly shows that if interjurisdictional commuters choose a low-cost commuting method, they must endure long commuting times (99.390 minutes on average, including 32.052 minutes of out-of-station walking time). On the other hand, if they wish to reduce commuting time by using a private car, they will face a significant financial burden—one that nearly equals their monthly rent. This result vividly illustrates the transport poverty faced by interjurisdictional commuters, a form of hardship stemming from their inability to afford housing in their working city, which forces them to live in other cities and bear the associated commuting costs.

To assess the robustness of the propensity score matching results, we conducted a sensitivity analysis by varying the caliper value used in the matching algorithm. The primary model applied a nearest neighbor matching strategy with a caliper of 0.02, which

restricts matches to control units whose propensity scores are within a narrow tolerance band of the treated unit. To evaluate whether the findings are sensitive to this parameter choice, we constructed an alternative matching scenario using a wider caliper of 0.05. Both models employed one-to-one nearest neighbor matching without replacement and controlled for the same set of workplace-related covariates, including nighttime light intensity, manufacturing sector job opportunities, and service sector job opportunities. The outcomes of interest were then compared across the two caliper settings in terms of group means and statistical significance. The comparison between the caliper = 0.02 and caliper = 0.05 matching models revealed a high degree of consistency. As shown in Table 4, increasing the caliper resulted in minimal changes in the control group's mean values and p-values for treatment-control differences. Specifically, for all outcome variables, the direction and magnitude of the effects remained stable, and all statistically significant differences in the baseline model persisted under the alternative caliper setting. These results indicate that the estimated treatment effects are not sensitive to the caliper specification and that the original model's conclusions are robust.

Table 3. Results of the PSM model (based on a caliper of 0.02)

Socioeconomic characteristics			
	Treatment group 1 (Inter-jurisdictional commuters)	Control group 1 (Intra-jurisdictional commuters)	p-value
Male%	61.1%	48.5%	0.014
Age	31.752 years old	35.758 years old	0.023
Migrants%	82.3%	69.1%	0.017
Residential characteristics			
	Treatment group 2 (Inter-jurisdictional commuters)	Control group 2 (Intra-jurisdictional commuters)	p-value
Housing area	81.838 m^2	78.458 m^2	0.069
Housing rent in total	3,136.521 *yuan* per month	4,802.540 *yuan* per month	0.007
Housing rent per m^2	35.171 *yuan* per month per m^2	67.562 *yuan* per month per m^2	0.005
Accessibility to facilities	0.003	0.037	0.001
Travel characteristics			
	Treatment group 2 (Inter-jurisdictional commuters)	Control group 2 (Intra-jurisdictional commuters)	p-value
Commuting distance	14.229 km	7.995 km	0.000
Commuting times (if by cars)	49.020 minutes	26.489 minutes	0.000
Commuting times (if by transit)	99.390 minutes	47.499 minutes	0.000
Out-of-station walking time (if commuting by transit)	32.052 minutes	15.110 minutes	0.001
Commuting cost (if by taxi)	67.041 *yuan* per trip	35.535 *yuan* per trip	0.000
Commuting cost (if by transit)	6.575 *yuan* per trip	3.225 *yuan* per trip	0.000

