Policy Evaluation of Wide-Area Cooperation between Municipalities: Empirical Analysis with "Self-support settlement region framework" as the Case Study[*]

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Abstract

This paper aims to quantitatively verify the outcomes of the "self-support settlement region framework" concept, which is a wide-area collaboration initiative between municipalities in Japan. Intermunicipal cooperation (IMC) has two effects. The first is that improvements in the efficiency of resource allocation for the supply of public services (internalization of economic externalities) are expected to contribute to an increase in the number of residents, or halt the decline in the number of residents, through improved daily life functions across the whole area. The second effect is an anticipated decline in the average cost of public services through economies of scale. In view of this, this paper uses the rates of population change and social change as performance indicators for the former, and real expenditure per capita as the performance indicator for the latter, to estimate the impact (causal effect) that the formation of the "self-support settlement region framework" has on such performance indicators. However, as the formation of the "self-support settlement region framework" is based on voluntary decision-making by the municipalities, areas that are experiencing a serious population decline may be more likely to select the formation of such areas in order to strengthen the sustainability of their community through area-wide initiatives. To avoid this selection bias, we combined the use of propensity score matching (PSM) and difference-in-difference (DID) analysis to eliminate municipality-specific effects that do not change over time. The analysis showed that the formation of the "self-support settlement region framework," compared to the non-formation of such areas, did not contribute to increasing or maintaining population numbers. Moreover, real expenditure per capita did not decrease after the formation of the "self-support settlement region framework," but rather,

demonstrated an upward trend. While a core city in the "self-support settlement region framework" should have facilitated consensus building and adjustment of interests with surrounding municipalities, in reality, the cooperation remained along the lines of conventional cooperation without extending beyond easily collaborative fields, such as industrial policy, tourism promotion, and disaster measures. Consequently, improvements to the daily life functions and economies of scale across the whole of the area were not realized, and the "self-support settlement region framework" did not ultimately contribute to maintaining or increasing population numbers, nor to reducing expenditures.

I. Introduction

The population of Japan was 125.05 million in 2021, which is a decrease of approximately 640,000 from the previous year.[1] As the population continues to decline, local governments need wide-area cooperation to maintain their administrative functions because of future resource constraints. Intermunicipal cooperation (IMC) has two effects—optimal supply of local public goods and lower average cost. In the former, local governments aim to internalize the spillover effects (positive externality) of public services of one local government by enhancing the functions of the entire region through cooperation with other local governments, thereby achieving optimal supply and increasing the number of residents or halting the decline in the number of residents. In the latter, local governments pursue economies of scale and then decrease average costs as the number of people increases through intergovernmental cooperation.

Several studies about other countries have examined the effects of these intermunicipal collaborations. For example, Banaszewska et al. (2022) found that IMC in Poland contributed little to the local economy positively, while Ferraresi et al. (2018) examined the effects of IMC in Italy and found the existence of cost-saving effects due to economies of scale.[2]

Although 13 years have passed since the introduction of the self-support settlement region framework, which is one of the intermunicipal partnerships in Japan, there is no academic study on the policy effects of such an area.[3] In particular, the formation of a self-sup-

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[1] Statistics Bureau, the Ministry of Internal Affairs and Communications, "Population Estimates - 2022 (April 2022)," <https://www.stat.go.jp/data/jinsui/pdf/202204.pdf l: accessed May 4, 2022>.

[2] Apart from these, using a meta-regression analysis, Bel and Sebő (2021) found that population size and governance have a significant impact on the cost reduction of public services through IMC.

[3] While wide-area cooperation among municipalities is progressing, there is little research on wide-area cooperation in Japan. Studies that have examined the factors that lead to the formation of wide-area cooperation between municipalities include those by Sugahara (2014) and Miyashita (2021). The details of the preceding studies are presented in Section II.

port settlement region is based solely on the voluntary decision of the constituent municipalities and is not randomly assigned. Randomization is necessary for estimating the causal effect, i.e., whether the outcome is due to the formation of a self-support settlement region framework or not. As the formation of a self-support settlement region framework is based on the voluntary decision of the constituent municipalities, the more serious the social decline in population is, the more likely they are to form an area to increase the sustainability of the area through a region-wide effort. As a result, there is a risk of observing a relationship in which the higher the number of municipalities that have formed a region, the more social decline of the population increases. To avoid such selection bias, studies such as those by Rosenbaum and Rubin (1983), Heckman et al. (1997), Abadie et al. (2004), Abadie and Imbens (2008), and Imbens (2015) employed a propensity score matching (PSM) for their analysis, which is effective in randomizing samples. We combine PSM with a Difference in Difference (DID) analysis to eliminate municipality-specific effects that do not change over time and examine the impact of wide-area cooperation between municipalities through self-support settlement regions on the demographics and average costs of local public services.

The rest of this paper is organized as follows. Section II summarizes domestic and international empirical studies on interlocal government cooperation and clarifies the outline and characteristics of the self-support settlement region framework. Section III presents the hypotheses to be tested and then details the results of the empirical analysis on the outcomes of the self-support settlement region framework using the PSM-DID. Section IV presents a summary of this paper and issues to be addressed. Finally, we summarized the process of deriving the propensity score by PSM and the balance check of the matching sample, etc. in the Appendix.

II. Local Government Collaboration

II-1. Economics of Local Government Partnerships

II-1-1. Economic Rationale for Interlocal Governmental Cooperation
As presented in Table 1, from an economic perspective, the existence of a large number of independent local governments is expected to have some advantages, such as the provision of local public goods that match local preferences (decentralization theorem),[4] improved efficiency in resource allocation through the promotion of intergovernmental competition (foot voting),[5] and policy experimentation and innovation.[6] However, problems such

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[4] When residents' preferences for local public goods differ among local governments, the uniform provision of local public goods by a single local government created through a merger in the region will result in welfare losses.
[5] Intergovernmental competition is expected to limit government actions aimed at maximizing tax revenues and improve the efficiency of resource allocation and minimize costs by maximizing residents' welfare.
[6] Mochida (2013) used it to point out the advantages and problems of independent local governments over the central government. Here it is used as a comparison of a case with a large number of local governments and a case with only a small number of local governments.

Table 1. Advantages and problems with a large number of independent local governments

Advantages	Problems
・Local public goods and regional preferences ・Intergovernmental competition ・Policy experimentation and innovation	・Benefit spillover ・Diseconomies of scale

Source: Mochida (2013), Figure 1. 3

as spillovers of benefits and diseconomies of scale arise. Interlocal government cooperation is expected to resolve these problems.

However, intergovernmental cooperation requires transaction costs for consensus building due to the involvement of multiple decision-making entities.[7] Moreover, if municipal councils and administrative organizations work hard to promote the number of public facilities and services they provide to residents in their regions, they may oppose intergovernmental coordination for fear of losing their authority over the public facilities and services in their regions rather than pursuing economies of scale. From the perspective of the public choice theory, these political costs are also a factor that increases the cost of consensus building.

II-1-2.   Empirical Analysis of Local Government Collaboration

As mentioned above, first, interlocal government cooperation is expected to improve the efficiency of resource allocation through the internalization of spillover effects (external economic effects) of the benefits of public services. This is expected to result in outcomes such as an increase in resident population and economic growth via the strengthening of functions within the collaboration area not only through public services and social capital but also through private sector investment and lifestyle-related services. Second, economies of scale can lead to cost reductions in public services. In the following sections, we will discuss the results of domestic and international empirical analyses of the two outcomes of intergovernmental cooperation and the determinants of such cooperation.

(1) Effects on Population and Economy

There are a few empirical studies on the first outcome. Banaszewska et al. (2022) analyzed the effect of intergovernmental cooperation on the performance of local economies for local governments in Poland. The results revealed that while the unemployment rate improved, the number of factory locations per population and the population growth rate did not. Ferraresi et al. (2018) also examined its effect on fertility, net migration, and elementary school enrollment and found that the effect of forming intergovernmental cooperation is nonexistent.

There are only two studies about Japan (Yokoyama, 2017; Yokoyama 2019) that exam-

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[7] As discussed below, Blåka (2017) found that the cost-saving effect of coordination declines as the number of coordinated governments increases.

ine the outcomes of core regional urban areas. Yokoyama (2017) analyzed whether the rate of change in the densely inhabited district (DID) population (hereafter referred to as the DID population change rate) was greater than the rate of change in the population within the region to verify whether the efforts within the region have increased the concentration of urban functions and enhanced the sustainability of the region. Yokoyama (2017) confirmed that there were some municipalities in the two areas with a high concentration of population. In addition, Yokoyama (2019) also verified the outcomes of the core regional urban areas using the "2010 and 2015 National Census", finding that it is sustainable in areas where the DID population change rate is greater than the population change rate. The analysis of the 28-core regional urban areas revealed that in which there were two highly sustainable areas (7.1%) in which the population change rate and the DID population change rate were both positive and in which the DID population change rate exceeded the population change rate.[8]

(2) Cost Reduction Effect

As the average cost of interlocal government cooperation in public service provision is expected to decrease due to the expansion of scale, a number of empirical studies on other countries have investigated whether the effect of decreasing average costs has been realized. However, the results of these studies are not consistent.

Among the studies that examined cost savings, Soukopová and Klimovskỳ (2016) and Soukopová and Vaceková (2018) found that interlocal government cooperation in the Czech waste management service has cost-saving effects. Niaounakis and Blank (2017) found that economies of scale through interlocal government coordination improve cost inefficiency for smaller governments, while Blåka (2017) analyzed the cost-saving effects of interlocal government coordination in the Norwegian fire service and found that the size of the effect depends on the type of coordination and the number of local governments.[9] Ferraresi et al. (2018) analyzed the cost-saving effects of interlocal government coordination in Italy and found that, compared with local governments without coordination, total expenditure per capita reduced by approximately 5%, and the expenditure reduction effect lasted six years after the coordination.

On the other hand, Allers and de Greef (2018) found that interlocal government cooperation in the Netherlands has no cost-reducing effect except in the area of tax collection, but small and large local governments increase their expenditures. Silvestre et al. (2020) analyzed the effect of interlocal government collaborations in Brazil and found that they have cost-reducing effects in social assistance, culture, and housing but not in the health sector. Given the different results emerging from these empirical studies on the relationship between interlocal government linkages and cost reduction effects, Bel and Sebő (2021) con-

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[8] The analysis of the 30-core regional urban areas revealed that both the rate of population change and the DID population change rate were positive, with 9 (30%) highly sustainable cities having a DID population change rate higher than the population change rate, and 16 (18%) of the 89 linked cities (linked cities with DID) having a DID population change rate higher than the population change rate.

[9] Blåka (2017) found greater cost savings with contractual agreements than with joint organizations and fewer local governments working together.

ducted a meta-regression analysis and found that cost reduction effects can be confirmed for small local governments and the transfer of authority to higher organizations for the supply of services.

There are many studies on the expenditure reduction effects of municipal mergers in Japan,[10] but to the best of the authors' knowledge, there is no study on the cost reduction effects of intergovernmental cooperation that target self-support settlement regions and core regional urban areas.

(3) Determinants of Collaboration

There are many studies on the factors that affect local government coordination. LeRoux and Carr (2007) analyzed local government road construction and maintenance as well as water and sewerage facilities in Michigan in the United States. They found that even in public services where economies of scale work, local government coordination is not selected because of the influence of regional characteristics such as population size or distribution. Bergholz and Bischoff (2018) investigated the attitudes of German local legislators toward intergovernmental cooperation in childcare services and road maintenance and found that the more politically influential legislators are, the more they oppose cooperation out of concern that their political influence will be lost. They also found that legislators in larger local governments were more supportive of intergovernmental linkages, while those in larger neighboring local governments tended to oppose them for fear of losing their political influence.

Studies on interlocal government linkages in Japan include those by Sugahara (2014), Miyashita et al. (2020), and Miyashita (2021), which examined whether spillovers of benefits in public service provision contribute to their formation. Sugahara (2014) clarified that a spillover index constructed from commuting data has a significant impact on the formation of a self-support settlement region framework. Miyashita et al. (2020) analyzed the factors that contribute to the formation of a core regional urban area. They found that the more reserves municipalities have, the less likely they are to choose to form a core regional urban area due to the fiscal common pool problem. Miyashita (2021) also analyzed whether the spillover index, defined as the ratio of commuters from other regions to all commuters in each municipality, affects the formation of a core regional urban area. The results revealed that the larger the spillover index for both core regional cities and neighboring municipalities, the more reluctant they are to form a core regional urban area.

II-2.   IMC in Areas Where There Is a Core City

Since 1969, wide-area administration among municipalities in Japan has been based on the concept of "wide-area administrative regions[11]" for approximately 40 years, but since

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[10] Nakazawa and Miyashita (2016) provided a comprehensive summary of studies on the cost-saving effects of municipal mergers in Japan and abroad.

FY2009, the concept has been converted to the concept of the "self-support settlement region framework" because of changes in the social environment such as population decline and the actual situation of municipalities after "the mass Amalgamations in the Heisei era." In response to the 30th Report of the Local Government System Research Council, [12] the "core regional urban area concept" has been implemented nationwide since FY2014.

After the "Heisei municipal amalgamations," the "self-support settlement region framework" and the "core regional urban area concept," which are new wide-area partnerships of municipalities, are based on the fact that it will be difficult to continue to secure a full set of daily life functions in all municipalities as before because of the declining and rapidly aging population. Therefore, instead of the conventional perspective of mutual use of public facilities and services, an effective option is to secure the sustainability of residents' lives in the entire area through "concentration and networking," where public and private facilities and services, including daily life services (large-scale commercial and entertainment facilities) and medical and welfare services, are concentrated in the core city and their roles are shared with the surrounding municipalities.

According to data from the Ministry of Internal Affairs and Communications, wide-area cooperation in Japan's local governments is classified into "cooperation between municipalities in areas with a core city" and "cooperation between municipalities in areas without a core city," as presented in Table 2. The former category includes the "self-support settlement region framework" and "core regional urban area," while the latter includes partial-affairs-associations, wide area unions, and councils in which related municipalities establish a consultative organization. As presented in Figure 1 and Table 3, the formation of "self-support settlement regions" and "core regional urban areas" have the following feature on a core city: (1) declaration of the core city with surrounding municipalities and declaration of the core regional city with neighboring municipalities, (2) conclusion of agreements and cooperative agreements with surrounding municipalities or neighboring municipalities, (3) desgin a vision, and (4) regular consultation and the establishment and progress management of key performance indicators (KPIs) for the vision.

There is a difference between "IMC in an area with a core city" and "IMC in an area without a core city" in terms of consensus building and interest adjustment for cooperation. In the former, the core city and surrounding (neighboring) municipalities (City B, Town C, and Village D in the example in Figure 1) discuss related matters on a one-to-one basis, whereas in the latter, the municipalities discuss among themselves or in a consultative organization of related municipalities. In the "self-support settlement region framework" and "core regional urban area," the core city is responsible for consensus building and interest

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[11] The term "wide-area administrative regions" has been used since 1991 as a generic term for both wide-area municipal regions and wide-area administrative regions near large cities (see "Outline of Measures for Wide-Area Administrative Regions" by the Ministry of Internal Affairs and Communications). Prior to Heisei municipal amalgamations, "wide-area municipal regions" did not presuppose mergers and covered the group treatment of administrative services for which wide-area treatment was expected to lead to cost reductions, such as firefighting, cleaning, and human waste treatment.

