Research in Transportation Economics 99 (2023) 101290

Contents lists available at ScienceDirect

Research in Transportation Economics

journal homepage: www.elsevier.com/locate/retrec

Research paper

Use of public transport and social capital building: An empirical study of Japan

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ARTICLE INFO

JEL classification:
R400 Transportation Economics: General

Keywords:
Social capital
Public transport
Mobility
Transport disadvantaged
Urban area
Rural area

ABSTRACT

Traditional discussions of public transport management in Japan have been primarily based on profit concerns. However, in recent years, the discourse has shifted to incorporate social capital considerations, with greater attention given to the relationship between public transport and social capital. The idea is that by increasing mobility, public transport can facilitate social activities and foster networks and trust among people. This makes it a valuable tool for building social capital, particularly in depopulated areas that are at risk of losing their local networks. This study aims to investigate whether there is a positive correlation between the use of public transport and social capital at the regional level in Japan, using a quantitative method. We examine municipal-level data from all municipalities in Japan and we find a strong and positive correlation between the use of public transport and social capital. These results have significant implications for policymakers seeking to manage Japan's public transport system, especially in rural areas. Our findings suggest that policymakers should shift the focus from purely economic benefits to also prioritize social benefits.

1. Introduction

Public transport in Japan is primarily provided by private companies as commercial services rather than as public services provided by the government (Utsunomiya, 2020). Thus, the evaluation of public transport operations is usually based on financial analysis, which leads to decision-making on service supply depending on whether it is profitable. As depopulation escalates in rural areas of Japan, the number of public transport users has declined, and suppliers have reduced their local businesses. The decline in public transport in rural areas has resulted in a lack of mobility for residents, particularly for the transport disadvantaged.

However, mobility, that is the ability of people to move from one location to another, is essential for people's quality of life. Lack of mobility increases the risk of social exclusion, resulting in various social consequences, such as undermining the cohesion of society, which has been widely discussed since the 1990s (Social Exclusion Unit, 2003; Levitas et al., 2007; Stanley et al., 2011). Social exclusion is described as people feeling it is difficult or impossible to participate in society, specifically in social activities and networks, due to poor mobility (Kenyon et al., 2003; Stanley et al., 2011). From this viewpoint, public transport as a low-cost transport option to maintain people's mobility can be considered as a factor affecting people's social connections.

The concept of social capital, popularized by Putnam in the 1990s, reflects social dimensions and refers to trust, norms, and social networks (Putnam, 1993). Individuals who are embedded in rich social connections, namely, those with rich social capital, are regarded as having a lower risk of being socially excluded (Currie & Stanley, 2008; Stanley et al., 2011). In this context, social capital can be used to evaluate the social benefits of public transport. In other words, public transport can be expected to provide more than just economic benefits, as it enables people to move around and build social connections, thereby contributing to the social capital building. However, there is little empirical evidence linking public transport to social capital.

This study aims to examine the relationship between public transport and social capital using a quantitative method using municipal data and attempts to provide implications for public transport policy in rural areas of Japan.

This paper is organized into six sections. Section 2 summarizes the literatures on public transport and social capital. The research framework, including data and variables, is outlined in Section 3. Section 4 presents the analytical results, and Section 5 discusses the results. The

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https://doi.org/10.1016/j.retrec.2023.101290
Received 21 November 2022; Received in revised form 10 March 2023; Accepted 16 March 2023
Available online 4 May 2023

final section provides a summary and conclusion of this research, including its academic contributions and policy implications.

2. Literature review

2.1. The concept of social capital

The term "social capital", first used by Hanifan in his work on children's education and local community development in America, refers to people's interaction within a group (Hanifan, 1916). This concept was developed academically and has been widely debated since the 1980s. The major contributions to the literature on social capital come from Bourdieu (1986), Putnam (1993), and Coleman (1990). While these scholars have varying interpretations of this concept, their works are uniform in suggesting that social capital is rooted in social structures, such as networks. This article follows Putnam's definition of social capital: "features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit" (Putnam, 1995, p. 67), which is the most widely accepted definition. Based on this framework, social capital is regarded as commons that generates positive externalities, such as facilitating the institutional performance, as pointed out by Putnam in his research of institutional performance of Italy (Putnam, 1993).

Inspired by Putnam's work, extensive research has been conducted to explore the benefits of social capital, including its impact on economic growth (Knack & Keefer, 1997; Youtou, 2005); health (Ziersch et al., 2009; Murayama et al., 2014) and crime prevention (Yamamura, 2009). Worldwide, scholars and policymakers have advocated the importance of social capital. In Japan, there is a growing movement calling for the incorporation of social capital into policymaking (Inaba & Fujiwara, 2010). Many policies have been launched to elevate social capital levels to tackle various social problems such as the declining birth rate and aging population. An instance of this is the manual aimed at creating healthy community developed by the Ministry of Health, Labour, and Welfare of Japan to guide municipalities on enhancing social capital through various local activities.[1]

Social capital, which has been theoretically shaped by numerous works, must be contextualized practically for policy implementation. This necessitates the quantification of this abstract concept. Social capital measurements can be categorized into two types. The first type of social capital measurement is collecting data from individuals by questionnaire, including specific questions about the number of friends, willingness to participate in civic activities, and other human interactions. This type of data directly reflects an individual's social capital at the individual level. The other way to measure social capital is to use statistical data that reflect social capital level at the aggregate level, illustrating the status of social capital at the macro level, for example, electoral turnout and participation in associations, which were used by Putnam (1993). By quantifying social capital, researchers and policymakers can determine policy targets and choose appropriate ways to enhance social capital.