Table 4. Sensitivity analysis results using PSM with a caliper of 0.05

Socioeconomic characteristics			
	Treatment group (Inter-jurisdictional commuters)	Control group (Intra-jurisdictional commuters)	p-value
Male%	61.1%	49.7%	0.017
Age	31.752 years old	36.044 years old	0.019
Migrants%	82.3%	71.3%	0.024
Residential characteristics			
	Treatment group (Inter-jurisdictional commuters)	Control group (Intra-jurisdictional commuters)	p-value
Housing area	81.838 m^2	77.754 m^2	0.069
Housing rent in total	3136.521 yuan per month	4795.788 yuan per month	0.007
Housing rent per m^2	35.171 yuan per month per m^2	68.138 yuan per month per m^2	0.000
Accessibility to facilities	0.003	0.037	0.001
Travel characteristics			
	Treatment group (Inter-jurisdictional commuters)	Control group (Intra-jurisdictional commuters)	p-value
Commuting distance	14.229 km	7.954 km	0.000
Commuting times (if by cars)	49.020 minutes	26.354 minutes	0.000
Commuting times (if by transit)	99.390 minutes	46.534 minutes	0.000
Out-of-station walking time (if commuting by transit)	32.052 minutes	14.967 minutes	0.001
Commuting cost (if by taxi)	67.041 *yuan* per trip	34.947 *yuan* per trip	0.000
Commuting cost (if by transit)	6.575 *yuan* per trip	3.221 *yuan* per trip	0.000

5 Discussion and conclusions

In response to increasing interjurisdictional commuting in China, this study examines the socioeconomic, residential and travel disparities between interjurisdictional and intrajurisdictional commuters in four Chinese cities using cellphone data. Through the application of a Propensity Score Matching (PSM) method that controls for workplace characteristics, the study offers robust comparative insights into who commutes across jurisdictions, why they do so, and how their commuting experience differs in terms of time, cost, and accessibility.

The results reveal several notable differences between interjurisdictional and intrajurisdictional commuters. First, interjurisdictional commuting is prevalent in the study area, particularly between pairs of adjacent cities where smaller, more affordable cities serve as residential bases for those working in economically dominant core cities—most notably from Foshan to Guangzhou and from Dongguan to Shenzhen. This directional pattern confirms the role of housing affordability as a key driver of interjurisdictional commuting.

Second, significant demographic and socioeconomic distinctions exist between the two commuter groups. Interjurisdictional commuters tend to be younger, more likely to be male and migrants, and generally reside in lower-rent neighborhoods with significantly poorer access to urban facilities. After controlling for workplace location, these findings indicate a form of spatial mismatch: workers are excluded from living in

the cities where their jobs are located due to high housing costs and are thus compelled to reside in peripheral areas with lower living expenses but inferior urban amenities.

Third, the commuting burden for interjurisdictional travelers is substantially higher in both temporal and financial terms. Interjurisdictional commuters travel nearly twice the distance of their intrajurisdictional counterparts and face disproportionately longer commuting times. When commuting by public transportation, they endure an average of 99.39 minutes per trip, including 32.05 minutes of out-of-station walking time—indicating poor spatial integration between public transport nodes and residential/workplace areas. Even when commuting by car or taxi, interjurisdictional trips take an average of 49.02 minutes—still considerably longer than the 26.49 minutes faced by intrajurisdictional commuters.

In terms of financial burden, interjurisdictional commuters spend almost double the amount on commuting compared to their intrajurisdictional counterparts. For instance, if they were to rely solely on taxis as a proxy for car use, their monthly commuting cost could reach 2,971.53 yuan—equivalent to 94.7% of their monthly rent. Even when using public transportation, the cost accounts for 9.2% of rent. Thus, interjurisdictional commuters are trapped in a difficult trade-off between time and cost: low-cost commuting entails unreasonably long travel durations, whereas faster modes are financially burdensome.

These findings contribute to the transport geography literature by shedding light on transport poverty through the lens of interjuridictional commuting. Unlike conventional definitions of transport poverty, which often focus on car-less households or low-income populations lacking access to transit, this study reveals a structural dimension of transport poverty stemming from regional governance fragmentation and housing market imbalances. More specifically, the research supports the theory of spatial mismatch and adds a regional scale to its analysis. Whereas prior work has mainly emphasized inner-city residential segregation and suburban job accessibility, this study demonstrates that spatial mismatch can also operate across jurisdictional boundaries in polycentric city-regions, driven by affordability gaps and governance silos. Moreover, the study illustrates how institutional fragmentation—in this case, the municipal-level management of public transportation—directly affects commuters' lived experiences. The lack of cross-jurisdictional coordination in transit planning not only exacerbates commuting time and inconvenience but also reinforces socioeconomic inequality by privileging those who can afford to live and work within the same jurisdiction. It must be acknowledged that the primary contribution of this study lies in expanding the research perspective, specifically by applying concepts of spatial mismatch and transport-related social exclusion to the context of interjurisdictional commuters, rather than methodological advances.