[12] The 30th Local Government System Research Council Report on Reform of the Metropolitan System and the Administrative Service Delivery System of Municipalities.

Table 2. Comparison of Consensus Building and Interest Coordination for Wide-Area Collaboration in Local Regions

	IMC in areas with a core city	IMC in areas without a core city
Concrete example	Self-support settlement regions and Core regional urban areas	Cooperation of related municipalities
Composition	Core city and surrounding municipalities	Smaller municipalities
Consensus building for collaboration, Characteristics of the Coordination of Interests	· The core city, which plays a central role in ensuring necessary urban and living functions, will play a role in consensus building and interest coordination with surrounding municipalities, such as in the formation of a "Self-support settlement region" or "Core regional urban area" and the creation of a vision, through one-on-one consultations on related matters with neighboring municipalities. The establishment of a consultative organization (wide-area administrative organization) is not a prerequisite. · The requests and intentions of neighboring municipalities are likely to be fully reflected.	· Consensus building and interest adjustment through mutual consultation among the municipalities concerned. In many cases, a consultative organization (wide-area administrative organization: partial-affairs-associations, etc.) is established among the municipalities involved. For example, the municipalities involved establish a statutory or voluntary council, and the council formulates a wide-area plan. In some cases, prefectures play a coordinating role. · The municipalities tend to incorporate the requests and intentions of each municipality as they are, and it is sometimes difficult to consolidate opinions and divide roles.
Responsibility	· The entity responsible for consensus building and interest coordination and the entity responsible for decisions are clear.	· The entity responsible for consensus building and interest coordination is unclear.

Source: Prepared with reference to "Wide-Area Collaboration" by the Ministry of Internal Affairs and Communications

coordination, which is different from the wide-area administrative regions or wide-area co-operation among small municipalities without a core city in the past.

Fukuda (2021) listed the following disadvantages of intergovernmental cooperation from the perspective of consensus building: 1) when unanimous consent of the entities concerned is required (as in the case of unions in Japan), prompt decision-making becomes difficult; 2) from the perspective of locus of responsibility, the location of responsibility becomes unclear because it involves the transfer of the entity that performs administrative tasks; 3) from the perspective of governance by residents, it becomes difficult for residents to monitor and reflect their intentions; and 4) residents will not have sufficient control over wide-area cooperation because they have the right of suffrage only within the municipality in which they reside and not to the municipality with which they cooperate.

On the other hand, as merits of wide-area cooperation with a core city, the existence of a

Figure 1. Procedures for Formation of Self-support settlement regions and Core regional urban areas

（1）Declaration of Core City, Declaration of Core Regional City

（2）Conclusion of Agreement on the Formation of a Self-support settlement region, Cooperation Agreement

（4）Regular consultation
Managing the progress of the vision

（3）Design a vision for symbiosis of self-support settlement regions and a vision for core regional urban areas

Source: Prepared with reference to "Wide-Area Collaboration" by the Ministry of Internal Affairs and Communications

Table 3. Procedures for the Formation of Self-support settlement regions and Core regional urban areas

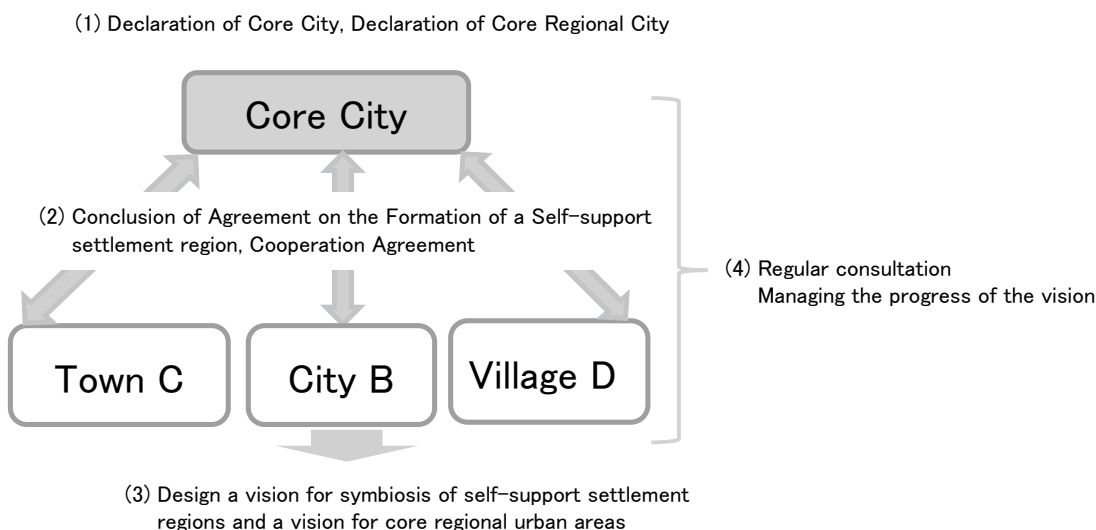| Procedure	Contents
(1)　Declaration of Core City, Declaration of Core Regional City	The core city, which has a considerable size and centrality in the local area, prepares a future vision of the urban area based on cooperation with surrounding municipalities and expresses its willingness to play a role in driving the economy of the entire area and supporting the livelihood of all residents in the area.
(2) Conclusion of Agreement on the Formation of a Self-support settlement region, [13] Cooperation Agreement	After the resolution of the council, the core city and surrounding municipalities (City B, Town C, and Village D in Figure 1) conclude a one-to-one agreement on the formation of a self-support settlement region or cooperation agreement that defines the overall direction of the area, areas of cooperation, and the division of roles.
(3) Design a vision for symbiosis of self-support settlement regions [14] and a vision for core regional urban areas	The core city will discuss with surrounding municipalities on the specific measures based on the agreement on the formation of a self-support settlement region or cooperation agreement and design vision for the area related to municipalities.
(4) Regular consultation Managing the progress of the vision	Regular consultations are held between the heads of the core city and surrounding municipalities, and KPIs for the vision are set and progress is managed.

Source: Prepared with reference to "Wide-Area Collaboration" by the Ministry of Internal Affairs and Communications

core city is expected to clarify the responsibilities of the entity in charge of consensus building and interest adjustment and the entity responsible for decisions, as well as to facilitate full reflection of the requests and intentions of neighboring municipalities through one-to-one consultations. This is expected to make it easier for the requests and intentions of neighboring municipalities to be fully reflected.

Therefore, if the core city smoothly forms an agreement; coordinates interests with neighboring cities, towns, and villages; and strengthens necessary livelihood functions for the entire area, it can be expected that settlement will increase and population decline will be suppressed, compared with a municipality without a core city or that does not form a partnership. However, if the relationship between the core city and surrounding municipalities is not made closer or if the surrounding municipalities are passive in their involvement in coordination efforts without clarification of the benefits, these effects would not be realized.

Among the cooperation between municipalities with a core city, as the number of core regional urban areas promoted in FY2014 is limited, in this paper, we will focus on the self-support settlement regions and clarify the outline of the system, the actual conditions such as the number of areas and size, and the survey results of its achievements.

II-3. *Self-support settlement region framework[15]*

II-3-1. Outline of the Concept of Self-support settlement region framework

Due to the declining birthrate and aging population in regional areas, the "self-support settlement region framework," which was launched nationwide in April 2009, was designed to encourage the flow of people to regional areas by forming areas in each region where residents can live comfortably and stop the outflow of population to the three major metropolitan areas, as well as provide residents of the three metropolitan areas with a choice of residence according to their life stages and lifestyles. Based on the concept of "concentration and network," the core city and surrounding municipalities mutually share roles and cooperate to secure the necessary lifestyle functions for the entire region.

The requirements for a core city to form a self-support settlement region framework are

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[13] An agreement on the formation of a self-support settlement region is an agreement between the declared core city and its surrounding municipalities that stipulates the purpose of forming a self-support settlement region, basic policies, and specific matters to be coordinated (policy areas related to strengthening living functions, strengthening ties and networks, and strengthening management capabilities of the area) to secure the living functions necessary for the settlement of the population. The agreement is based on the resolution of the council (based on Paragraph 2, Article 96 of the Local Autonomy Act) for each municipality to conclude or change the agreement.

[14] As the agreement on the formation of a self-support settlement region has no legal status and relates to cooperation in general, it is necessary to establish a separate agreement for the group treatment of actual administrative work under the Local Autonomy Act (e.g., entrustment of administrative work and joint establishment of councils or agencies) according to the content of the agreement.

[15] II-3 refers to the "Self-support settlement region framework" and "Outline for Promotion of Self-support Settlement Region Framework" on the Ministry of Internal Affairs and Communications' website (https://www.soumu.go.jp/main_sosiki/kenkyu/teizyu/index.html: accessed April 20, 2022). Kimura (2019) provided more details on wide-area cooperation in general, including the establishment of a self-support settlement region framework.

as follows: (1) a population of about 50,000 or more (at least 40,000), (2) a ratio of daytime and nighttime population of 1 or more, and (3) a city outside the three metropolitan areas (within the three metropolitan prefectures, the percentage of commuters who commute to work or school in a special ward or designated city is less than 10% of the total number of residents). A ratio of daytime and nighttime population of 1 or more means that residents of surrounding municipalities enjoy the urban functions of the core city, i.e., there is a spillover of benefits.

The policy areas and roles required of the region[16] include (1) strengthening livelihood functions by sharing roles among municipalities (e.g., operating holiday and night clinics, providing childcare for sick and injured children, providing legal advice on consumer affairs, and fostering local industries), (2) strengthening ties and networks between municipalities (e.g., operating demand bus services, promoting stay-and-experience type tourism and green tourism, and improving roads for daily life), and (3) strengthening management capabilities (e.g., conducting joint training programs, exchanging personnel, and inviting outside experts).

The financial support that cities receive to encourage the formation of self-support settlement regions[17] includes financial assistance from the central government and support from various ministries and agencies for municipalities that work on the vision of symbiosis for self-support settlement regions. As the main financial support measure, the core city received a special local allocation tax of about 85 million yen from FY2014 (40 million yen until FY2013), and surrounding municipalities received 18 million yen from FY2021 (10 million yen until FY2013 and 15 million yen from FY2014 to FY2020). In addition, financial measures can be taken for expenses required for the use of external human resources and securing local medical care, and local government bonds can be allocated for regional revitalization projects (municipalities use 90% of bonds for the project and get 30% of local allocation tax for the repayment) only in the three areas of medical care and welfare, industrial promotion, and public transportation.

II-3-2.   Actual Condition of the Self-support settlement region framework

In this section, we clarify the actual condition of the self-support settlement regions and the status of efforts in the policy field.

(1) Actual Conditions of the Self-support settlement region framework

According to the Ministry of Internal Affairs and Communications, regarding the "Status

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[16] To ensure the necessary livelihood functions for population settlement, the regulations will stipulate coordination items for at least one or more of the three policy areas related to strengthening livelihood functions, ties and networks, and the management capacity of the area.

[17] The second phase of the "Comprehensive Strategy for Creation of New Towns, People, and Work" (2020 revised version) called for the "formation of attractive regional blocs through interregional cooperation" and sets the number of the formation of "Core regional urban areas" and "Self-support settlement regions" as KPIs. The plan also aims to increase the number of self-support settlement regions in which agreements are concluded from 128 as of October 2020 to 140 by the end of FY2024 and stipulates that the government will provide active support through local financial measures, provision of information on advanced initiatives in each region, and consideration in the adoption of subsidized projects.

of Efforts to Establish Self-support Settlement Region Framework,"[18] Figure 2[19] shows that the number of "declared core cities" increased from 16 in FY2009 to 140 in FY2021, and the number of areas that concluded agreements or formulated a vision for formation of self-support settlement regions increased from 30 in FY2010 to 129 in FY2021 (as of April 1 of each fiscal year). In FY2021, two of the 129 areas (Ishinomaki City and Tateyama City) had only concluded agreements or formulated policies for the formation of self-support settlement regions, but 127 areas had formulated a vision for symbiosis. Moreover, the number of municipalities that concluded agreements in the 129 areas, including the core cities and surrounding municipalities, reached 542.[20] The 129 areas included 12 "border-type areas" that straddle prefectural borders,[21] 8 "multiple vision type core city areas" with multiple declared core cities, and 31 "merged one-city areas," where one area has become one city due

Figure 2. Declared core cities and the number of areas in the self-support settlement region framework
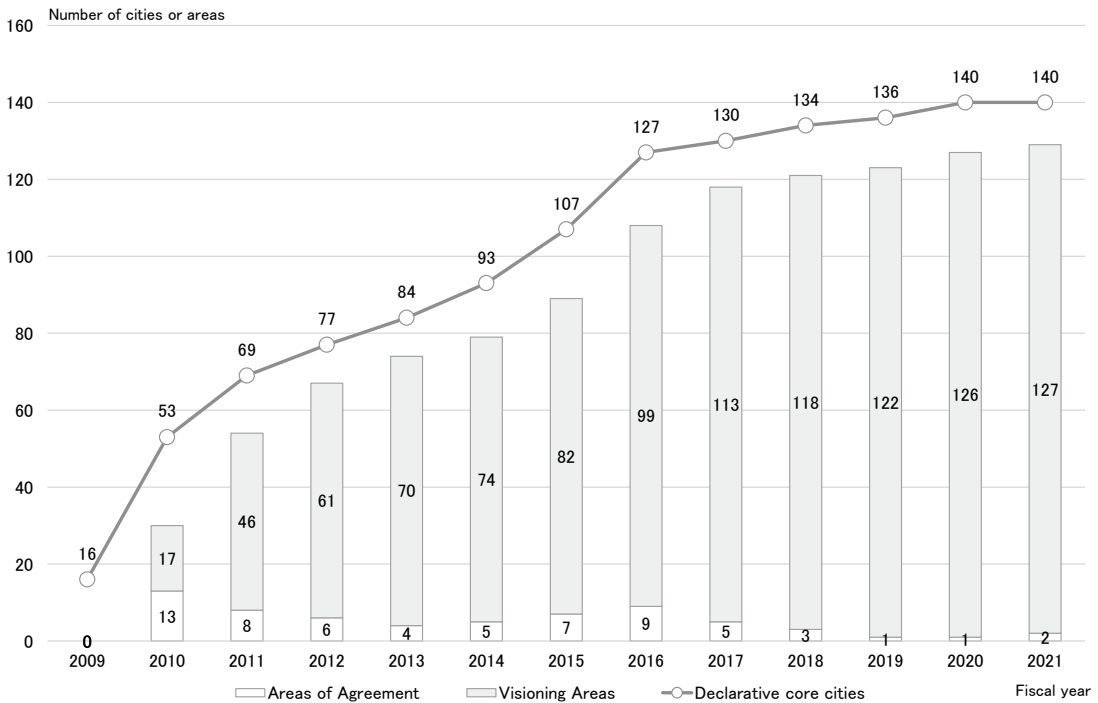
Note: Figures as of April 1.
Source: The Ministry of Internal Affairs and Communications' "Status of Efforts to Establish Self-support Settlement Region Framework"

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[18] The Ministry of Internal Affairs and Communications' "Status of Efforts to Establish Self-support Settlement Region Framework." (https://www.soumu.go.jp/main_content/000758777.pdf: accessed April 20, 2022)
[19] The number of areas that have already concluded an agreement to form a self-support settlement region or have formulated a vision for forming a self-support settlement region.
[20] Self-Support Settlement Region Framework Information (https://www.teijyu-jiritsu.jp/index.html: accessed April 20, 2022).
[21] In some cases, such as the Iga—Yamashiro—Minami/Higashi—Daiwa Self-support Settlement Region, the core city is Iga City in Mie Prefecture, and the surrounding municipalities are Kasaki Town, Minamiyamashiro Village in Kyoto Prefecture, and Yamazoe Village in Nara Prefecture, which straddle three prefectures.

to municipal mergers, thus creating a diverse range of areas.