Enhancing the social capital level requires specifying the determinants of social capital, which have been investigated in previous studies and are already supported by empirical evidence. These determinants include personal attributes, such as age, education level, and marital status, and regional factors, such as t regional characteristics (Iyer et al., 2005; Qin & Tanaka, 2017). The living environment of individuals also affects their activities, and it is reasonable to assume that transport convenience is one of the environmental factors that might influence social capital building based on this rationale.

[1] The information is from the website of Ministry of Health, Labour and Welfare of Japan: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000092042.html.

2.2. Social capital and public transport

While the topic of transport is not widely discussed in the literature on social capital, it is not difficult to find conversations surrounding its social implications. We often associate this discussion with the opportunity to move, which should be a fundamental human right that affects human well-being (Bauman, 1998). Larsen et al., 2006 argued for the importance of mobility in extending the social networks through which people generate social interaction. Although there are virtual ways for people to extend their networks as communication technology develops, physical travel and face-to-face communication remain important for people (Urry, 2003). Previous literatures have empirically demonstrated that individuals' accessibility to either car or public transport is closely linked to their level of social participation (Xiong et al., 2019; Anciaes & Metcalfe, 2023).

Facing the importance of providing mobility to people, we have to admit that, although options exist to achieve mobility, those with low incomes, low educational level, or disabilities face limited options for mobility. This group, referred to as the transport disadvantaged, is categorized as having limited mobility owing to physical barriers or economic conditions (Church et al., 2000; Delbosc & Currie, 2011). Given the reality of inequality in the opportunity to move (Bauman, 1998), public transport plays a crucial role in ensuring mobility for those who are transport disadvantaged, thus preventing social exclusion (Stanley & Stanley, 2007; Stanley et al., 2011). In addition to providing mobility, public transport, which people typically share with others, increases contact, generates interactions among individuals, and contributes to the formation social capital (Currie & Stanley, 2008). Therefore, not only do the transport disadvantaged need public transport, but society as a whole can benefit from using public transport. Similar findings have been presented in the literatures of transit-oriented development (TOD). People living in TOD areas have more interactions and civic engagement than those in other areas (Kamruzzaman et al., 2014; Noland et al., 2016), suggesting that the use of public transport, even if only for commuting, might still help build social capital.

Utsunomiya investigated the relationship between public transport and social capital in Japan and provided some empirical evidence (2016; 2019). The two studies that used prefectural data revealed that the main correlation between public transport and social capital was positive. However, the detailed components of social capital indicators show different results according to different proxies of public transport: bus mileage (2016) is correlated with civic participation and networks except trust, whereas bus usage rate (2019) is not correlated with civic participation.

Case studies have also been conducted to investigate the influence of public transport on social capital in specific cities in Japan, including Nagareyama and Kamagaya (small metropolitan city: Yamashita & Arai, 2014); Toyama (local city: Utsunomiya, 2016); and Kobe (big metropolitan city: Utsunomiya, 2019). Case studies in Toyama and Kobe revealed differences in people's activities before and after the opening of a new public transport service. Following the launch of a new transport service, people tend to be more active. In a study by Yamashita and Arai (2014), which focused on users of local buses, it was found that the use of buses is positively correlated with social capital indicators (trust, norms, and networks).

There are two types of proxies for public transport used in previous studies: the use of public transport (e.g., number of user or frequency of use) and the supply of public transport (e.g., mileage). So far, few studies have distinguished between them, but in fact they are not entirely equal. The former represents the behaviour of demand side, while the latter represents the amount of supply. While the existence of public transport is a prerequisite for its use, the presence of supply does not always imply that individuals will choose to use it. Different proxies might lead to different results (Utsunomiya, 2016, 2019) and provide different policy implications. If the existence of public transport can contribute to social

capital building, policy makers need to provide this service, even if it retains only a small demand and requires subsidy. If it is the use of public transport that can influence social capital building, policymakers need to not only ensure that the service is being provided but also promote its usage, which requires that the service supplied precisely meets the consumers' needs, including the price and route. Policymakers should pay close attention to the gap between them when supply fails to meet the needs of residents.

3. Research framework and data

3.1. Research objective and research framework

By identifying the differences between the use of public transport and supply of public transport, this study explored the correlation between the use of public transport and social capital. Additionally, this study considers regional variations, such as the differences in the supply level of public transport, as these factors may affect what we want to test. Therefore, we will also compare different regional characteristics.