The findings underscore the urgent need for regional coordination in housing and transport policies. Several policy recommendations are proposed. First, municipal governments in the PRD should enhance the mechanisms for cross-jurisdictional coordination in public transit planning. Integrated ticketing systems, harmonized scheduling, and expanded intercity transit routes—especially feeder services to major job centers—can reduce out-of-station walking times and overall commute durations. Second, peripheral cities like Foshan and Dongguan should adopt TOD strategies that increase urban density and improve facility accessibility around major transit nodes, which would help reduce the first-mile and last-mile gaps currently faced by interjurisdictional commuters. Third, policymakers could consider targeted subsidies for long-distance commuters who are financially constrained. For example, travel vouchers, discounted monthly passes, or income-based fare systems can help alleviate transport poverty and ensure equitable access to employment opportunities. Overall, the empirical case highlights the limitations of a purely municipal approach to infrastructure and

housing issues in mega-city regions such as PRD. A regional planning authority, or at least a formal inter-municipal coordination platform, should be established to oversee infrastructure investments, land-use planning, and economic development across jurisdictions.

The study has several limitations. First, while the study adopts fine spatial units (i.e., 500-meter-by-500-meter grids), the classification between interjurisdictional and intrajurisdictional commuting may be problematic in cases where trips cross jurisdictional boundaries by only a very short distance (e.g., less than 500 m). Second, the socioeconomic variables only include only male%, migrants%, and age, while other demographic attributes, such as education level and race, cannot not be inferred from the cellphone dataset and thus not be incorporated to the model. Third, while PSM offers a strong method for controlling workplace characteristics, unobserved variables—such as personal preferences, lifestyle choices, school locations or job flexibility—may still influence decisions regarding residential and workplace choices. Future research should incorporate factors like personal preferences and school locations in order to enhance the applicability of findings—particularly in other regions that may exhibit greater cultural diversity. Fourth, the study relies on taxi fares as a proxy for car commuting costs, which, while practical, may not fully capture the broader financial and institutional implications of car ownership, including parking fees, maintenance, and vehicle regulation policies (Yang et al., 2022). Future studies could explore these dimensions using longitudinal data or household panel surveys. Fifth, this study focuses on the PRD region; however, interjurisdictional commuting is a growing phenomenon in other mega-city regions in China, such as the Yangtze River Delta and the Beijing-Tianjin-Hebei region. Comparative studies could reveal whether similar patterns of transport poverty and spatial mismatch exist elsewhere and how different governance structures influence outcomes.

Despite these limitations, the present study contributes to the existing literature by highlighting that interjurisdictional commuting in the PRD is not merely a matter of geographic distance. Rather, it reflects deeper issues of housing affordability, governance fragmentation, and infrastructural inequality. Addressing these challenges requires a shift from city-centric planning to regionally integrated strategies that recognize the everyday realities of mobile populations. Without such changes, interjurisdictional commuters will continue to bear disproportionate burdens of time, money, and well-being in their pursuit of livelihood.

Data Availability

The cellphone datasets analyzed in this study are described in section 3 and are not publicly available, as required by the data provider, for privacy reasons.

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Author contribution

The authors confirm contribution to the paper as follows: study conception and design: Z. Chen, Y. Wu; data collection and programming: Z. Chen, Y. Wu; analysis and interpretation of results: Z. Chen, Y. Wu; draft manuscript preparation: Z. Chen, Y. Wu. All authors reviewed the results and approved the final version of the manuscript.

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