On the other hand, according to the Advisory panel on the promotion of self-support settlement region framework,[22] there were 138 declared core cities as of November 1, 2019, while there were 69 undeclared core cities and 194 surrounding municipalities (municipalities in the 10% commuting area) in the assumed area of the undeclared core cities. In this paper, they are considered as candidate core cities in "small sample," and candidate surrounding municipalities in "small sample." However, the number of undeclared core cities is 116, including the 69 cities mentioned above plus the number of cities that have already declared themselves as a core regional city (22 cities), designated or core cities (13 cities), and cities that are already working as surrounding cities in a "self-support settlement region" or "core regional urban area" (12 cities). In this paper, we define 118 cities, including two cities that have declared but not yet formed their own areas, as candidate core cities in the "large sample," and surrounding municipalities in their assumed areas as candidate surrounding cities in the "large sample."

To clarify the actual status of the number of municipalities and population size, etc., of the self-support settlement regions, the following presents the status of the 121 areas and 129 declared core cities, which are listed in the "Status of Efforts to Establish Self-support Settlement Region Framework."[23] Out of the 121 areas, the number of "prefectural border-type" areas is 11 (excluding Tottori City), 8 "compound eye type core city areas," and 30 "merged one-city areas" (excluding Shimonoseki City). The number of declared core cities and areas in Figure 3 differs from those in Figure 2 due to the difference in the time of tabulation.

Table 4 presents the number of municipalities, population size, area, and the respective percentages of the total number of municipalities in Japan, classified into declared core cities and surrounding municipalities, candidate core cities in the large sample, candidate surrounding municipalities in the large sample, and other municipalities. The number in Table 4 are compiled as of FY2019. Other municipalities include municipalities in the three major metropolitan areas and municipalities in regional areas that do not meet the requirements for a self-support settlement region framework.

Out of the 1,718 municipalities, about 30% or less (of these, 7.5% (129 cities) are declared core cities, and 21.8% (374 municipalities) are surrounding municipalities) are the municipalities that form the self-support settlement region framework, and about 45% are other municipalities that do not meet the requirements for a self-support settlement region in the three major metropolitan and regional areas. The percentage of candidate cities is about 34% (of which 9.0% (154 cities) are candidates for the core city, and 25.0% (429 municipal-

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[22] The Advisory panel on the promotion of self-support settlement region frameworks' (16th meeting) material, "Progress of Self-support Settlement Region Framework and Measures Taken by the Ministry of Internal Affairs and Communications" (November 27, 2019).
  (https://www.soumu.go.jp/menu_sosiki/kenkyu/02gyosei08_04000195.html: accessed April 20, 2022)
[23] Precisely, 122 areas (as of April 1, 2021) are listed, but 121 areas are covered because Yamagata City, which had formed a self-support settlement region by FY2019, was added, and Numata City and Tateyama City, which signed an agreement in FY2020, were excluded. Nasushiobara City is the core city in two of the zones.

Table 4. Status of self-support settlement regions and candidates for self-support settlement regions

		Municipalities		Population		Area	
Self-support settlement region framework	Declarative core cities	129	(7.5)	11,808	(10.0)	63,240	(17.0)
	Surrounding municipalities	374	(21.8)	5,068	(4.3)	83,472	(22.4)
The candidates of Self-support settlement region framework	The candidates for core cities	154	(9.0)	29,429	(25.0)	70,733	(19.0)
	The candidates for surrounding municipalities	429	(25.0)	14,361	(12.2)	66,664	(17.9)
Others		778	(45.3)	62,521	(53.2)	130,782	(35.2)
Total of all municipalities		1,718	(100)	117,567	(100)	371,850	(100)

Note 1: The population is in thousands, and the area is in km^2. Figures in parentheses are percentages, covering the area as of FY2019.
Note 2: Candidate municipalities for a self-support settlement region include not only those that belong to a self-support settlement region but also those that belong to an undeclared core city region.

ities) are candidates for surrounding municipalities).

In terms of population size, the ratio of municipalities that formed a self-support settlement region is about 15% (of which 10.0% (11.81 million) are declared core cities, and 4.3% (5.07 million) are surrounding municipalities), and the ratio of other municipalities that do not meet the requirements for a self-support settlement region is about 53% of the total population in the three metropolitan and regional areas. Further, the ratio of candidate municipalities population is about 37% (of which 25.0% (29.43 million people) in the core city and 12.2% (14.36 million people) in the surrounding municipalities).

In terms of area, the ratio of municipalities that form a self-support settlement region is about 40% (of which 17.0% (63,240 km^2) are declared core cities and 22.4% (83,472 km^2) are surrounding municipalities); and 37% are candidates for a self-support settlement region (of which 19.0% (70,733 km^2) are core cities, and 17.9% (66,664 km^2) are surrounding municipalities); the ratio of municipalities that do not meet the requirements for a self-support settlement region in the three metropolitan and regional areas is about 35%.

Table 5 and Figure 3 present the distribution of the self-support settlement regions by prefecture and geography, respectively. Table 5 indicates that, to some extent, the number of declared core cities is proportional to the number of municipalities in each prefecture, with Hokkaido having the largest number (16 cities), accounting for 12.4%, followed by Akita, Tochigi, Niigata, Nagano, Hyogo, and Kumamoto prefectures (all accounting for 4.7%). Surrounding municipalities are also distributed in proportion to the number of municipalities in Hokkaido, Nagano, Aomori, and Yamagata prefectures. However, the number of cities that are candidates for declaring a core city is high in Niigata, Ibaraki, Fukushima, and Shizuoka prefectures (more than 4% and more than 7 cities in each of them), and the number of candidates for surrounding municipalities is high in Fukuoka, Fukushima, Nagano, and Gifu prefectures (more than 5% and more than 22 cities and towns in each of them), indicating that there are some undeclared cities even outside the three nonmetropolitan areas. In the three Hokuriku prefectures and Wakayama Prefecture, there are two or three candidate core cities, but none of them has been declared yet.

Table 5. Distribution of self-support settlement region framework and the candidates for self-support settlement region framework by prefecture

	Declarative core cities		Surrounding municipalities		the candidates for core cities		the candidates for surrounding municipalities		Others		Total	
Hokkaido	16	12.4	102	27.3	5	3.2	15	3.5	54	6.9	179	10.4
Aomori	5	3.9	23	6.1	3	1.9	11	2.6	9	1.2	40	2.3
Iwate	5	3.9	5	1.3	6	3.9	11	2.6	14	1.8	33	1.9
Miyagi	2	1.6	6	1.6	3	1.9	11	2.6	14	1.8	35	2.0
Akita	6	4.7	7	1.9	5	3.2	7	1.6	8	1.0	25	1.5
Yamagata	5	3.9	21	5.6	3	1.9	17	4.0	5	0.6	35	2.0
Fukushima	3	2.3	11	2.9	7	4.5	26	6.1	21	2.7	59	3.4
Ibaraki	1	0.8	10	2.7	8	5.2	20	4.7	13	1.7	44	2.6
Tochigi	6	4.7	4	1.1	5	3.2	13	3.0	2	0.3	25	1.5
Gunma	1	0.8	1	0.3	5	3.2	20	4.7	9	1.2	35	2.0
Saitama	2	1.6	7	1.9	0	0.0	0	0.0	54	6.9	63	3.7
Chiba	1	0.8	0	0.0	1	0.6	3	0.7	49	6.3	54	3.1
Tokyo	0	0.0	0	0.0	0	0.0	0	0.0	39	5.0	39	2.3
Kanagawa	0	0.0	0	0.0	0	0.0	0	0.0	33	4.2	33	1.9
Niigata	6	4.7	10	2.7	9	5.8	15	3.5	1	0.1	30	1.7
Toyama	0	0.0	0	0.0	2	1.3	8	1.9	5	0.6	15	0.9
Ishikawa	0	0.0	0	0.0	3	1.9	9	2.1	7	0.9	19	1.1
Fukui	0	0.0	0	0.0	3	1.9	13	3.0	1	0.1	17	1.0
Yamanashi	1	0.8	0	0.0	3	1.9	11	2.6	13	1.7	27	1.6
Nagano	6	4.7	35	9.4	5	3.2	24	5.6	15	1.9	77	4.5
Gifu	1	0.8	7	1.9	5	3.2	22	5.1	8	1.0	42	2.4
Shizuoka	1	0.8	0	0.0	7	4.5	13	3.0	14	1.8	35	2.0
Aichi	2	1.6	3	0.8	4	2.6	5	1.2	41	5.3	54	3.1
Mie	4	3.1	10	2.7	4	2.6	7	1.6	6	0.8	29	1.7
Shiga	3	2.3	4	1.1	2	1.3	2	0.5	9	1.2	19	1.1
Kyoto	0	0.0	2	0.5	2	1.3	3	0.7	21	2.7	26	1.5
Osaka	0	0.0	0	0.0	0	0.0	1	0.2	42	5.4	43	2.5
Hyogo	6	4.7	10	2.7	5	3.2	7	1.6	18	2.3	41	2.4
Nara	1	0.8	4	1.1	0	0.0	0	0.0	34	4.4	39	2.3
Wakayama	0	0.0	0	0.0	3	1.9	9	2.1	18	2.3	30	1.7
Tottori	2	1.6	5	1.3	0	0.0	0	0.0	12	1.5	19	1.1
Shimane	4	3.1	3	0.8	0	0.0	0	0.0	12	1.5	19	1.1
Okayama	2	1.6	5	1.3	2	1.3	15	3.5	10	1.3	27	1.6
Hiroshima	2	1.6	0	0.0	5	3.2	10	2.3	8	1.0	23	1.3
Yamaguchi	3	2.3	1	0.3	3	1.9	2	0.5	10	1.3	19	1.1
Tokushima	2	1.6	15	4.0	0	0.0	0	0.0	7	0.9	24	1.4
Kagawa	1	0.8	4	1.1	2	1.3	3	0.7	8	1.0	17	1.0
Ehime	2	1.6	3	0.8	6	3.9	9	2.1	4	0.5	20	1.2
Kochi	2	1.6	4	1.1	1	0.6	2	0.5	25	3.2	34	2.0
Fukuoka	4	3.1	15	4.0	5	3.2	33	7.7	14	1.8	60	3.5
Saga	2	1.6	1	0.3	2	1.3	10	2.3	5	0.6	20	1.2
Nagasaki	1	0.8	0	0.0	3	1.9	6	1.4	11	1.4	21	1.2
Kumamoto	6	4.7	16	4.3	4	2.6	11	2.6	13	1.7	45	2.6
Ooita	2	1.6	2	0.5	2	1.3	4	0.9	9	1.2	18	1.0
Miyazaki	5	3.9	10	2.7	2	1.3	4	0.9	6	0.8	26	1.5
Kagoshima	4	3.1	8	2.1	5	3.2	5	1.2	23	3.0	43	2.5
Okinawa	1	0.8	0	0.0	4	2.6	12	2.8	24	3.1	41	2.4
Total	129	100.0	374	100.0	154	100.0	429	100.0	778	100.0	1718	100.0

Note 1: In each category, the first column presents the number of municipalities, and the second presents the percentage by prefecture.

Note 2: We regard municipalities that not only belong to the self-support settlement region but also belong to the region of undeclared core cities as the candidate municipalities.

Figure 3. Nationwide distribution of the self-support settlement region framework and candidates
(The self-support settlement region framework)

(Candidates for the self-support settlement region framework)

Note 1: Black: core cities and candidate core cities; gray: surrounding municipalities and candidate surrounding municipalities; white: not applicable (three major metropolitan areas and municipalities that do not meet the requirements).
Note 2: As of FY2019.
Source: Prepared by the author using ArcGIS, and it is based on the data on self-support settlement regions developed in this paper.

In summary, in FY2019, the self-support settlement regions occupied about 40% of the national land area but accounted for less than 15% of the total resident population. In terms of geographical distribution, as Figure 3 depicts, the self-support settlement regions are distributed in Hokkaido, the Sea of Japan side of the Tohoku region, San-in region, and Southern Kyushu. The total area of the self-support settlement regions, including the undeclared candidate areas, is about 65% of the national land area, and the resident population is about 47% of the total population.

Tables 6 to 8 present the actual status of the self-support settlement regions from FY2009 to FY2019 in terms of the number of municipalities, population size, and area distribution. First, the number of municipalities ranges from 1 to 19, and Table 6 indicates that the average number of municipalities is 4 to 5. The mode is one city, which is due to the existence of merged one-city areas. Next, looking at the population size of the areas, there are areas with a population ranging from about 30,000 to 719,000, and the average population in FY2019 is 142,000, as presented in Table 7. The mode is between 100,000 and 200,000, and

Table 6. Distribution of the number of municipalities that make up the self-support settlement region framework

Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	3	11	16	18	18	19	25	27	28	28	30
2	3	7	7	8	9	10	10	10	11	14	15
3	0	2	2	5	5	6	10	11	13	14	14
4	4	6	5	5	5	9	13	17	17	16	16
5	4	6	7	9	10	12	13	13	13	14	15
6	1	4	4	5	5	5	6	7	7	7	7
7	1	1	2	2	2	2	2	2	2	2	2
8	4	4	5	5	7	6	7	8	8	9	9
9	0	1	1	1	1	1	2	3	3	3	3
10	0	1	1	2	2	4	4	4	4	4	4
11 —	1	2	5	5	6	6	6	6	6	6	6
Total	21	45	55	65	70	80	98	108	112	117	121
Average	5.0	4.3	4.7	4.6	4.8	4.8	4.5	4.5	4.4	4.4	4.3

Note: Figures in the table represent the number of areas; however, the average value is the average number of municipalities in the area.

Table 7. Distribution of self-support settlement region framework by population size

Pop. \ Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
−50000	0	2	3	4	5	6	8	10	10	12	14
50000−100000	5	12	17	22	22	24	32	33	36	39	39
100000−200000	10	17	17	20	21	27	34	39	40	39	42
200000−300000	4	9	9	10	12	14	15	15	15	17	15
300000−400000	1	2	6	6	6	5	6	7	7	6	6
400000−500000	1	3	3	3	4	4	3	3	3	3	3
500000−750000	0	0	0	0	0	0	0	1	1	1	2
Total	21	45	55	65	70	80	98	108	112	117	121
Average	168.1	164.6	168.7	161.5	166.8	160.9	149.4	152.1	149.0	145.1	141.6

Note: Figures in the table represent the number of areas; however, the average value is the average population size of the area (in thousands).

Table 8. Distribution of the self-support settlement region framework by area

Fiscal Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
−500km²	6	16	16	20	20	23	27	31	32	33	34
−1000km²	5	11	16	17	17	19	23	26	26	27	29
−2500km²	8	14	17	22	26	31	41	44	47	50	50
−5000km²	1	3	3	3	3	3	3	3	3	3	4
−7500km²	1	1	2	2	3	3	3	3	3	3	3
−10000km²	0	0	0	0	0	0	0	0	0	0	0
10000km²−	0	0	1	1	1	1	1	1	1	1	1
Total	21	45	55	65	70	80	98	108	112	117	121
Average	1,280	1,108	1,383	1,332	1,431	1,376	1,324	1,268	1,258	1,255	1,255

Note: Figures in the table represent the number of areas; however, the average value is the average area (unit: km^2).