Previous studies (Utsunomiya, 2016, 2019) have used prefectural data in Japan to provide empirical results on the overall tendencies in Japan. This study attempts to determine not only the tendency of Japan but also to investigate regional variations. Because there is a disparity in socio-economic conditions, such as public transport supply within one prefecture, using prefectural-level data eliminates this important information. This study uses data at the municipal level, the most local based government.[2] We divided 1741 municipalities into different groups based on their regional features using municipal data.

The regional difference between rural and urban area is the largest, which explains differences in the natural environment, population density, lifestyle, and the degree to which public transport services can be provided commercially by private operators. Because the aging population is another feature of rural areas, the demographic attributes of the area will also be considered.

Therefore, all municipalities were categorized into one of four kinds of areas: urban, suburban, rural, and depopulated areas, as shown in Table 1. There are many approaches to defining rural and urban areas, and we apply the densely inhabited district (DID) criteria for grouping.

According to the Japanese Statistics Bureau,[3] a DID is defined as:1) the area with a population density of 4000 people per km^2 or above; 2) the combined population of contiguous districts exceeding 5000. A DID area is usually defined as an urban area. However, at the municipal level, DID and non-DID may exist in the same municipality. Therefore, we defined municipalities without any DID as rural area. Municipalities with DID were categorized as urban areas. However, considering that downtown areas differ from suburban areas, we separated these urban groups into urban and suburban areas. Municipalities with more than 50% of the population living in DID were defined as urban areas. Other groups, with no more than 50% of the DID population, were categorized into suburban areas. In this study, we define municipalities in rural areas with an older adult population rate of more than 35% as depopulated areas[4] to explore any distinctive patterns or tendencies that may differentiate them from other rural areas.

3.2. Data

The data used in this study were collected from the National Census of Japan, covering 1741 municipalities. The variables used for analysis are listed in Tables 2–4.

3.2.1. Dependent variables

In this study, we used a composite index to measure social capital based on statistical data consisting of electoral turnout and the number of public facilities per capita.[5] The composite index is commonly used in the social sciences to evaluate a subject with multiple dimensions. According to Putnam's definition, social capital comprises three key factors: trust, norms, and social networks. Using a composite index to evaluate this subject is better than using a single proxy. Putnam (1993) also adopted this approach in his Italian study of social capital (Putnam, 1993).

Electoral turnout can be considered an indicator of the absence of a civic community (Putnam, 1993), as well as a measure of an individual's commitment to society (Harper, 2002), which are important components of social capital: norms and trust. The electoral turnout used here is the data from the House of Representatives election in Japan in 2014.

Public facilities represent the local platform on which people can gather and interact, thus building social networks. It is better to use data on participation in associations that reflect individuals' activities directly as a proxy for networks, as Putnam did in his work (Putnam, 1993). However, due to the data availability, we used the number of public facilities per capita to measure the local social networks of residents in each area.

To calculate the composite index, these two variables were subjected to the normalization process to ensure that they are in a common basis. The composite index of social capital is the arithmetic average of the normalized value of electoral turnout and number of public facilities per capita. The statistical information is provided in Table 2.

3.2.2. Independent variables

The proxy used to measure the use of public transport was the percentage of commuters going to work and school by train or bus out of total commuters. This metric provides insight into the level of public transport usage in a given area. Although it only considers commuting and schooling, we believe it is indicative of the transport habits of residents when faced with various transport options. If residents can use public transport for commuting and schooling, they also can use it for

Table 1
Four sample groups.

	Grouping Criteria	Number of Municipalities
Urban Area	DID population is more than 50%	469
Suburban Area	DID population is less than 50%	374
Rural Area	DID population is 0	898
Depopulated Area	DID population is 0, and the older adult (older than 65) rate is more than 35%	250

Table 2
The statistical description of the dependent variable.

	Obs.	Mean	Min	Max	Std. Dev.
Social capital index	1741	0.0453	−3.1418	7.0845	0.7546
Electoral turnout	1741	0.5726	0	0.9128	0.0932
Public facility number per capita	1741	0.0047	0	0.2214	1.1396

[2] Japanese government system consists of three tiers: national, prefectural, and municipal: https://www.metro.tokyo.lg.jp/ENGLISH/ABOUT/STRUCTURE/structure01.htm (accessed 2022.6.1).

[3] The definition of DID quoted from the website of Japanese Statistics Bureau: https://www.stat.go.jp/data/chiri/1-1.html (Accessed 2023.3.7).

[4] One of the conditions that Japanese government defines depopulated area in Japan is the elderly population higher than 35%, we use this criterion here to define depopulated areas in this study: https://www.soumu.go.jp/main_content/000807173.pdf (accessed 2022.5.3).

[5] Public facilities consists of library and community centre (Kou min kan).

Table 3
List of independent variables.

Variables	Definition	Year	Source
Older adult rate	The population older than 65 years divided by the total population	2010	Portal site of Official Statistics of Japan
School number per capita	The total school number (including kindergarten, elementary, middle, and high school) divided by the total population	2009	Portal site of Official Statistics of Japan
Financial capability index	Composite index to evaluate the financial situation of the municipality	2010	Portal site of Official Statistics of Japan
Use of public transport	Number of commuters going to school or work by train or bus divided by the total number of commuters	2010	Portal site of Official Statistics of Japan

Table 4
List of dependent variables.

