

The Factors Impacting Commuting Time

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Contributor: Mei Zhang , Jia Tang , Jun Gao

Commuting time holds a significant role in people's daily routines, representing the duration spent traveling between home and work in the context of daily time use. In the context of rapid urbanization in developing countries, commuting time is increasing. However, excessive commuting time can have significant economic, social, and environmental consequences. For example, longer commuting time hampers per capita income growth and reduces productivity. It also impedes social interactions among residents, leading to a decline in social and economic vitality. Moreover, commuting accounts for a large proportion of urban transportation demand and is closely linked to urban carbon emissions. Additionally, it has detrimental effects on both physical and mental health, as well as the well-being of individuals. Therefore, it is crucial to investigate the factors that influence commuting time in order to mitigate its continual increase.

commuting time

spatial heterogeneity

individual characteristics

built environments

1. Introduction

A large number of studies have provided evidence of the impact of various factors on commuting time, with particular attention on built environments and individual characteristics ^{[1][2][3][4]}. For example, researchers have demonstrated that built environments, such as a built-up area, population density, and land-use mix, significantly impact an individual's commuting time ^{[5][6]}. However, few studies have examined such effects in the context of spatial heterogeneity ^{[7][8][9][10]}.

Spatial heterogeneity refers to the varying impact of the same factors across different spatial scales or geographical locations ^[6]. It is crucial to consider spatial heterogeneity when examining the association between built environments as well as individual characteristics and commuting time, as this relationship may vary from city to city. Failing to account for spatial heterogeneity may lead to ecological fallacy, where the global association between two variables derived from all regions may contradict the local association between the same variables derived from individual regions ^[11]. As suggested by scholars in the field, the association between environmental attributes and commuting behavior is not globally consistent but rather varies and can even reverse across different regions ^{[6][11]}. Therefore, when it comes to comprehensive study across multiple regions, it is necessary to control for the interference brought by such spatial heterogeneity. This approach provides accurate and context-specific insights into the factors influencing commuting time while also ensuring the provision of a scientific basis for urban planning and construction.

2. Impacts of Built Environments on Commuting Time

A built environment is a human-crafted environment that emerges through artificial design modifications to natural conditions, primarily related to patterns of land use, urban design, and transportation systems [12]. It constitutes a multiple constructs concept, which has been described by a variety of interconnected spatial variables [13]. An increasing number of studies have examined the correlation between built environments and commuting time [8][14][15][16]. The typical elements of built environments are outlined in “5D” framework, which include density, diversity, design, destination accessibility, and distance to transit [17].

Density expresses the concentration of population, housing, employment, buildings, activities, and other elements within a spatial unit [18]. Scholars have identified two different linear relationships between density and commuting time. Some scholars have suggested that under certain conditions, a high population density and a high residential density are associated with shorter commuting time [19]. However, others have revealed that an increase in urban population density often leads to higher traffic congestion, which, in turn, is expected to increase commuting time [3][7][20]. The non-linear relationship between density and commuting time has also raised concerns [15][21]. For example, higher employment density may reduce commuting times for transit commuters living in non-downtown urban areas and new town areas, but it may increase commuting times for those living in downtown areas [15].

Diversity reflects the degree of mixed land use within an area. Highly mixed land uses are believed to promote proximity between residences and workplaces, thus having positive impacts on reducing commuting time [1][6]. However, it has also been argued that increasing the degree of mixed land use in residential areas tends to reduce the chance of driving and, thus, increases commuting time in general [5].

The concept of design consists of various aspects, such as structural design, road network features, and community design, which distinguish between pedestrian-oriented and motorized-oriented environments [18]. The impact of urban spatial structure and road network characteristics on commuting time has been a focal point of research. Studies have found that commuting time varies according to the nature and stage of development of the polycentric structure [22][23]. Additionally, a higher road area per capita has been found to contribute to a reduction in commuting time [7][24].

Destination accessibility expresses the ability to reach activities or locations by modes of travel or the number of destinations that can be reached in a given travel time [18]. Several studies have highlighted the association between accessibility and commuting time [2][25]. It has been observed that shorter commuting times are associated with higher accessibility to public transit or private vehicles [3][16]. However, it is worth noting that higher public transit accessibility has also been found to be significantly linked to longer commuting time for those who use non-motorized vehicles [8].

Distance to transit refers mainly to the distance to the nearest public transit station [18]. Research has consistently shown that living closer to a public transit station is associated with shorter commuting time [26][27]. Furthermore, the improvement of a rail transit system has been found to have positive effects on reducing commuting time to employment centers [28].