81 areas (about 67%) were concentrated in the range of 50,000 to 200,000 in FY2019. Furthermore, regarding the status of the size of the areas, there are areas ranging from 86 km^2 to 10,828 km^2, with an average of 1,255 km^2 in FY2019 (Table 8), and 113 areas are concentrated in the area ranging up to 2,500 km^2.

(2) Status of Efforts in Policy Areas

Table 9 indicates that more than 100 of the 129 regions are working on medical care, welfare, education, and industrial promotion ((1) strengthening of livelihood functions by sharing roles between municipalities), local public transportation, exchange migration ((2) strengthening of ties and networks between municipalities), joint training, and personnel exchange ((3) strengthening of regional management capabilities). However, cooperation in addressing wide-area environmental issues and in the development of wide-area ICT and transportation infrastructure is sluggish.

The formation of these areas was based on the voluntary decisions of the constituent municipalities, and the agreements between the municipalities were reached based on the

Table 9. Initiatives by policy area and number of areas in 129 self-support settlement region frameworks

(1) Strengthening of livelihood functions by sharing roles between municipalities		(2) Strengthening of ties and networks between municipalities		(3) Strengthening of regional management capabilities	
Medical care	125 regions	Local public transport	125 regions	Joint training and personnel exchange	112 regions
Welfare	112 regions	ICT infrastructure development	47 regions	Invitation of outside experts	44 regions
Education	108 regions	Transportation infrastructure development	84 regions		
Industrial promotion	124 regions	Local production for local consumption	52 regions		
Environment	65 regions	Exchange migration	107 regions		

Source: The Ministry of Internal Affairs and Communications, "Status of Efforts to Establish Self-support Settlement Region Framework" (as of April 1, 2021).

voluntary division of roles between them. Fukuda (2021) pointed out that although some cases have achieved a certain level of success, they are limited to services that are relatively easy to coordinate or to the continuation of existing cooperation, and only a few of these efforts lead to the compacting, consolidation, and networking of urban functions, such as reorganization of public facilities and wide-area urban development, which were originally intended by the formation of these self-support settlement regions.[24]

　　As described above, the concept of "self-support settlement regions" has both quantitative and qualitative challenges. Quantitatively, more than 50% of the core cities and surrounding municipalities that are targeted for forming a self-support settlement region have not yet been formed, although it has been more than 10 years since the establishment of the framework. Qualitatively, only a few efforts have been made to compact, consolidate, and network urban functions as originally intended.[25]

　　To understand the factors behind the lack of progress in wide-area cooperation both quantitatively and qualitatively, the Ministry of Internal Affairs and Communications conducted a hearing survey of municipalities that are candidates of the self-support settlement regions and core regional urban areas but have not yet formed them[26], which is a useful reference. According to the survey, the following reasons were given to indicate that there is no need to form new wide-area cooperation: (1) A council for wide-area cooperation has already been established. (2) The existing framework of partial-affairs-associations and coordination by individual measures is sufficient. (3) There is no core city, because the population and economic scale of the surrounding municipalities are the same or larger. (4) The wide-area mergers of municipalities have resulted in a certain concentration of population and urban functions.

II-3-3.　Outcomes of the Self-support settlement region framework

　　As mentioned above, even today, only a limited number of surveys and studies have specifically verified the results of the concept of the self-support settlement region.

　　Based on the results of the study conducted by the Advisory panel on the promotion of self-support settlement region framework and the Ministry of Internal Affairs and Communications, the following three points of outcomes of the self-support settlement region framework can be summarized.

　　First, the following are the results of the "Status and Effects of Efforts to Promote the

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[24] Similar points regarding the core regional urban areas have been made by Nakayama (2016) and others. Nakayama (2016) also pointed out that there is a difference in the level of importance of the measures of the area between the core cities and the municipalities in a region. Hiraoka (2019) pointed out that the expansion of projects undertaken by the core regional cities will lead to a decline in the autonomy of citizens, and the concentration of urban functions in the core regional cities will lead to a population shift from the neighboring municipalities, resulting in a decline in the communities in the neighboring municipalities.

[25] Seta (2020) pointed out that, in the phase of declining population, the mechanism of the policy for a self-support settlement region, which centralizes functions in the core city to maintain urban services, lacks rationality, and each municipality does not have the regulatory and guidance means to guide land use and realize compact and concentrated urban areas due to the violation of property rights, and therefore, the report pointed out that wide-area cooperation does not function.

[26] Report for the 27th Expert Subcommittee Meeting of the 32nd Local Government System Research Council, "Current Status and Issues of Wide-Area Cooperation."

　(https://www.soumu.go.jp/main_content/000658214.pdf: accessed April 20, 2022)

Concept of Self-support Settlement Regions"[27] conducted by the Regional Independence Support Division of the Local Administration Bureau of the Ministry of Internal Affairs and Communications, targeting core cities in 114 areas that have already formulated a symbiotic vision for self-support settlement regions as of April 1, 2019. Most respondents (78.1%) believe that the reason for promoting the concept of a self-support settlement region for permanent residences was "to strengthen living functions," followed by "to stop population outflow" (65.8%). Next, regarding the "connection between the municipalities that make up the self-support settlement region and the municipality before the project," the most common responses were "integration of medical services" (72.8%), "integration of commuting areas" (68.4%), and "integration of business areas" (60.5%). Furthermore, "regular exchange of opinions between municipal officials and deputy mayors" (60.5%), "regular exchange of opinions between mayors of municipalities" (49.1%), and "use of new venues such as the council of self-support settlement regions and the meeting of section chiefs" (43.9%) were frequently cited as methods of communication and coordination with surrounding municipalities.

The results of the self-support settlement region framework revealed that a total of 104 organizations (91.2%) responded that "the promotion of the self-support settlement region framework has been very effective" or "somewhat effective," while no organization responded that "it has not been very effective." In percentages, 85.1%, 66.7%, 64.0%, 57.0%, and 50.9% of "strengthening livelihood functions," "strengthening ties with related municipalities," "strengthening human resource development within the area," "developing wide-area measures," and "improving administrative efficiency" were "effective," respectively. However, only 10.5% of the respondents answered that "the outflow of the population has been halted."[28]

Second, by a notice dated September 23, 2016, the Ministry of Internal Affairs and Communications requested each region to set KPIs to measure projects in FY2016 based on its characteristics. For this reason, the Ministry of Internal Affairs and Communications has introduced an evaluation process (PDCA cycle) for the formulation of the symbiosis vision for self-support settlement regions, such as project implementation, verification of project effects, project improvement, and updating of the symbiosis vision to a self-support settlement region framework. According to the Ministry of Internal Affairs and Communications' "Status of Establishment of Key Performance Indicators (KPIs) in Self-support Settlement Regions,"[29] all of the 114 areas that have established a vision of symbiosis for self-support settlement regions (excluding areas that have already been transferred to a core regional urban

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[27] Material from the 16th meeting of the Advisory panel on the promotion of self-support settlement region framework (November 27, 2019). The Regional Independence Support Division of the Regional Power Creation Group of the Ministry of Internal Affairs and Communications (2019) "Survey on the Status of Efforts and Effectiveness of Efforts to Promote the Idea of Self-support Settlement Region Framework".

[28] However, only 24.6% of the respondents answered that there was "no effect" on population outflow, so it can be expected that the formation of the self-support settlement region framework had some inhibitory effect. Thus, if the population outflow accelerates in most of the candidate municipalities, and if the population outflow weakens in the self-support settlement region, it may be possible to confirm the results through quantitative analysis.

area) as of the end of February 2020 have established KPIs based on the characteristics of each area. However, the document only introduced case studies and did not report an exhaustive survey on the status of the achievement of KPIs.[30]

Third, the documents of the Advisory panel on the promotion of self-support settlement region framework (16th Meeting) presented the results of a survey on the net migration in the self-support settlement region.[31] The net migration of the population is an indicator of the outcome of the self-support settlement region. According to this document, for the 126 regions that have concluded agreements on self-support settlement regions as of November 12, 2019, the net migration data (the Basic Resident Registration) for four years prior to the start of the promotion of the self-support settlement region framework (April 1, 2005, to March 31, 2009) and the most recent four years (January 1, 2015, to December 31, 2018) was tabulated. The results of the survey of the net migration of the population indicate that 23 (18.3%) of the regions had a net migration increase; 85 (67.5%) had a decline in the degree of decrease of a net migration; and 18 (14.3%) had an increase in the degree of decrease of a net migration (see Table 10). Similarly, assuming the formation of a self-support settlement region with surrounding municipalities within 10% commuting distance, for the 69 undeclared core cities, the results of the net migration data (the Basic Resident Registration) for four years before the start of the promotion of the concept of a self-support settlement region and the most recent four years revealed that 20 (29.0%) areas had a net migration increase; 39 (56.5%) areas had a decline in the degree of decrease of a net migration; and 10 (14.5%) areas had an increase in the degree of decrease of a net migration.

Table 10. Net migration of the population in self-support settlement region frameworks

		Self-support settlement region			Undeclared region (assumed)		
		Number of regions	Ratio	Rate of change	Number of regions	Ratio	Rate of change
Increase of net migration		23	18.3%	0.8%	20	29.0%	1.1%
Decrease of net migration	Decline in the degree of decrease	85	67.5%	−1.4%	39	56.5%	0.9%
	Increase in the degree of decrease	18	14.3%	−1.1%	10	14.5%	1.2%
Total amount		126	100.0%	−0.8%	69	100.0%	0.1%

Source: Reprinted from the 16th meeting of the Advisory panel on the promotion of self-support settlement region framework

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[29] The Ministry of Internal Affairs and Communications' "Status of Establishment of Key Performance Indicators (KPIs) in Self-support settlement regions".
   (https://www.soumu.go.jp/main_content/000542107.pdf: accessed April 20, 2022)
[30] However, looking at the content of business KPIs in the case studies of initiatives by field listed in the Ministry of Internal Affairs and Communications' "Status of Efforts to Establish Self-support Settlement Region Framework," there are cases where output and outcome indicators are not distinguished and cases where the formulation of the plan itself is set as a KPI, indicating issues in setting KPIs.
   (https://www.soumu.go.jp/main_content/000758777.pdf: accessed April 20, 2022)
[31] The Advisory panel on the promotion of self-support settlement region frameworks' (16th meeting) material, "Progress of Self-support Settlement Region Framework and Measures Taken by the Ministry of Internal Affairs and Communications" (November 27, 2019).
   (https://www.soumu.go.jp/menu_sosiki/kenkyu/02gyosei08_04000195.html: accessed April 20, 2022)

The impact of the formation of a self-support settlement region on population outflow cannot be confirmed as the undeclared region has a higher proportion of regions with net migration increase than the self-support settlement region, but the self-support settlement region has a higher proportion of regions with a decline in the degree of decrease of a net migration than the undeclared region. However, as discussed below, if the choice of self-support settlement regions is influenced by demographics, it is not appropriate to evaluate their outcomes through a simple comparison of demographics between groups from the perspective of selection bias.[32]

Next, Morikawa (2014) studied self-support settlement regions, pointing out that, regarding the requirements for the formation of a core city, many small cities vanish out of the region because of the existence of many areas that do not meet the requirements for the formation of a self-support settlement region in terms of population size and ratio of daytime and nighttime population. On the other hand, if the requirements are relaxed, the city faces the problem of being unable to fulfill its urban functions. He also stated that the regional disparity (in outcomes) will widen as the areas are distinguished into those that have formed a self-support settlement region, those that have not yet formed a zone, and those that are outside the region. However, the report has yet to quantitatively analyze the differences in outcomes between the areas of self-support settlement region and the candidate areas.[33]

III.   Empirical Analysis

III-1.   *Hypothesis*

As we have seen in the preceding sections, intergovernmental cooperation has two effects. The first effect is the efficiency of resource allocation through internalization of spillover effects (external economic effects) of public service benefits, which in turn increases the number of residents or halts the population decline in municipalities through resource allocation efficiency. In fact, since the Japanese central government positions the concept of the "self-support settlement region framework" as a component of regional development, one of its policy objectives is to control the outflow of population from rural areas. The second effect is the economies of scale, whereby the municipality could decrease the average cost of local public services by collaborating with other municipalities and increasing the population to which it provides public services. To examine the policy effects of the self-support settlement region framework, this study tests the following two hypotheses:[34]
Hypothesis 1: Municipalities that form a self-support settlement region framework retain a

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[32] As the formation of a self-support settlement region is based on the voluntary decision of the constituent municipalities, the lower the rate of net migration decrease at the start, the less need there is to form the region, and the more the net migration actually observed may be. Therefore, it is possible to confirm the relationship that the rate of net migration decrease is relatively low in regions that do not form a region.

[33] Although Yokoyama (2017) and Yokoyama (2019) dealt with the outcomes of the core regional urban area, their analysis does not include the unformed municipalities, so they could not obtain causal effects on the outcomes of the formation of the areas.

larger population than the candidates for a self-support settlement region framework.
Hypothesis 2: Municipalities that establish a self-support settlement region framework decrease the total expenditure per capita more than the candidates for a self-support settlement region framework.

One municipality may attempt to form a self-support settlement region framework with other municipalities to internalize public services' spillover (positive externality) and improve overall living functions. As a result, because a self-support settlement region framework allows municipalities to collaborate to improve public services and livelihood functions in the entire area, it may reduce population outflow compared to municipalities that have not yet formed a self-support settlement region framework. Therefore, if the self-support settlement region framework functions in accordance with their original policy objectives, then Hypothesis 1 is supported.

Furthermore, suppose municipalities collaborate with other municipalities to provide public services. In that case, they can easily demonstrate economies of scale. Thus, as shown by Ferraresi et al. (2018), total expenditure per capita will be lower than in the candidate municipalities of a self-support settlement region framework, implying the validity of Hypothesis 2. However, if municipalities in a self-support settlement region framework limit the ability of a few areas to cooperate with others, they will not be able to decrease the costs of local public services.

After testing these hypotheses, the central government should promote wide-area cooperation further if it contributes to reducing population outflow and decreasing expenditure per capita.

Figures 4-6 show the changes in population change rate (average value), net migration rate (average value), and real total expenditure per capita (average value)[35] for the four groups: (1) the core cities in the self-support settlement region framework, (2) the surrounding municipalities in the self-support settlement region framework, (3) the candidates for the core cities, and (4) the candidates for surrounding municipalities. We note that the calculation period of the rates of population and net migration by municipality published in the "Counts of population, vital events and households derived from Basic Resident Registration" of the Ministry of Internal Affairs and Communications has been changed from fiscal year (until March 31, the end of the fiscal year until 2012) to one year (until December 31, 2013, and thereafter). Therefore, in Figures 4, and 5, the population change, and net migration rates for FY2012 are treated as missing values and are not shown.

Figure 4 shows that the rate of population change in the core cities and surrounding municipalities that formed a self-support settlement region framework is lower than in the candidate for a self-support settlement region framework. However, all groups show a similar

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[34] As mentioned above, the Regional Independence Support Division of the Local Administration Bureau of the Ministry of Internal Affairs and Communications (2019) conducted a questionnaire survey of 114 core cities and found that 10.5% of the respondents answered that the self-support settlement region was effective in "halting population outflow" and 50.9% answered that it was effective in "improving administrative and fiscal efficiency".