	Obs.	Mean	Min	Max	Std. Dev.
Older adult rate	1741	0.2724	0.0919	0.5724	0.0700
School number per capita	1741	0.0007	0.0001	0.2131	0.0009
Financial capability index	1712	0.5278	0.0500	2.5500	0.3128
Use of Public transport	1741	0.1081	0	0.5802	0.1112

other purposes. However, we acknowledge that this metric does not fully capture all residents' transport preferences. Due to data availability, we rely on the indicators of commuters as an approximation of the broader population's transport habits.

The other control variables were the older adult rate, the financial capability index of the municipality, and number of schools per capita.[6]

Previous studies have highlighted the beneficial impact of education on social capital, and while age has been also found to be positively correlated with social capital levels (Iyer et al., 2005; Qin & Tanaka, 2017). Education can provide individuals with the knowledge and communication skills necessary to expand their social networks (Iyer et al., 2005). Moreover, the fiscal condition of municipalities is closely related to ability of local government to provide institutional support for residents in various fields, such as facilitation of public facilities as well as subsidies for NGO (Non-Governmental Organization) activities, which are considered to have impact on residents' daily lives and contribute to building social capital.

4. Results

Before running the regression, we calculated the correlation coefficient to check the correlation between use of public transport and the social capital index. Table 5 shows the correlation coefficients of the five samples. These different outcomes imply that the correlation between these two variables may differ across areas.

Table 5
Correlation coefficients between use of public transport and social capital index.

Group	All	Urban Area	Sub-urban Area	Rural Area	Depopulated Area
Correlation coefficient	−0.1836	0.0713	0.0443	−0.0857	−0.1078

[6] School here includes kindergarten, elementary school, middle school, and high school.

The scatter plots (see Figs. 1- 5) provide information similar to the correlation coefficients. The correlation between the use of public transport and social capital shows a positive sign in urban and suburban areas. It becomes negative for the entire sample and in rural areas, including depopulated areas.

To check the correlation between the use of public transport and social capital by considering the influences of other control variables that are assumed to affect the social capital level (Putnam, 2000; Iyer et al., 2005; Qin & Tanaka, 2017), we applied multiple linear regression to examine the correlation between social capital and the use of public transport, adding three control variables: older adults rate, school number and the financial capability index of municipality. We run five regressions on different samples to compare different areas. Table 6 summarizes the results of regressions results for five samples.

The analytical results for the entire sample show that the use of public transport positively and significantly correlated with the social capital index. This indicates that areas with a higher share of people using public transport enjoy a higher level of social capital. The older adult rate was also significantly and positively correlated with the social capital index, which is consistent with previous findings that older adults tend to have richer social capital (Iyer et al., 2005; Qin & Tanaka, 2017). The number of schools per capita also shows a positive correlation with social capital, implying that education can contribute to social capital building, which is consistent with previous findings (Putnam, 2000; Iyer et al., 2005; Qin & Tanaka, 2017). The correlation between the financial capability index and social capital was not supported by the analysis of all the municipalities.

The results for urban and suburban areas are mostly consistent with the regression for all municipalities (1). The positive correlation between the use of public transport and social capital are reinforced by regressions (2) and (3). However, the analytical results of rural and depopulated areas show different tendencies. Regressions (4) and (5) do not support the correlation between the use of public transport and social capital in rural and depopulated areas. These differing results indicate that the use of public transport does have different influences across areas.

5. Discussion

Social capital is embedded in an individual's social structure (Putnam, 1993), and is supposed to be influenced by people's behaviour. Therefore, to examine the impact of the use of public transport on social capital building, in comparison with data on the supply side, such as the number of bus stops or railway length, we consider the indicator reflecting users' activities to be more appropriate as a proxy for public transport. The overall result shows that the use of public transport is positively correlated with the social capital level. Meanwhile, the results differ across different areas, as suggested in the scatter plots, which requires further discussion.

First, the positive correlation shown by the analysis of all municipalities in Japan provides evidence of a positive link between the use of public transport and social capital. Second, this correlation was not observed in the analysis of rural areas, including depopulated areas, which differs from the results for urban and suburban areas. This suggests that regional differences may lead to different consequences.

Previous studies working on the relationship between public transport and social capital in Japan have conducted some case studies focusing on urban areas: small metropolitan city (Yamashita and Arai, 2014), big metropolitan city (Utsunomiya, 2019) and local city (Utsunomiya, 2016). All of these are uniform in suggesting a positive link between use of public transport and social capital.