In addition, other built environments and their interrelated spatial variables, such as urban size and urbanization rate, have also been identified as influential factors affecting commuting time. For example, research has shown that commuting time tends to increase with urban size [9][29][30]. Similarly, the larger the built-up area, the longer the commuting time for residents [24]. Additionally, urbanization can induce various environmental transformations [31], potentially resulting in prolonged commuting times for residents in cities with high urbanization rates compared to those in cities with low urbanization rates [32]. Overall, the previous findings highlight the nuanced relationship between built environments and commuting time.

3. Impact of Individual Characteristics on Commuting Time

The typical individual characteristics affecting commuting time include an individual's jobs–housing relationship, work characteristics, and socio-demographic attributes. Specifically, individual jobs–housing relationships consist of elements such as jobs–housing balance, commuting distance, commuting mode, etc. Research has consistently shown that jobs–housing imbalances are the most important determinant for longer commuting time [33]. In particular, based on the data from a survey of employees at their workplaces in the sub-centers of Beijing, a study has revealed that the jobs–housing balance has a more significant impact on workers' commuting times than socio-demographic characteristics [34]. Commuting distance is found to be roughly proportional to commuting time [25][30]. For commuting modes, some literature has demonstrated that commuting by public transit tends to take longer in terms of travel time than private car travel [3][7][10]. This discrepancy is attributed to factors such as the spatial and temporal arrangement of services (e.g., bus schedules and predetermined routes and stops), the interchanges between different travel modes, as well as the ease of walking access to and from public transit stations [35]. However, it is important to note that the benefits of private car commuting have gradually diminished as escalating private car ownership has led to persistent traffic congestion and, subsequently, lower travel speeds [35].

Work characteristics, such as working hours and allowances, are additional factors that can affect commuting time. Research has shown that there is a positive correlation between working hours and commuting time [36]. Moreover, scholars have also found an inverted U-shaped relationship between commuting time and work duration [29][37]. Furthermore, the financial incentives provided by employers may influence commuters' behavior [38][39]. For example, employer-provided allowance, such as travel allowance or parking fees, can significantly reduce solo commuting trips by more than 30% [38].

Socio-demographic attributes play a significant role in determining commuting time among individuals, as evidenced by a substantial body of literature. According to the household responsibility hypothesis, women who bear the bulk of household maintenance duties (e.g., child care) tend to choose shorter commuting times [20][40]. Age has been found to exhibit varying effects on commuting time. It was found that older workers are more likely to have longer commuting times than those under age 25 [36]. At the same time, other studies have revealed that younger commuters (under 35 years old) were less sensitive to the cost of time and tended to have longer commutes [41]. Moreover, it has also been found that there is a non-linear relationship between age and commuting time, with middle-aged commuters more inclined to have the longest commuting time [42]. Education level has also been found to be positively associated with commuting time [10][43]. Occupations exhibit distinct effects. Individuals

who work in the private sector are more likely to accept longer commuting times due to the concentration of their jobs in specific locations compared to their more evenly distributed residential areas [44], and compared to low-skilled professional employees, mid- to high-level professional employees are more prone to have higher commuting times [10]. Income has been recognized as an important factor affecting commuting time. A study conducted using data from Brazil between 1992 and 2009 has found that workers in the poorest 10% of the population spend, on average, 20% more time commuting compared to the wealthiest 10% [45]. This can be attributed to low-income individuals facing spatial constraints in terms of accessing a workplace and their need for affordable accommodation [46]. However, other scholars have made different observations, revealing that higher-income residents in China have longer commuting times due to the fact that they are more likely to drive to workplaces [7][47]. Additionally, household attributes, such as married status and having children, are considered potential factors influencing commuting time [44].

To summarize, while previous studies have examined the relationship between built environments, individual characteristics, and commuting times, few have shed light on their impacts within the context of spatial heterogeneity across cities. Overlooking spatial heterogeneity across cities can lead to inconsistent parameter estimation, as a single linear model only “averagely” captures the global relationship rather than the local part of the relationship [48]. In recent years, there has been a growing recognition of the importance of spatial heterogeneity in commuting studies, with findings indicating that the effects of factors vary across different spatial units [49][50]. Furthermore, the majority of the literature focuses on commuting issues within individual cities, drawing conclusions based on the unique characteristics of those specific cities. As a result, the insights gained may not directly apply to the broader challenges faced by a wider range of cities.

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