[35] It is valued at 2010 prices substantiated by the government spending deflator.

Figure 4. The average rate of population changes in the self-support settlement region framework and the candidates
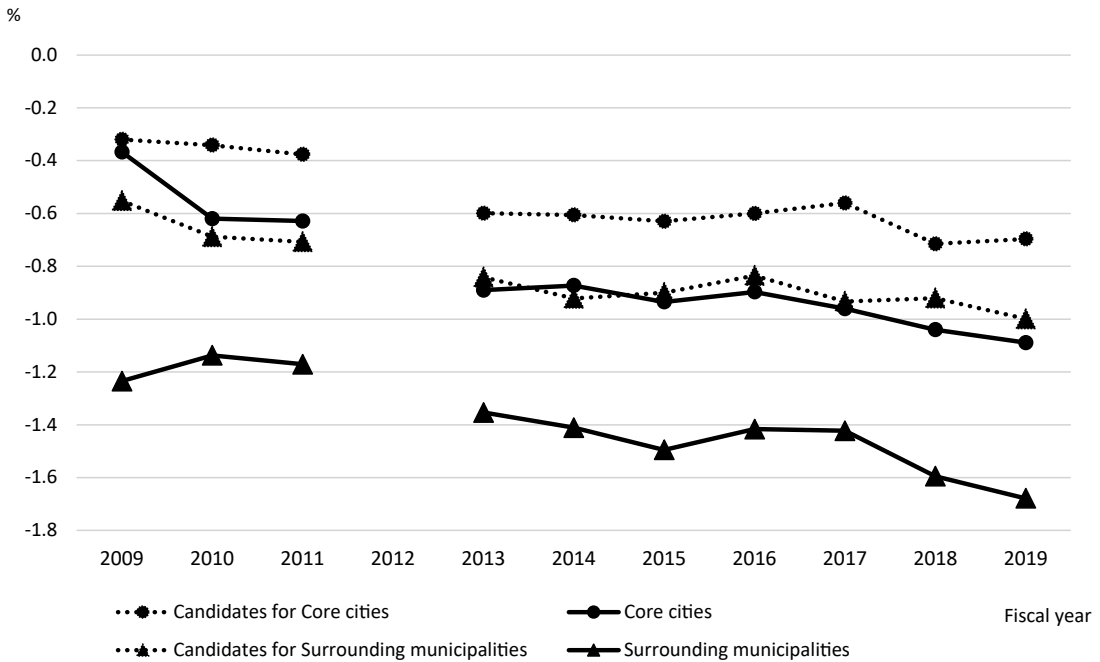
Note 1: The data excludes Yubari City, specific municipalities affected by the disaster, and merged local munici-palities during the analysis period.
Note 2: We treated the data for 2012 as missing values because of the different survey period.
Source: The Ministry of Internal Affairs and Communications, "Counts of population, vital events and house-holds derived from Basic Resident Registration"

downward trend in the rate of population change from FY2009 to FY2019. Similarly, Figure 5 shows that the rate of net migration in the core cities and surrounding municipalities that formed a self-support settlement region framework is lower than that of the candidates for a self-support settlement region framework, but the rate of net migration has remained nearly unchanged from FY2009 to FY2019. Figure 6 shows that the real total expenditure per capita (average value) is increasing across all groups. However, although the real total expenditure per capita of surrounding municipalities that formed a self-support settlement region framework increased by 215,000 yen from 738,000 yen in FY2009 to 953,000 yen in FY2019, the candidate's real total expenditure per capita increased by only 109,000 yen. This suggests that the increase in real total expenditure per capita in surrounding municipalities of a self-support settlement region framework is remarkable. The real total expenditure per capita in the core cities that formed a self-support settlement region framework increased more than that of the candidate core cities. In FY2009, the real total expenditure per capita was 447,000 yen in the core cities of the self-support settlement region framework and 426,000 yen in the candidate for core cities. In FY2009, the difference was 21,000 yen. In FY2019, real total expenditure per capita in the self-support settlement region framework core cities was 552,000 yen and 486,000 yen in the candidate for the self-support settlement

Figure 5. Net migration rate (average) in self-support settlement region framework and the candidates
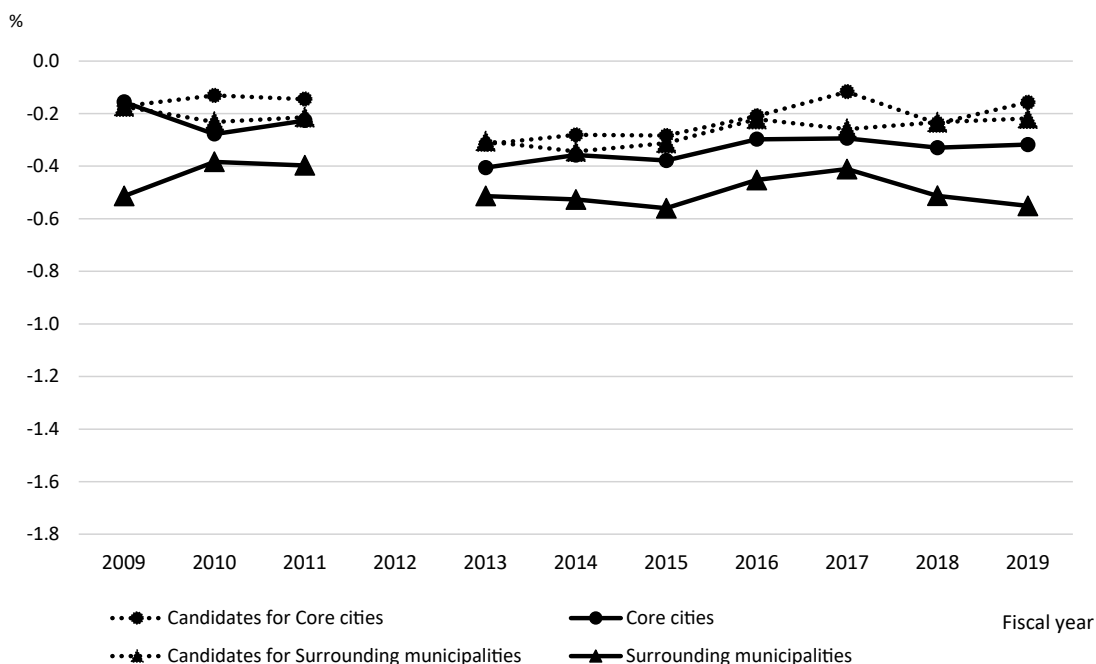

Note 1: The data excludes Yubari City, specific municipalities affected by the disaster, and merged local municipalities during the analysis period.
Note 2: We treated the data for 2012 as missing values because of the different survey period.
Source: The Ministry of Internal Affairs and Communications, "Counts of population, vital events and households derived from Basic Resident Registration"

region framework for core cities. The difference in FY2019 was 66,000 yen, which was then increased from FY2009. Based on these demographic and real total expenditure per capita trends, the municipalities that comprised the self-support settlement region framework may not have achieved the aforementioned results, as population has declined, and real total expenditure per capita has increased in the municipalities of the self-support settlement region framework. However, due to their declining population and fiscal situation, the municipalities of the self-support settlement region framework may collaborate with other municipalities. By collaborating with other municipalities, they may also avoid hastening the population decline and increasing real total expenditure per capita above the current level. Therefore, because our simple comparison did not account for the factors that led each municipality to form a self-support settlement region framework, we cannot determine whether the self-support settlement region framework had a policy effect. In the next and subsequent sections, we will examine the causal effects of the self-support settlement region framework on population dynamics and average costs.

Figure 6. Average real total expenditure per capita in the self-support settlement region framework and the candidates

thousand yen
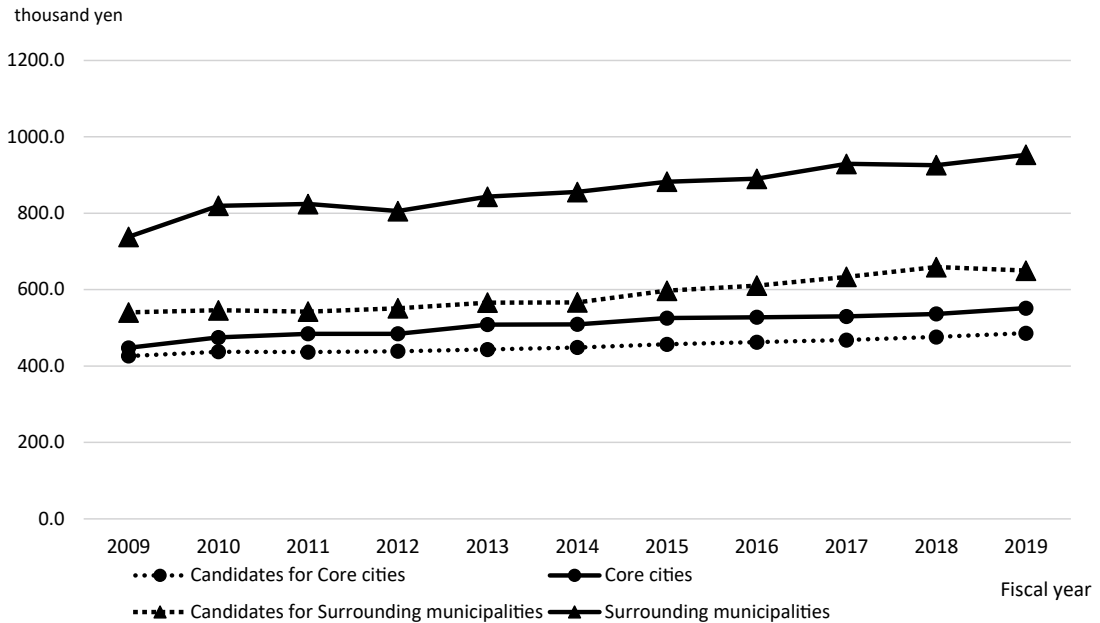

Note 1: The data excludes Yubari City, specific municipalities affected by the disaster, and merged municipalities during the analysis period.
Note 2: The expenditure was valued at 2010 prices, as supported by the government spending deflator.
Source: The Ministry of Internal Affairs and Communications, "The Survey of local public finance" (each fiscal year version); the Ministry of Internal Affairs and Communications, "Counts of population, vital events and households derived from Basic Resident Registration"

III-2. Analytical Methods

III-2-1. PSM-DID

Previous research has shown that randomizing samples using propensity score matching (PSM) avoids selection bias and allows for the estimation of causal effects, as demonstrated by Rosenbaum and Rubin (1983), Heckman et al. (1997), Abadie et al. (2004), Abadie and Imbens (2008), and Imbens (2015). Therefore, the present study calculates and validates the average treatment effect on treated (ATT) in equation (1) after matching using propensity scores.

$$\widehat{ATT} = \frac{1}{n} \sum [y_i^1 - y_i^0] \tag{1}$$

where y_i^1 is the outcome indicator for the municipalities that formed a self-support settlement region framework (treatment group), and y_i^0 denotes the outcome indicators for the municipalities that have not yet formed a self-support settlement region framework (control group).[36] However, this analysis holds the risk that we will be unable to evaluate the effect of the self-support settlement region framework because the outcome indicators are affected by differences between each municipal fixed effects that persist regardless of time. Therefore,

in addition to PSM, we employ PSM-DID, which employs difference-in-differences (DID) analysis to remove municipal fixed effects that do not change over time. Equation (2) calculates the average treatment effect in the treatment group after matching, and its significance is verified by the t-test.

$$\widehat{ATT} = \frac{1}{n} \sum [(y_{it=1}^{1} - y_{it=0}^{1}) - (y_{it=1}^{0} - y_{it=0}^{0})] \tag{2}$$

Here, t = 0 refers to the period before the formation of the self-support settlement region framework, and t = 1 refers to the period after the formation of the self-support settlement region framework.

Studies on local government finance using PSM-DID include Reynolds and Rohlin (2015), Hirota and Yunoue (2017), Ferraresi et al. (2018), and Hirota and Yunoue (2020). The following is the analytical procedure based on these studies.

We begin by specifying the formation factors of the self-support settlement region framework using the Probit model. Then, we compute the propensity score (predicted formation probability of the self-support settlement region framework). Sugahara (2014) examined the formation factors only for the core city. However, in this paper, to examine the effects of the self-support settlement region framework policy comprehensively, we estimate the formation factors for both the core cities and surrounding municipalities using the Probit model with the dummy variable as a dependent variable. Furthermore, using models (1) - (4), we analyze the formation factors of the self-support settlement region framework. Each model is made up of four parts: (1) the analysis subject is the core cities and the candidates for core cities, and the independent variables include commuting rates to and from other municipalities; (2) the analysis subject is the core cities and the candidates for core cities, and the independent variables exclude commuting rates to and from other municipalities; and (3) the analysis subject is the surrounding municipalities and the candidate for surrounding municipalities, and the independent variables included the commuting rates to and from other municipalities; (4) the analysis subjects are the surrounding municipalities and the candidate for surrounding municipalities, and the independent variables excluded the commuting rates to and from other municipalities. We summarize the detailed result of the Probit model in Appendix V-1.

We then examine the propensity score's discrimination and goodness of fit. The degree of overlap (common support) between the actual distribution and the distribution by the propensity score should be checked to confirm whether the propensity score can accurately discriminate the success or failure of forming a self-support settlement region framework. Specifically, the receiver operating characteristic (ROC) curve is drawn with the dummy for the

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[36] For evaluating the policy effects of a self-support settlement region framework, we will need to combine the data of the municipalities that comprise the area and verify them on an area-by-area basis. However, as confirmed in the previous section, while each area has the goal of growing or keeping the population, the municipalities don't have the same policy goals in each area, since the surrounding municipalities that collaborate with the core city are different in each area. In addition, while each municipality keeps its own administrative area in a self-support settlement region framework, each area has various forms of coordination. For this reason, this paper examines the policy effects of self-support settlement region frameworks based on data by municipalities. In the future, we will evaluate the policy effects of each self-support settlement region framework.

formation of a self-support settlement region framework as the state variable and the propensity score as the test variable, and the area under the curve (Area Under Curve: AUC) is obtained. This area is also called the C-statistic and is $0.5 \leq c \leq 1.0$.[37]

The Hosmer-Lemeshow test is used to assess the propensity score's goodness of fit by comparing the predicted probability from the propensity score for forming a self-support settlement region framework with the actual ratio in 10 steps in order of the propensity score. χ^2 test is performed to compare predicted and actual ratios. To judge the propensity score as a good fit, the test should not reject the null hypothesis that there is no difference between the predicted probability and the actual ratio based on the propensity score χ^2. After evaluating the propensity score's discrimination and goodness of fit, we could find matching pairs using the propensity score. Previous studies used three matching methods: Nearest Neighbor Matching, Radius Matching, and Kernel Matching. The following are the definitions of each matching method.

First, Nearest Neighbor Matching is a method of matching the closest propensity scores using equation (3).

$$min_j \| P_i - P_j \| \tag{3}$$

where P_i is the propensity score of the treatment group municipality, and P_j is the propensity score of municipalities in the control group.