The study of Toyama (a local city) and Kobe (a large metropolitan city) examine the changes in residents' social activities following the launch of new public transport service. These two cases show that people tend to go out, meet friends and relatives more often, and even extend new social networks after new public transport services become

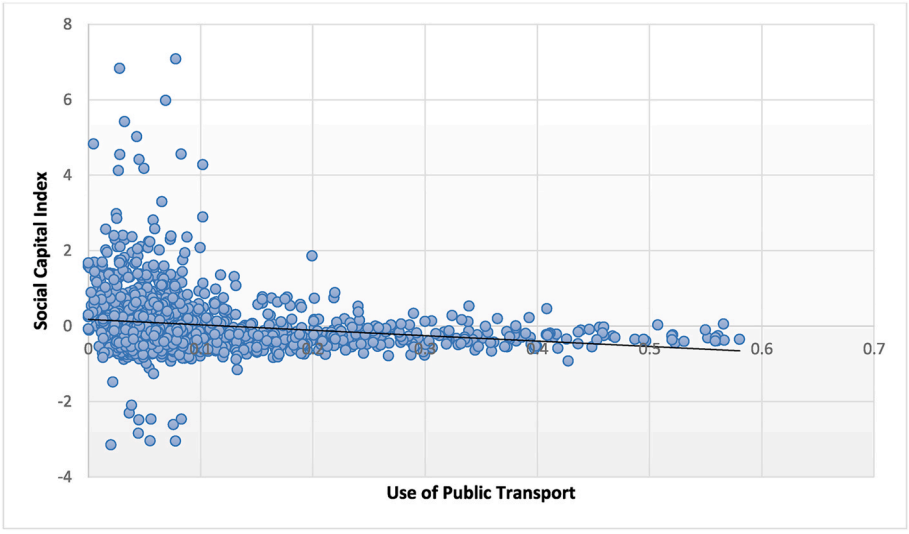

Fig. 1. Scatter plot (All municipalities).
Data Source: portal site of Official Statistics of Japan

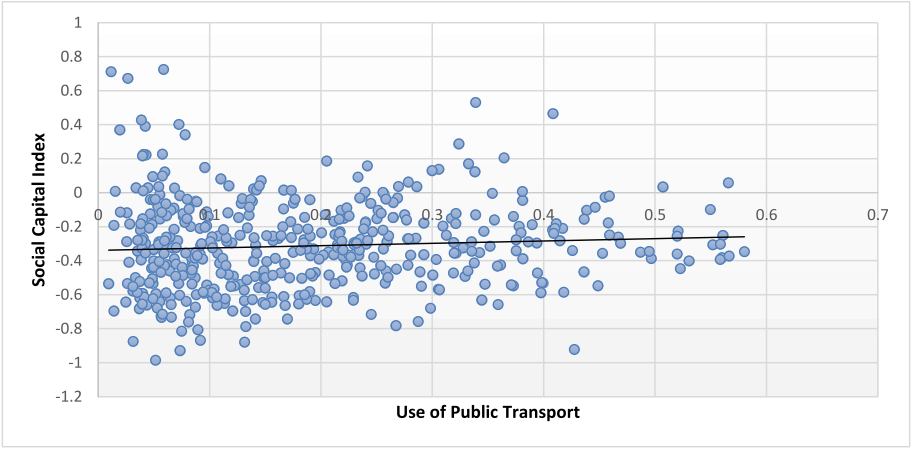

Fig. 2. Scatter plot (urban areas).
Data Source: portal site of Official Statistics of Japan

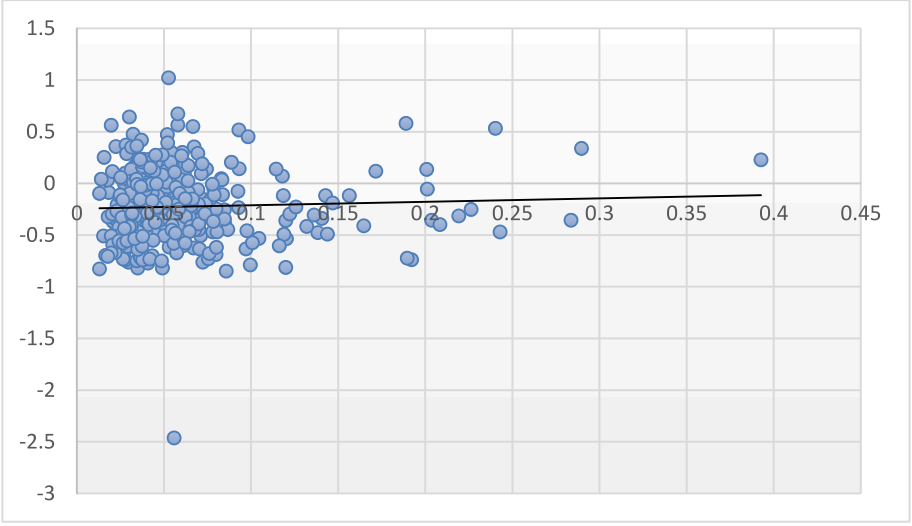

Fig. 3. Scatter plot (sub-urban areas).