Next, Radius Matching is the method that matches only those within a radius r as in equation (4).[38]

$$(P_j | \| P_i - P_j \| < r) \tag{4}$$

Furthermore, Kernel Matching is defined as weighting the distance of propensity scores as in equation (5), and the weighted means of the expected values of the outcome measures in the treatment and control groups are compared and matched.

$$W(i, j) = \frac{K\left(\frac{P_j - P_i}{h}\right)}{\sum_{j=1}^{N_0} K\left(\frac{P_j - P_i}{h}\right)} \tag{5}$$

where K is the Kernel function and h is the bandwidth parameter.[39]

We should examine the covariate balance from each matching. If the matching is successful, the characteristics of the treatment and control samples should be similar. Therefore, we use the t-test to determine whether there is a statistically significant difference in the explanatory variables used in the Probit model between the matched sample's control and treatment groups. However, because other papers have criticized the use of the t-statistic as a balance check,[40] this paper used the likelihood ratio test (LR test) to determine how much the bias has decreased before and after matching.

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[37] The closer to 1, the more desirable, but 0.7-0.8 is preferable. We cannot use the propensity score if C-statistic is too close to 1, because the propensity score can be judged to be almost identical to the actual distribution; see Okamoto (2012) for details on AUCs.

[38] Since previous studies such as Hirota and Yunoue (2017) set r = 0.01, we set r = 0.01 in this paper as well.

[39] Referring to previous studies such as Hirota and Yunoue (2017), we analyzed five cases of 0.1, 0.03, 0.05, 0.06, and 0.01 for bandwidth, and based on the results of the likelihood ratio test (LR test) and other tests, we set h = 0.06 in this paper.

Finally, we calculate the average treatment effect in the treatment group and validate its significance using the matched sample t-test. We use the population growth rate, population social growth rate, and real total expenditure per capita as the outcome indicators of the self-support settlement region framework. Because the core city's financial support measures and roles on the self-support settlement region framework differ from those of surrounding municipalities, this paper examines the policy effects by dividing the data into core cities and surrounding municipalities.

III-2-2.   DID Using Panel Data
(1) DID Using Panel Data

We can use panel data from municipalities that belong to a self-support settlement region framework and municipalities that meet the requirements for a self-support settlement region framework but have not yet formed the area (candidates for self-support settlement region framework). Hence, to identify differences in outcomes due to differences in the number of years that have passed since the self-support settlement region framework was established, the number of municipalities in the area, and the population size of the zone, we use DID analysis to eliminate the effects of unobserved time invariant effects.[41]

First, we estimate the two-way fixed effects linear model as in equation (6).

$$Y_{i,t} = \mu_i + \tau_t + \beta IMC_{i,t} + \varepsilon_{i,t} \tag{6}$$

The independent variable Y in this case is the rate of population change, net migration rate,[42] and real total expenditure per capita. We defined them as the self-support settlement region framework's outcome indicator. *IMC* (Intermunicipal Cooperation) is the dependent variable of the dummy variable, with 1 assigned to municipalities that formed the self-support settlement region framework and 0 assigned to municipalities that did not form such framework. Municipalities do not easily achieve economies of scale because total expenditures include social assistance expenses and debt service. Because municipalities in a self-support settlement region receive the special local allocation tax and the regional revitalization project loan, they will increase expenditures. Therefore, we calculated real total

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[40]   For example, Imai et al. (2008) lists the following two characteristics of statistics in balance checks. One is that statistics should depend on the property of the sample, not of the hypothetical parent set, and the other is that statistics don't have the influence from a sample size.

[41]   Ferraresi et al. (2018) also examine the impact of the number of years of local intergovernmental cooperation (IMC), the number of area municipalities, and population size on per capita expenditures from the matched sample obtained by Kernel Matching.

[42]   Given that the total population in Japan is on a declining trend, DID analysis for the population might not satisfy the Stable Unit Treatment Value Assumption for the treatment effect, since the population decline in the control group may arise from the effect of the treatment group when the population increases in the treatment group. Therefore, our analysis for the population may not satisfy the Stable Unit Treatment Value Assumption for each treatment effect. However, as confirmed in the previous section, the population of a self-support settlement region framework and candidates for a self-support settlement region framework account for about 47% of the total population, that is to say, the analysis in this paper does not cover all municipalities. Therefore, the population change in the treatment group does not necessarily have a direct effect on the control group. In addition, since the total population in Japan is declining, it may be difficult that we identify the policy effects based on the population data. However, as we have seen in the previous section, the policy goal of a self-support settlement region framework is to increase or maintain the population in the area. Based on the above, this paper adopts the change rate of the population and of net migration as the dependent variables in DID analysis, which are indicators of the policy goals of the self-support settlement region framework.

expenditure per capita by deducting social assistance expenses, debt service, the special lo-cal allocation tax, and the regional revitalization project loan from total expenditure. Then, we used them as the dependent variable alongside the distinction of original real total expenditure. μ is the fixed effect, τ is the annual effect, and ε is the error term, where i is each municipality and t is the year from FY2009 to FY2014.

As previously stated, the formation of a self-support settlement region framework is a voluntary decision made by each municipality, and it is not random. Therefore, we estimate using an all sample (without matching) and a matched sample randomly assigned by Kernel Matching to the self-support settlement region framework and candidate municipalities that meet the requirements for the self-support settlement region framework.[43] The control group is the candidates for the self-support settlement region framework in the large sample.

(2) Event Study

To ensure the validity of DID analysis, our studies must satisfy the parallel trend as-sumption. If the self-support settlement region framework did not exist, the outcome vari-ables of the treatment group that belongs to the framework and the control group that did not form the area should not differ and should then trend in parallel over time. Therefore, we clarify whether our studies satisfy the parallel trend assumption by following Autor (2003) and Ferraresi et al. (2018) and estimating equation (7) using an event study approach.

$$Y_{i,t} = \mu_i + \tau_t + \sum_{k=-3}^{3} \pi_k IMC_{i,t+k} + \varepsilon_{i,t} \tag{7}$$

In equation (7), $t = 0$ is the year when each municipality forms a self-support settlement region framework, and the trend dummies before the formation are $IMC_{i,t-3}$, and $IMC_{i,t-2}$ and $IMC_{i,t-1}$ and the trend dummies after the formation are $IMC_{i,t+1}$, and $IMC_{i,t+2}$ and $IMC_{i,t+3}$. In other words, we enter the dummy variables for the three years before and after forming the self-support settlement region framework into the model. The coefficients of π_{-3}, π_{-2}, and π_{-1}, the trend dummies before forming the self-support settlement region framework must not be statistically significantly different from zero to satisfy the parallel trend assumption.

(3) Extended Model of Analysis

In the following, we consider not only the effect of a self-support settlement region framework's existence or non-existence, but also the effect of its duration, the size of the municipalities in the area, and the number of municipalities within the self-support settle-ment region to which each municipality belongs.

(i) Effect of Duration

Because the analysis in equation (6) does not account for the difference in the duration of the self-support settlement region framework, we use *PM* (permanence), which is the length of time since the formation of the self-support settlement region framework, as in

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[43] In Appendix Table 6, the bias of the sample by PSM is the lowest in Kernel Matching, both mean and median, except for surrounding municipalities in the large sample, and thus we determined that Kernel Matching sample is more suitable than oth-er matching samples for panel data analysis.

equation (8).

$$Y_{i,t} = \mu_i + \tau_t + \beta IMC_{i,t} + \gamma PM_{i,t} + \varepsilon_{i,t} \tag{8}$$

The longer the period, the more likely the effects of the self-support settlement region framework's measures will be what we hoped for. Therefore, the expected sign of γ is positive for population growth and net migration, but negative for real total expenditure per capita.

(ii) Impact of the Number of Municipalities within the Area

The more municipalities within the self-support settlement region framework to which each municipality belongs, the more time, and money municipalities will need to spend on consensus building and interest adjustment with others. Hence, the self-support settlement region framework could not achieve a sufficient policy effect. To test such an effect, we enter *Size,* the number of municipalities within the self-support settlement region to which each municipality belongs, as mean in equation (9).

$$Y_{i,t} = \mu_i + \tau_t + \beta IMC_{i,t} + \theta IMC_{i,t} * Size_{i,t} + \varepsilon_{i,t} \tag{9}$$

Size is assigned 1 for municipalities that are candidates for a self-support settlement region framework and 2 or more for municipalities that form a self-support settlement region framework, depending on the number of municipalities in the area.[44]

Because the greater the number of municipalities in a self-support settlement region, the greater the time required for the effects of the region's policy, the expected sign of the coefficient θ of the intersection term with *IMC* is negative for the rate of population change and net migration, and positive for real total expenditure per capita. Therefore, this estimation result allows us to determine the number of municipalities within a self-support settlement region where they could achieve the effects, if θ *is* significant.

(iii) Impact of Population Size

Because municipalities with smaller populations benefit from greater economies of scale through collaboration with others, we include *large*, which captures the impact of population size (large or small), as in equation (10).

$$Y_{i,t} = \mu_i + \tau_t + \beta IMC_{i,t} + \delta IMC_{i,t} * large_{i,t} + \varepsilon_{i,t} \tag{10}$$

According to Ferraresi et al. (2018), *large* is a dummy variable that is assigned 1 for municipalities with populations greater than the self-support settlement region's average population and 0 for municipalities with populations less than the average population. In this case, β is the small municipality's effect on the formation of the self-support settlement region framework, and the coefficient δ of the intersection term with *IMC* is the large municipality's effect on forming the self-support settlement region framework. Small municipalities are less effective at increasing population through their own policies due to budget constraints, but if they collaborate with others for population growth, they may have a better

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[44] However, as mentioned above, there are 31 merged 1-city areas resulting from mergers of municipalities that form a self-support settlement region framework, and then there are cases where 1 is assigned even to a municipality that forms a self-support settlement region framework.

chance of increasing population through the self-support settlement region framework. Therefore, although both β and δ are positive, the effect of β might be larger than δ. In terms of real total expenditure per capita, since smaller municipalities benefit more from economies of scale through the cooperation between others, both β and δ are negative, but the effect of β might be larger than δ. In addition, the surrounding municipalities with small populations could obtain more effect from economies of scale than the core cities.

III-3. Analysis Data

In this paper, we create our own panel data by municipality to examine the policy effects of the self-support settlement region framework. The analysis spans the fiscal years 2008 to 2014 (FY2008-FY2014). The fiscal year before the self-support settlement region framework is FY2008. Although data from FY2015 and later are available, we use data unitl FY2014 to eliminate the impact of the core region urban areas, which began in 2015.

The treatment group includes municipalities with a self-support settlement region framework,[45] whereas the control group does not. However, the "Outline for the Promotion of Self-support Settlement Region Framework" predetermines the requirements for a self-support settlement region framework. As previously stated, a core city must have a population of 50,000 or more, a ratio of daytime and nighttime population of 1 or more, and generally be located outside of Japan's three metropolitan areas. In other words, the Ministry of Internal Affairs and Communications determines the requirements for the candidate core cities and candidate surrounding municipalities; therefore, we must identify the candidate municipalities for the policy evaluation of the self-support settlement region framework. As mentioned in II-3-2, the Advisory panel on the promotion of self-support settlement region framework[46] organizes candidates for core cities and surrounding municipalities that have not yet formed a self-support settlement region framework as of November 2019. There are 69 undeclared core cities and 194 surrounding municipalities within 10% commuting distance adjacent to the undeclared core cities. Suppose we include the declared collaborative core city, ordinance-designated cities, candidate core cities already involved in the self-support settlement region framework or the core regional urban area as surrounding cities, and two cities declared as core cities but have not yet formed the area. In that case, the total number of candidate core cities is 118. However, according to the literature, the Advisory

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[45] In this paper, we define the formation of a self-support settlement region framework as the date of agreement. The reason for this is that we believe that the cooperation between municipalities becomes apparent from the agreement of the formation for a self-support settlement region framework. In addition, the Ministry of Internal Affairs and Communications (MIC) document, "Status of Efforts to Establish Self-support Settlement Region Framework" (April 2019) comprehensively organized the date of conclusion of agreements for each self-support settlement region framework, so we could make the data by considering the "date of conclusion of agreement" as the "date of agreement" for the self-support settlement region framework. Therefore, there are differences in the number of core cities, the number of self-support settlement regions, and the date of the establishment in Figure 2 and Table 4.

[46] The literature of the Advisory panel on the promotion of self-support settlement region framework (16th meeting), "Progress of Self-support Settlement Region Framework and Measures Taken by the Ministry of Internal Affairs and Communications" (November 27, 2019).

   (https://www.soumu.go.jp/menu_sosiki/kenkyu/02gyosei08_04000195.html: accessed April 20, 2022)

panel on the promotion of self-support settlement region framework did not list 49 candidate surrounding municipalities adjacent to the candidate core cities other than undeclared core cities, and we uniquely discovered 204 candidate surrounding municipalities adjacent to the candidate core cities other than undeclared core cities within 10% commuting area.[47] We define 69 undeclared core cities as the small sample of candidate core cities in the following analysis, and the 118 candidate core cities mentioned above as the large sample. Furthermore, we define 194 municipalities adjacent to the candidate core cities as the small sample of candidate surrounding municipalities and 204 municipalities adjacent to the candidate core cities as the large sample of candidate surrounding municipalities.

Tables 11 and 12 show the time series of the core cities and surrounding municipalities that have formed a self-support settlement region framework and the candidates for core cities and surrounding municipalities in small and large samples, respectively. We excluded from the analysis data the specified disaster-struck municipalities affected by the Great East Japan Earthquake and other disasters because their fiscal demands differ from those of other

Table 11. Number of municipalities of self-support settlement region and a small sample of candidates for self-support settlement region framework

Fiscal year	Core cities	Candidates for Core cities	Percentage of Core cities	Surrounding municipalities	Candidates for Surrounding municipalities	Percentage of Surrounding municipalities
2009	17	141	10.8%	71	413	14.7%
2010	36	122	22.8%	129	355	26.7%
2011	46	112	29.1%	181	303	37.4%
2012	55	103	34.8%	205	279	42.4%
2013	58	100	36.7%	232	252	47.9%
2014	68	90	43.0%	263	221	54.3%

Note 1: We exclude Yubari City, specified disaster-struck municipalities, and municipalities merged after 2006 from the analysis data.
Note 2: The sum of the core cities, surrounding municipalities, and candidates is used as the denominator, and the sum of the core cities and surrounding municipalities is used as the numerator.
Source: "Status of Efforts to Establish Self-support Settlement Region Framework" by the Ministry of Internal Affairs and Communications, "Progress of Self-support Settlement Region Framework and Measures Taken by the Ministry of Internal Affairs and Communications" by the Ministry of Internal Affairs and Communications.

Table 12. Number of municipalities of self-support settlement region and a large sample of candidates for self-support settlement region framework

Fiscal year	Core cities	Candidates for Core cities	Percentage of Core cities	Surrounding municipalities	Candidates for Surrounding municipalities	Percentage of Surrounding municipalities
2009	17	169	9.1%	71	560	11.3%
2010	36	150	19.4%	129	502	20.4%
2011	46	140	24.7%	181	450	28.7%
2012	55	131	29.6%	205	426	32.5%
2013	58	128	31.2%	232	399	36.8%
2014	68	118	36.6%	263	368	41.7%

Note: Same as Table 11.

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[47] We chose candidates for surrounding municipalities based on commuting data for each municipality from the "2005 National Census", which the central government made before the launch of the "Self-support settlement region framework."

local governments. For the same reason, we did not include Yubari City, which is in the process of fiscal rebuilding, and merged municipalities during the analysis period in the data.