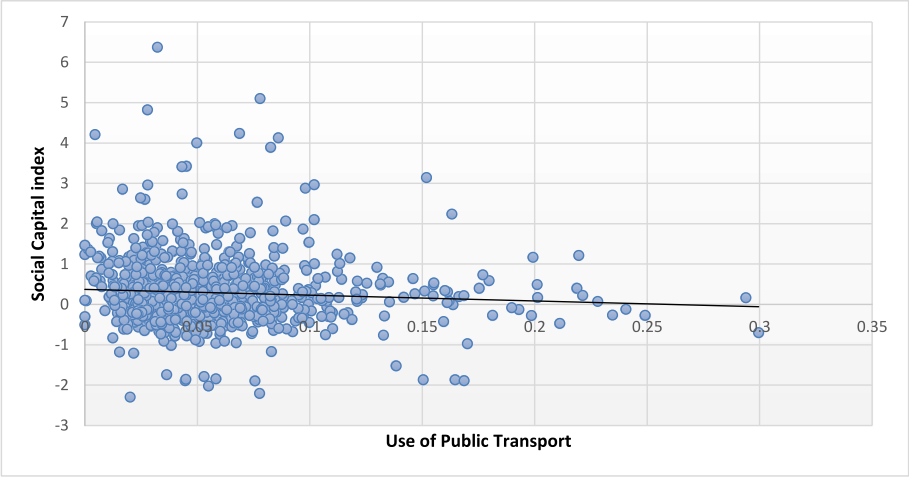

Fig. 4. Scatter plot (rural areas).
Data Source: portal site of Official Statistics of Japan

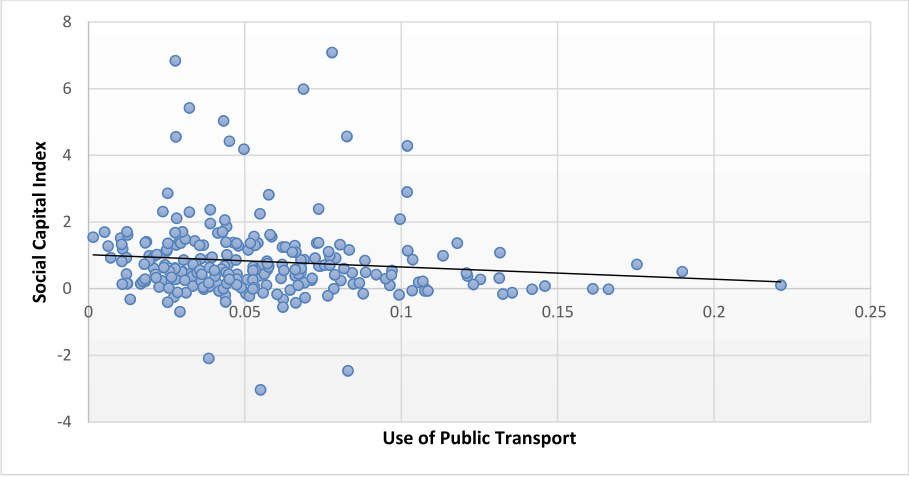

Fig. 5. Scatter plot (depopulated areas).

available (Utsunomiya, 2016, 2019). However, there are some distinctions between these two cases that provide us new implications. The new public transport service opened in Toyama is a light rail service that link train station and port town area. In addition to people reporting more frequent social activities, an obvious decline in the use of private car was also observed in the case studies of Toyama Light Rail (Utsunomiya, 2016), while this change was small in Kobe's case. Toyama is a local city while Kobe is a metropolitan city; thus, dependence on private cars is relatively higher in Toyama. This may explain why the change in private car usage was observed only in Toyama. The case study of Kobe examines the community bus mainly operating in residential areas, and neighbourhood connection are found to be more active after the bus starts operating (Utsunomiya, 2019). Community buses in Kobe are typically used by residents of the same residential area, whereas the light rail in Toyama links two different areas in city. This may explain why a large enhancement in bonding ties was observed in Kobe's case. This implies that different types of public transport may lead to the formation of different types of social capital.

Bonding and bridging social capital are two distinct types of social capital that are often compared: bonding type refers to networks that "bring together people who are like one another in important aspect" whereas bridging type refers to networks that "bring together people who are unlike each other" (Putnam & Goss, 2002, p. 11). In daily life, bonding social capital normally refers to family ties and local community networks characterized by homogeneous while bridging social capital refers to the social networks involving diverse people. In terms of transport issues, bridging social capital has been found to be more closely linked with mobility (Currie & Stanley, 2008; Stanley et al., 2010; Xiong et al., 2019), since traveling to different places and interacting with different people might generate so called bridging social capital. However, the case of a community bus in Kobe (Utsunomiya, 2019) shows that bonding social capital may also be generated through public transport. While it is possible for individuals to develop strong bonds with their neighbours and family members without traveling to other locations, bonding ties can be strengthened by increasing interaction with members of the wider community. This can be achieved by spending more time outside the home and exploring new places. By doing so, individuals can broaden their social network and build deeper relationships with those around them. This implication may be important for our future studies on the link between public transport and bonding and bridging social capital.

Another important implication of these case studies is the shift from private car use to public transport after the introduction of the new public transport service in Toyama (Utsunomiya, 2016). This implies the

Table 6
Analytical results.

	All (1)	Urban Area (2)	Suburban Area (3)	Rural Area (4)	Depopulated Area (5)
Use of Public Transport	0.4133**	0.4263***	0.9192**	−0.0973	−1.5031
Older adult rate	4.0056 ***	0.9670***	1.8962 ***	3.9146***	2.8896
School number	247.6 ***	354.1611***	255.8847***	223.4437***	343.0162***
Financial Capability Index	−0.1027	0.1283**	00.0075	−0.1601	0.0619
N	1712	446	374	892	250
R-squared	0.3290	0.1383	0.1164	0.2324	0.0988
RMSE	0.6225	0.2458	0.3210	0.8026	1.1331

*** denotes $p < 0.01$, ** demotes $p < 0.05$.

Table 7
The possession rate of private cars (2010).

	Obs.	Mean	Min	Max	Std. Dev.
All	1741	0.3760	0.0331	1.2678	0.1436
Urban areas	469	0.2126	0.0331	0.4487	0.0924
Sub-urban areas	374	0.3764	0.1974	0.5614	0.0713
Rural areas	898	0.4612	0.0983	1.2678	0.1104

Table 8
The share of public transport use of commuters (2010).

	Obs.	Mean	Min	Max	Std. Dev.
All	1741	0.0924	0	0.5802	0.0966
Urban areas	469	0.2107	0.0095	0.5802	0.1356
Sub-urban areas	374	0.0588	0.0129	0.3927	0.0446
Rural areas	898	0.0571	0	0.2996	0.0391

use of public transport may be constrained by its availability and increasing the public transport supply may lead to an increase in its usage.

The proxy we used in this study for public transport is an indicator on the user's side, reflecting user behaviour in public transport usage. However, the demand reflected in this indicator is constrained by supply. Given the tendency in overall that use of public transport is positively correlated with social capital, the missing link in rural areas might be due to the insufficient public transport supply. Consequently, people living in rural areas may not have the same level of convenience in using public transport as those living in urban or suburban areas. Therefore, the actual willingness of rural residents to use public transport may be underestimated by the current data. As discussed previously, the case studies on the relationship between public transport and social capital in Japan all focus on cities classified as urban areas in our studies. This reinforces the possibility of disparities in public transport availability between rural and urban areas of Japan, as the social impact of public transport is only observable in areas with a sufficient level of service.

As depopulation in rural areas escalates, public transport services in rural areas have declined dramatically over the past decades. The number of abandoned train routes is increasing every year.[7] By 2010, the public transport blank area accounted for approximately 30% of the entire Japanese territory, and this area continued to increase as the public transport service paired down in rural areas.[8] This leads resident living in rural areas to rely heavily on private cars because public transport services are insufficient or unavailable. This raises another concern regarding forced car ownership. People might have to purchase one or more cars at the expense of other goods (Stanley et al., 2010), or being compelled to drive a car even though their health conditions do not recommend doing so, as is the case with older adults driving, a fiercely discussed issue in Japan in recent years.

Table 7 compares the possession rates of private cars in the different areas.[9] The average number of private cars per capita is higher in rural areas than in urban areas. By contrast, the use of public transport in rural areas was the lowest, as shown in Table 8. The high rate of private car ownership and low use of public transport in rural areas indicate that public transport might not be convenient or even available for residents in these areas.

Therefore, we can interpret the missing link between public transport and social capital in rural areas as a consequence of an insufficient supply of public transport. If residents in rural areas enjoy public transport service as convenient as residents in urban and suburban areas do, we might be able to find a positive correlation between public transport use and social capital in rural areas as well. It is the insufficient supply of public transport that hides the potential link.

The lack of public transport in rural areas could potentially result in fewer outings for residents, a problem that has already led to several issues in Japan, including the phenomenon known as "shopping disadvantaged" (refers to the phenomenon where individuals feel difficult to access shopping mall or supermarket).

In rural areas of Japan, the proportion of older adults is higher than in urban areas.[10] Older adults with health concern tend to rely heavily on public transport for travel as they may face greater challenges in walking or driving. In the low-density rural areas, accessing widely dispersed facilities such as hospitals, shopping centres can be challenging without the use of transport. The inconvenience of public transport in these areas may significantly undermine the mobility of residents particularly older adults.

However, this does not imply that social capital is poorer in rural areas than in urban areas of Japan. Previous study has suggested that social capital, both bonding and bridging social capital, are richer in rural areas (Qin et al., 2022). While rural areas of Japan may currently have rich bonding and bridging social capital, it is essential to be aware of the risk of a decline in social capital, particularly bridging social capital, when public transport is insufficient. As bridging social capital is often linked to regional revitalization in Japan (Hayashi et al., 2018; Tanaka et al., 2018), policymakers should pay close attention to the demand of public transport in rural areas especially for the older adults.

The financial capability index is a common indicator used in Japan to

[7] According to the documents from the Ministry of Land, Infrastructure, Transport and Tourism of Japan: https://www.mlit.go.jp/common/001344605.pdf.

[8] Public transport blank area is defined as the residential area without bus stop in 500 m and railway station in 1 km, according to the documents from the Ministry of Land, Infrastructure, Transport and Tourism of Japan: https://www.mlit.go.jp/common/001011383.pdf.