Table 11 shows that during the fiscal year 2014, 43% of the candidates for core cities and 54.3% of the candidates for surrounding municipalities formed a self-support settlement region framework during the analysis period. As shown in Table 12, in FY2014, 36.6% of the candidates for core cities and 41.7% of the candidates for surrounding municipalities formed a self-support settlement region framework.

III-4.   Analysis Results

III-4-1.   PSM-DID Results[48]

First, we assessed the discrimination of the propensity score derived from Probit estimation[49] (see Appendix Table 2) concerning the factors that lead to the formation of a self-support settlement region framework. The C statistic's AUC was around 0.7-0.8 for all models, and we confirmed that the propensity score correctly differentiated between the formation and non-formation of the self-support settlement region framework (see Appendix Table 3). The propensity score's goodness of fit test (Hosmer-Lemeshow) results also showed no difference between the predicted probability and the actual probability of forming a self-support settlement region framework (see Appendix Table 4).

Next, we tested the pre- and post-matching balance, and the results showed that the differences between the variables of the treatment and control groups were no longer significant after matching (see Appendix Table 5), and the LR test showed that bias had been eliminated. Kernel Matching had the lowest bias for both mean and median, confirming that the bias was lower than in other matching methods except for surrounding municipalities in the large sample (see Appendix Table 6). Therefore, the sample based on Kernel Matching was most randomly assigned to the treatment and control groups in the self-support settlement region framework.

The results of the PSM-DID analysis are presented in Tables 13 (the rate of population change), 14 (the rate of net migration), and 15 (real total expenditure per capita). The difference between FY2008 (before the formation of the self-support settlement region framework) and FY2014 is the outcome indicator for the self-support settlement region framework.

First, we summarize the results for population change and net migration rates from Tables 13 and 14. In any of the matching cases, there were no significant differences in the rates of population change and net migration in the core cities. In any of the matching cases, there was no significant difference in the rate of population change in the surrounding municipalities. Furthermore, the results for the net migration rate, both in the small and large

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[48] The results of the Probit estimation, the discriminant test of the propensity score, the goodness of fit test, and the test results for matching are all summarized in Appendix V-1.

[49] Since commuting rates to and from other municipalities are highly correlated, in subsequent PSM-DID, we use the model (2) for core cities and model (4) for surrounding municipalities in Appendix Table 2.

Table 13. PSM-DID Analysis Results (Rate of population change)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	-0.203	-0.259	0.056	0.053	1.05
		Nearest Neighbor Matching	-0.214	-0.175	-0.039	0.071	-0.55
		Radius Matching	-0.201	-0.168	-0.033	0.063	-0.52
		Kernel Matching	-0.214	-0.161	-0.053	0.064	-0.83
	Large	Unmatched	-0.203	-0.238	0.036	0.049	0.73
		Nearest Neighbor Matching	-0.187	-0.073	-0.114	0.076	-1.50
		Radius Matching	-0.211	-0.135	-0.076	0.069	-1.11
		Kernel Matching	-0.187	-0.150	-0.038	0.058	-0.65
Surrounding municipalities	Small	Unmatched	-0.161	-0.257	0.096	0.075	1.27
		Nearest Neighbor Matching	-0.181	-0.061	-0.120	0.123	-0.98
		Radius Matching	-0.174	-0.173	-0.001	0.102	-0.01
		Kernel Matching	-0.183	-0.156	-0.027	0.093	-0.29
	Large	Unmatched	-0.146	-0.222	0.076	0.064	1.19
		Nearest Neighbor Matching	-0.167	-0.197	0.031	0.124	0.25
		Radius Matching	-0.146	-0.191	0.045	0.089	0.51
		Kernel Matching	-0.167	-0.136	-0.031	0.084	-0.37

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 14. PSM-DID Analysis Results (Rate of net migration)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	0.003	-0.037	0.040	0.055	0.74
		Nearest Neighbor Matching	-0.009	0.055	-0.064	0.070	-0.92
		Radius Matching	0.019	0.067	-0.048	0.064	-0.74
		Kernel Matching	-0.009	0.071	-0.081	0.065	-1.25
	Large	Unmatched	0.003	-0.019	0.022	0.050	0.45
		Nearest Neighbor Matching	0.021	0.146	-0.125	0.077	-1.63
		Radius Matching	-0.003	0.092	-0.095	0.070	-1.35
		Kernel Matching	0.021	0.089	-0.068	0.060	-1.13
Surrounding municipalities	Small	Unmatched	0.088	-0.039	0.127	0.069	1.84 *
		Nearest Neighbor Matching	0.063	0.010	0.054	0.113	0.47
		Radius Matching	0.078	0.019	0.060	0.094	0.64
		Kernel Matching	0.063	0.051	0.013	0.086	0.15
	Large	Unmatched	0.099	-0.009	0.108	0.059	1.81 *
		Nearest Neighbor Matching	0.078	0.039	0.039	0.115	0.34
		Radius Matching	0.104	0.038	0.066	0.081	0.81
		Kernel Matching	0.078	0.071	0.007	0.077	0.09

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 15. PSM-DID Analysis Results (Real total expenditure per capita)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	0.082	0.059	0.023	0.008	2.89 ***
		Nearest Neighbor Matching	0.083	0.073	0.009	0.010	0.90
		Radius Matching	0.084	0.078	0.006	0.010	0.60
		Kernel Matching	0.083	0.070	0.013	0.009	1.36
	Large	Unmatched	0.082	0.054	0.028	0.007	3.79 ***
		Nearest Neighbor Matching	0.081	0.076	0.005	0.012	0.39
		Radius Matching	0.079	0.078	0.001	0.011	0.12
		Kernel Matching	0.081	0.073	0.008	0.009	0.88
Surrounding municipalities	Small	Unmatched	0.171	0.101	0.070	0.015	4.56 ***
		Nearest Neighbor Matching	0.159	0.121	0.038	0.020	1.94 *
		Radius Matching	0.152	0.120	0.031	0.017	1.83 *
		Kernel Matching	0.159	0.133	0.026	0.016	1.56
	Large	Unmatched	0.173	0.089	0.084	0.012	6.93 ***
		Nearest Neighbor Matching	0.163	0.156	0.007	0.020	0.34
		Radius Matching	0.162	0.144	0.018	0.016	1.15
		Kernel Matching	0.163	0.138	0.024	0.015	1.63

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

sample, were positive and significant in the unmatched sample (Unmatched) for surrounding municipalities, but the matched sample did not show any significant difference compared to the candidates. Although the municipalities established the self-support settlement region framework to increase population, they do not contribute positively to the rate of population change and net migration compared to other unmatched candidates for core cities and surrounding municipalities during the time period analyzed in this paper. In other words, it was demonstrated that the previous policy for the self-support settlement region framework may not have promoted settlement.[50] These results contradict Hypothesis 1 presented in III-1.

The results for real total expenditure per capita from Table 15 are then summarized. The results of the core cities are significantly positive in both the large and small sample sizes (unmatched), but not in any of the matched samples. In other words, there is no real total expenditure per capita difference between core cities and candidates for core cities. When compared to the candidates in the small sample, the results of the surrounding municipalities obtained positive and significant results in Nearest Neighbor Matching and Radius Matching. Therefore, it is possible that after the formation of the self-support settlement region

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[50] In the questionnaire survey by the Regional Independence Support Division of the Local Administration Bureau of the Ministry of Internal Affairs and Communications (2019), some core cities responded that the self-support settlement region framework was effective in halting the outflow of population. Therefore, we conducted our own questionnaire survey to 11 core cities which have responded to "the achievement of the maintenance of the population". The results showed that these core cities have implemented their own population control measures as well as cooperating with surrounding municipalities in the fields of medical care, childcare support, and employment since the formation of the self-support settlement region framework.

framework, real total expenditure per capita of surrounding municipalities increased in the small sample. However, in the small sample, the result in Kernel Matching for the surrounding municipalities is not significant. The surrounding municipalities' results are positive and significant in the large sample (Unmatched), but not in the matched sample. Given these findings, Hypothesis 2 presented in III-1 is not supported, and both the core cities and surrounding municipalities may fail to reduce average costs through economies of scale even after forming the self-support settlement region framework.[51]

However, concluding the hypothesis solely on PSM-DID analysis is difficult because the results vary depending on the sample and matching method. In fact, the surrounding municipalities' average costs may have increased after the formation of the self-support settlement region framework when compared to the candidate for surrounding municipalities in the small sample. However, the difference is not significant when compared to the large sample of candidates for surrounding municipalities. Therefore, whether a difference exists in real total expenditure per capita between the candidates and the surrounding municipalities remains unclear. Our research on PSM-DID has looked at the impact of whether or not a municipality has established a self-support settlement region framework. However, differences in the timing or duration of the formation of each self-support settlement region framework could not be considered in the PSM-DID analysis because the analysis only examined at differences in the rates of population change, net migration, and real total expenditure per capita between FY2008 and FY2014. Furthermore, variations in the number of municipalities and population size may impact the demographics and expenditures of each self-support settlement region. In the following section, we will test our hypothesis further using DID analysis on the panel data after matching.

III-4-2.   Estimation Results of DID Using Panel Data
(1) Estimation Results of DID Using Panel Data

Through the event study, we found that our model satisfied the parallel trend assumption when estimating DID using panel data in both the core cities and the surrounding municipalities.[52]

Tables 16 and 17 show the results of DID estimation using panel data and equation (6) for the core cities and surrounding municipalities. We use two types of data for real total expenditure per capita: one is total expenditure: the other is total expenditure minus the social assistance expenses, debt service, the special local allocation tax, and the regional revitalization project loan. We analyze the matching sample obtained through Kernel Matching. In each table, column (a) shows the estimation results using the entire sample, while column (b) shows the results using the matching sample. Please keep in mind that all estimation re-

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[51] In order to confirm whether we could find the effect of the self-support settlement region framework after the inception of the framework and only in the treatment group, we used the placebo test by PSM-DID based on data from FY2006 to FY2008, before the start of the framework. We summarize the details in Appendix Table 7-9. Since the results of the analysis differ significantly between before the start of the self-support settlement region framework in Appendix Table 7-9 and after the start of the framework in Table 13-15, the results in Table 13-15 show the effect of the framework.

[52] See Appendix Table 11 in Appendix V-3 for the results of the analysis.

Table 16. Estimation results of DID using panel data (Core cities)

| | Rate of population change | | Rate of net migration | | Real total expenditure per capita | | | |
| | | | | | Total expenditure | | Total expenditure excluding social assistance expenses, etc. | |
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Dummy variable of self-support settlement region framework	-0.038 [-0.546]	-0.054 [-0.641]	-0.028 [-0.429]	-0.038 [-0.474]	0.007 [1.939]*	0.007 [1.647]*	0.002 [0.531]	0.003 [0.662]
Observations	1,116	1,092	1,116	1,092	1,116	1,092	1,116	1,092
F-value	102.222	100.269	110.877	108.695	29.400	27.531	12.467	11.207
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All	Matching	All	Matching	All	Matching	All	Matching

Note 1: We omitted fixed effects and year effects.
Note 2: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

Table 17. Estimation results of DID using panel data (Surrounding municipalities)

| | Rate of population change | | Rate of net migration | | Real total expenditure per capita | | | |
| | | | | | Total expenditure | | Total expenditure excluding social assistance expenses, etc. | |
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Dummy variable of self-support settlement region framework	0.038 [0.750]	0.028 [0.527]	0.074 [1.572]	0.071 [1.457]	0.023 [3.506]***	0.025 [3.683]***	0.027 [4.024]***	0.028 [4.161]***
Observations	3,810	3,606	3,810	3,606	3,810	3,606	3,810	3,606
F-value	111.744	110.412	129.456	126.884	31.224	29.270	25.751	23.538
Prob > F	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000
Sample	All	Matching	All	Matching	All	Matching	All	Matching

Note 1: We omitted fixed effects and year effects.
Note 2: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

sults take fixed and year effects into account.

The estimation results for the core cities are shown in Table 16. First, when population change and net migration rates are used as the dependent variables, the dummy variable of the self-support settlement region framework is not statistically significant, although we expect that the dummy is significantly positive not only in the total sample but also in the matching sample. Next, when we use total expenditure as the dependent variable, the dummy variable is positive and significant at the 10% level in columns (a) and (b). However, when we exclude social assistance and other expenses, the dummy variable is not statistically significant, contrary to expectations that it is significantly negative.

Table 17 shows the estimation results for the surrounding municipalities. First, when population, and net migration rates are used as the dependent variables, the self-support settlement region framework dummy variable is not statistically significant in the matching sample. Next, in both all sample and the matching sample, when we use total expenditure and expenditure excluding social assistance and so on as the dependent variable, the dummy variable is significantly positive (columns (a) and (b)) contrary to the expectation that the dummy is significantly negative.[53]

These findings indicate that, as with PSM-DID in the preceding subsection, the self-support settlement region framework policy did not achieve the desired results.

(2) Extended Model Estimation Results

Tables 18-20 show the outcome indicator's estimation results for equations (8)-(10). In each table, columns (a) and (d) are the estimation results from equation (8), columns (b) and (e) from equation (9), and columns (c) and (f) from equation (10). Furthermore, we use the full sample in columns (a), (b), and (c) and the matching sample in columns (d), (e), and (f).

Tables 18 and 19 show that when the rates of population change and net migration are used as the dependent variables, the results are similar. First, contrary to expectations, the dummy variable of the self-support settlement region framework is not statistically significant in the matching sample (columns (d), (e), and (f)). Second, the number of years elapsed since the region was formed is also not statistically significant (column (d)). Third, the number of the municipalities in the region is also not statistically significant (column (e)). Fourth, the municipalities' population sizes are not statistically significant (column (f)). Unlike Hypothesis 1, these results suggest that municipalities forming a self-support settlement region framework have been unable to prevent population decline or outflow compared to candidates for the self-support settlement region framework.

Table 20 shows the estimation results when real total expenditure per capita is used as the dependent variable. First, in columns (a) and (d), when the number of years since the formation of the self-support settlement region framework for core cities is included as the independent variable in both the total sample and the matching sample, the dummy variable

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[53] We guess that expenditures increased in the surrounding municipalities because of the effect of the cooperative projects through the formation of the self-support settlement region framework rather than the effect of economies of scale.