[9] Number of private cars per capita: data are collected from Portal site of Official Statistics of Japan.

[10] According to the report "Future Forecast of Rural Population and Agricultural Villages" published by Ministry of Agriculture, Forestry and Fisheries of Japan in 2019, the older adult rate is higher in rural areas compared to urban areas: https://www.maff.go.jp/primaff/seika/attach/pdf/190830_2.pdf.

evaluate the financial condition of each municipality. The higher the index, the larger the financial resources, meaning that the government can allocate the budget more flexibly.[11] With more stable financial resources, the government should be more capable of providing support for community or NGO activities which are supposed to be linked to social capital building. However, few studies have explored the role of government in social capital building. We use this variable to observe whether government's financial condition is linked to social capital. We found only a weak correlation in the analysis of the urban areas with a significant level of 5%. Our hypothesis in this regard was not strongly supported by this analysis.

Number of School was the only variable that displayed a positive and significant correlation with social capital in all five regressions which might indicate the strong influence of education on social capital. As substantial literature has shown, individuals can obtain the communication skill and knowledge necessary for building social capital from education (Iyer et al., 2005). Moreover, schools not only shape human capital but also generate social capital by delivering the value of reciprocity (Fukuyama, 2000). In Japan, substantial research has found that schools might help build local connections among residents because they provide opportunities for students, teachers, parents, and local community organizations to interact with each other (Kashiwagi, 2016). We use the number school not only to explore the role of education in social capital building, but also to highlight the special function of school, as bridges for networking among residents. These findings emphasize the crucial role of education in building social capital and underscore the vital contribution of schools in this regard.

6. Conclusions

Previous studies focusing on the influence of public transport on social capital building have provided some empirical evidence of the relationship between public transport and social capital (Utsunomiya, 2016, 2019). However, there is little discussion on the distinction between use and existence of public transport which is quite essential to the policy implications of public transport.

Based on the distinction on these two different aspects, this study explores whether the use of public transport can help build social capital by examining the correlation between the use of public transport and social capital. Using the municipal-level data covering areas with different features, this study provides empirical evidence supporting the positive link between the use of public transport and social capital in Japan.

Cross-sectional data do not enable us to test causality; therefore, it is inappropriate to claim that using public transport can increase the social capital level based on the results we obtained in this study. However, we can conclude that municipalities with higher levels of public transport tend to have higher levels of social capital, suggesting the possibility that the use of public transport might be one of the factors that contribute to social capital building.

From the perspective of social capital, this study contributes to identifying the potential determinants of social capital, which have not been fully explored and lack empirical evidence. From a transport research perspective, this study provides a novel approach for evaluating the benefits of public transport. The traditional role of public transport is to provide mobility related to welfare. The discussion of the social dimension of public transport primarily draws on individuals' human rights or well-being (Horcher & Tirachini, 2021). By framing it into the context of social capital, benefits of public transport can be extended to the entire society as social capital is regarded as commons that can generate positive externalities (Putnam, 1993). Therefore, the decision on public transport supply requires consideration of benefits such as social capital, rather than traditional economic benefits.

It is essential to maintain the mobility of people, which requires a sufficient public transport supply to prevent a social capital crisis. However, in Japan, most public transport is provided by private sector, and the role of this sector in the provision of public transport service is not clear (Utsunomiya, 2020). To ensure that public transport services, especially in rural areas of Japan, meet the demands of residents, both central and local governments should be more involved in the supply decision-making process by facilitating coordination among different stakeholders and increasing financial support for the public transport business.

Finally, we would like to specify the limitations of this study. Despite contributions summarized above, the implications of this study are constrained by certain data limitations. First, due to the use of cross-sectional data, the analysis could not establish causality, which is a crucial aspect in supporting our main argument that use of public transport can contribute to building social capital. Second, the dependent variable we use in this study only includes commuters' travel which means that elderly people who are supposed to rely heavily on public transport are not observed in our analysis. According to survey conducted by Cabinet Office of Japan in 2016, older adults aged 60 to 69 prefer to use private cars rather than public transport, while those over 70 tend to use public transport more frequently.[12] On the other hand, people younger than 30 tend to use public transport most frequently, and these people are likely to be identified as commuters in our analysis. This limitation highlights a potential oversight in the use of public transport with the indicator only including commuters. Third, the municipal data used in this study are macro-level data, that do not allow for the investigation of individual behaviour. Even within the same municipality, individuals with different characteristics such as age, may take different actions on transport. To fully examine the mechanism through which the use of public transport influences social capital building, individual-level data are required, which remains a topic for our further research.

CRediT authorship contribution statement

Ziyi Qin: Conceptualization, Methodology, Software, Writing – original draft, preparation. **Daisuke Fukuda:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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[11] According to the definition of financial capability index from Ministry of Internal Affairs and Communications of Japan: https://www.soumu.go.jp/iken/zaisei/R03_chiho.html.

[12] The public opinion poll conducted by Cabinet Office of Japan in 2016: https://survey.gov-online.go.jp/h28/h28-kotsu/zh/z01.html (Accessed 2023/3/7).

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