Table 18. Extended Model Estimation Results (Rate of population change)

	Core cities						Surrounding municipalities					
	(a)	(b)	(c)	(d)	(e)	(f)	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	-0.0447 [-0.564]	-0.0395 [-0.451]	-0.0544 [-0.281]	-0.0433 [-0.532]	-0.0317 [-0.355]	-0.0192 [-0.086]	0.0049 [0.087]	0.0552 [0.813]	0.0300 [0.565]	0.0187 [0.319]	0.0308 [0.416]	0.0223 [0.403]
Number of elapsed years	0.0039 [0.175]			0.0072 [0.315]			0.0224 [1.367]			0.0060 [0.353]		
Number of the municipalities in the region		0.0004 [0.025]			0.0001 [0.008]			-0.0026 [-0.379]			-0.0004 [-0.059]	
Population size of the municipalities			0.0183 [0.090]			-0.0132 [-0.057]			0.0739 [0.532]			0.0476 [0.327]
Observations	1,116	1,116	1,116	1,092	1,092	1,092	3,810	3,810	3,810	3,606	3,606	3,606
F-value	87.53	87.52	87.53	85.87	85.85	85.85	96.07	95.78	95.80	94.63	94.61	94.63
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sample	All			Matching			All			Matching		

Note 1: We omitted fixed effects and year effects.
Note 2: ∗∗∗, ∗∗, and ∗ indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

Table 19. Extended Model Estimation Results (Rate of net migration)

	Core cities						Surrounding municipalities					
	(a)	(b)	(c)	(d)	(e)	(f)	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	-0.034 [-0.458]	-0.028 [-0.341]	-0.082 [-0.444]	-0.034 [-0.435]	-0.022 [-0.257]	-0.046 [-0.219]	0.043 [0.833]	0.087 [1.384]	0.071 [1.438]	0.059 [1.084]	0.076 [1.110]	0.072 [1.414]
Number of elapsed years	0.004 [0.168]			0.007 [0.326]			0.021 [1.354]			0.008 [0.516]		
Number of the municipalities in the region		0.000 [-0.004]			0.000 [0.000]			-0.002 [-0.314]			-0.001 [-0.103]	
Population size of the municipalities			0.060 [0.310]			0.027 [0.123]			0.030 [0.230]			-0.012 [-0.088]
Observations	1,116	1,116	1,116	1,092	1,092	1,092	3,810	3,810	3,810	3,606	3,606	3,606
F-value	94.941	94.934	94.958	93.090	93.064	93.068	111.253	110.944	110.936	108.769	108.723	108.723
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All			Matching			All			Matching		

Note 1: We omitted fixed effects and year effects.
Note 2: ∗∗∗, ∗∗, and ∗ indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

Table 20. Extended Model Estimation Results (Real total expenditure per capita)

(1) Real total expenditure per capita

Core cities

	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	0.0001 [0.022]	0.007 [1.525]	0.036 [3.688]***	-0.0005 [-0.112]	0.006 [1.390]	0.038 [3.398]***
Number of elapsed years	0.004 [3.692]***			0.004 [3.497]***		
Number of the municipalities in the region		0.00005 [0.065]			-0.000005 [-0.006]	
Population size of the municipalities			-0.033 [-3.193]***			-0.035 [-2.999]***
Observations	1,116	1,116	1,116	1,092	1,092	1,092
F-value	27.492	25.174	26.908	25.638	23.572	25.092
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All			Matching		

Surrounding municipalities

	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	0.022 [2.956]***	0.016 [1.779]*	0.025 [3.640]***	0.025 [3.338]***	0.016 [1.677]*	0.027 [3.813]***
Number of elapsed years	0.001 [0.478]			0.000 [-0.063]		
Number of the municipalities in the region		0.001 [1.272]			0.001 [1.348]	
Population size of the municipalities			-0.018 [-0.982]			-0.019 [-1.000]
Observations	3,810	3,810	3,810	3,606	3,606	3,606
F-value	26.789	26.999	26.901	25.081	25.355	25.231
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All			Matching		

(2) Real total expenditure per capita, excluding social assistance expenses, etc.

Core cities

	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	0.001 [0.318]	0.007 [1.528]	0.045 [4.710]***	0.000 [0.018]	0.006 [1.311]	0.041 [3.799]***
Number of elapsed years	0.004 [3.245]***			0.003 [3.042]***		
Number of the municipalities in the region		0.0001 [0.195]			0.000001 [0.002]	
Population size of the municipalities			-0.042 [-4.247]***			-0.039 [-3.454]***
Observations	1,116	1,116	1,116	1,092	1,092	1,092
F-value	12.301	10.680	13.460	11.016	9.595	11.427
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All			Matching		

Surrounding municipalities

	(a)	(b)	(c)	(d)	(e)	(f)
Dummy variable of self-support settlement region	0.022 [2.978]***	0.022 [2.418]**	0.030 [4.244]***	0.027 [3.526]***	0.021 [2.222]**	0.031 [4.377]***
Number of elapsed years	0.003 [1.510]			0.001 [0.489]		
Number of the municipalities in the region		0.001 [0.892]			0.001 [1.056]	
Population size of the municipalities			-0.025 [-1.356]			-0.026 [-1.355]
Observations	3,810	3,810	3,810	3,606	3,606	3,606
F-value	22.407	22.184	22.341	20.204	20.335	20.443
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000
Sample	All			Matching		

Note 1: We omitted fixed effects and year effects.
Note 2: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

for the formation of the area is not statistically significant, despite the expectation that the dummy is significantly negative. Second, the number of years since the area's formation is significantly greater than zero. Since the formation of the area, real total expenditure per capita has increased with each passing year. The dummy for the formation of the self-support settlement region framework is positive and significant in both the total sample and the matching sample when we use the sample of surrounding municipalities, but the number of elapsed years to form the framework has no significant effect on real total expenditure per capita. Next, contrary to the expectation that the dummy is significantly positive (columns (b) and (e)), the number of municipalities in the region is not statistically significant in both the core cities and the surrounding municipalities. Finally, the effect of population size on columns (c) and (f) is confirmed. The dummy of self-support settlement region framework formation is positive and significant in both the all sample and the matching sample for both core cities and surrounding municipalities. However, the population size of the core cities, which evaluates the effect of large municipalities, is significantly negative at the 1% level, whereas the population size of the surrounding municipalities is not, contrary to the expectation that small municipalities achieve the effect of economies of scale. Thus, we confirm that although the large core cities have decreased the real total expenditure per capita by the economies of scale, which form a self-support settlement region framework, the small core cities and surrounding municipalities have increased compared to the candidate municipalities of the framework, unlike hypothesis 2.[54] Furthermore, even when we use real total expenditure per capita excluding social assistance and so on as the dependent variable, the small core cities and surrounding municipalities do not decrease real total expenditure per capita, despite the expectation that they would achieve economies of scale by forming a self-support settlement region framework.

In light of the foregoing, the DID analysis using matching panel data shows that we did not confirm the desired results in the self-support settlement region framework, even after accounting for differences in the number of years, number of municipalities in the region, and population size of the framework's municipalities.

IV. Conclusion

This paper quantitatively examines the impact of a self-support settlement region framework on demographics and average costs. Forming a self-support settlement region framework is based on the municipalities' voluntary decision. Therefore, the more serious the so-

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[54] In III-4-1, when we analyzed PSM-DID which targets the surrounding municipalities in the large sample by Kernel Matching, the result wasn't any significant difference in real total expenditure per capita of the surrounding municipalities that have formed a self-support settlement region compared to the surrounding municipalities that have not yet formed the region. These differences in results may be due to differences in the analytical data. In PSM-DID, we define the municipalities that have formed a self-support settlement region as of 2014 as a treatment group (Treated) and those that have not yet formed as a control group (Untreated), while in DID based on the matching panel data, we classify the treatment group (Treated) according to the time of the formation of a self-support settlement region up to FY2014, and the control group (Untreated) according to the previous years before the formation of the regions. The panel data processing method is based on Ferraresi et al. (2018), but we will make the data to maintain consistency between PSM-DID and DID from the matching panel data in the future.

cial decline in population, the more they may choose to form a region to increase the region's sustainability through wide-area cooperation between municipalities. We used PSM-DID as the analytical method to avoid such selection bias.

The analysis yielded the following results. First, the self-support settlement region framework did not affect population growth or maintenance. The rates of population change and net migration in the core cities and surrounding municipalities of the self-support settlement region framework were not significantly different from those in the candidate municipalities that could form the region. Using the panel data after matching in DID analysis, we found no significant differences in the rates of population change and net migration between municipalities that had formed a self-support settlement region framework and those that had not. The same is true even when we used the number of elapsed years in the self-support settlement region framework, the number of municipalities in the region, and the population size of the municipalities as explanatory variables. The hypothesis was also not supported by the findings on real per capita expenditure, which tended to increase rather than decrease in the core cities and surrounding municipalities of the self-support settlement region framework after the region's formation, when compared to candidate municipalities that had not yet formed a region. Specifically, when compared to candidate core cities that had not yet formed a region, the core cities increased real total expenditure per capita with time after the formation of the region. However, when the population size of the core cities was large, economies of scale tended to limit expenditure compared to the candidate core cities. Furthermore, using PSM-DID, and post-matching panel data, we confirmed that the surrounding municipalities' real total expenditure per capita tended to be significantly higher than that of the unformed candidate surrounding municipalities, even when they could reduce the expenditure through economies of scale.

Previously, municipalities formed the self-support settlement region framework and then collaborated in relatively simple policy areas such as industrial policy, tourism promotion, and disaster countermeasures. As a result, they were unable to maintain and improve the region's daily functions, which did not contribute to population growth or retention. Furthermore, because the self-support settlement region framework's wide-area collaboration between municipalities has been limited in the scope of policy coordination, it has not been able to achieve economies of scale and has not resulted in a reduction in real total expenditure per capita. We hope that in the future, a self-support settlement region framework will encourage the expansion of policy areas where cooperation between municipalities is difficult. For example, suppose the self-support settlement region framework establishes a mutual network by concentrating advanced urban functions to core cities or sharing roles with surrounding municipalities by reaching an agreement on the joint development and utilization of facilities, infrastructure, and specialized human resources, or city planning throughout the entire region. In that case, the municipalities may be able to prevent the region's population decline and achieve the economies of scale.

Finally, we summarize the paper's issues. First, to evaluate the outcomes of wide-area municipal cooperation, we should conduct a more comprehensive analysis that includes the

outcomes for core region urban areas and the outcomes for the self-support settlement region framework after FY2015. Second, we could improve the analytical method to validate regional coordination's effects. Specifically, region-specific data, such as the degree of concentration of urban functions in the region's core cities, must be constructed, and compared for each region. Third, improved output indicators are required. Instead of the total population, we should use the working-age population, the young population, the fertility rate, and economic indicators used in previous studies. Fourth, we should consider the relationship between wide-area cooperation and changes in the quality of public services in this analysis. The formation of the self-support settlement region framework may have improved the quality of public services in each municipality while increasing output (expenditure). In the future, it would be preferable to improve the empirical analysis for evaluating policy not only through output (expenditure), but also through the quality of public services.

V. Appendix

V-1. Propensity Score Matching

(1) Results of Probit Estimation

We use the dummy variable as independent variable in Probit estimation to calculate the propensity score of the self-support settlement region, with 1 for municipalities that have formed a self-support settlement region by FY2014 and 0 for municipalities that have not formed a self-support settlement region. The factors that contribute to the formation of self-support settlement region are the ordinary balance ratio, the local allocation tax rate (local allocation tax/standard financial scale), the outstanding local government bonds rate (outstanding local government bonds/standard financial scale), the number of members of partial-affairs-associations, dummy variable of wide-area unions, dummy variable of a secondary medical care area, the rate of elderly people at least 65 years old, the number of hospitals per 10,000 people, commuting rate to other municipalities (number of commuters to other municipalities/number of workers), commuting rate from other municipalities (number of commuters from other municipalities/number of workers in the place of employment), population, area, and dummy variable of municipal mergers are used based on Sugahara (2014) and Miyashita (2021). We use these data as of FY2008, the year before the start of the self-support settlement region framework in consideration of endogenous characteristics as the independent variables.

Each municipality may expect financial support measures from a self-support settlement region framework. Municipalities with a higher ordinary balance ratio, higher dependency on the local allocation tax rate, and higher outstanding local government bonds rate are more likely to form a self-support settlement region. These variables are used as financial factors in the formation of a self-support settlement region. In addition, as the formation or non-formation of inter-municipal cooperation that existed before the formation of the self-support settlement region may affect the formation of the region, the number of mem-

bers of partial-affairs-associations, dummy variable of wide-area unions, and dummy variable of a secondary medical care area are considered.[55] The rate of elderly people at least 65 years old and the number of hospitals per 10,000 people are added as independent variables to take into account the impact of each municipality on medical care, because medical care was the top area in which the outcomes of the self-support settlement regions were particularly evident by the Regional Independence Support Division of the Local Administration Bureau of the Ministry of Internal Affairs and Communications (2019). The commuting rate to other municipalities (the number of commuters to other municipalities/the number of workers) and the commuting rate from other municipalities (the number of commuters from other municipalities/the number of workers in the place of employment) were considered as spillover effects in Sugahara (2014), so they are also used as independent variables in this paper. Population and area are control variables for the characteristics of each municipality. Finally, the dummy variable of municipal mergers is the data that indicates 1 for municipalities that merged during the period of the Special Municipal Mergers Law from FY1999 to FY2005 and 0 for all other municipalities. The merger dummy is added as an independent variable to account for the possibility that municipalities that did not merge under the Special Municipal Mergers Law may choose to cooperate with other municipalities for anticipation of economies of scale in administrative services.

The descriptive statistics for each variable used in Probit estimation and PSM-DID are shown in Appendix Table 1 below. Note that the data are for core cities and candidate core cities, as well as for surrounding municipalities and candidate surrounding municipalities.

Appendix Table 2 shows the results of Probit estimation of the factors that contribute to the formation of a self-support settlement region, using the candidate core cities and the candidate surrounding municipalities as control groups in the large sample. As commuting rates to and from other municipalities are highly correlated, they are excluded as independent variables in model (2) and (4). The ordinary balance ratio is negative and significant only in model (4). Before this estimation, it was thought that municipalities with a rigid financial structure would form self-support settlement regions, but the more flexible the financial structure is in surrounding municipalities, the more likely they are to form self-support settlement regions. This may be due to the fact that the formation of a self-support settlement region is accompanied by an increase in additional expenditures in cooperation with other municipalities. However, no significant results are obtained for the core cities, a result consistent with Sugahara (2014), who examined the factors that lead to the formation of a self-support settlement region in the core city. The results for the rate of the local allocation tax rate are positive and significant except for model (3). This suggests that municipalities with a higher rate of local allocation tax are more likely to form a self-support settlement region. The outstanding local government bonds rate is positive and significant in models (3) and (4). In the surrounding municipalities, the higher the rate of outstanding local govern-

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[55] We created dummy variables for wide-area unions and a secondary medical area, with 1 for cases in the same area and 0 for other cases, so that the relationship between the core city and surrounding municipalities could be taken into account.

Appendix Table 1. Descriptive Statistics (Probit Model and PSM-DID)

① Core cities in large sample

Variables	Unit	Observations	Mean	Std. Dev.	Min.	Max.	Data Source
Ordinary balance ratio	%	186	91.703	6.388	64.800	107.500	A
Local allocation tax rate	%	186	33.643	19.217	0.000	71.453	A
Outstanding local government bonds rate	%	186	1.900	0.460	0.569	3.907	A
Partial-affairs-associations	number	186	6.720	3.761	2.000	26.000	A
Dummy variable of wide-area unions	dummy	186	0.129	0.336	0.000	1.000	B
Dummy variable of secondary medical area	dummy	186	0.737	0.442	0.000	1.000	C
Rate of elderly people at least 65 years old	%	186	25.025	4.156	13.753	37.249	D
Number of hospitals per 10,000 people	rate	186	0.824	0.427	0.153	2.292	D、E
Commuting rate to other municipalities	%	186	22.366	13.117	0.248	54.575	F
Commuting rate from other municipalities	%	186	25.180	13.436	0.437	61.062	F
Population	number	186	149,927	226,159	18,444	1,930,496	D
Area	km^2	186	439.415	333.600	19.090	2,177.670	G
Dummy variable of municipal mergers	dummy	186	0.323	0.469	0.000	1.000	H
Dummy variable of self-support settlement region framework	dummy	186	0.366	0.483	0.000	1.000	I、J
Difference of population change rate	points	186	-0.225	0.321	-1.497	0.652	D
Difference of net migration rate	points	186	-0.011	0.328	-1.336	0.953	D
Difference of real total expenditure per capita	million yen	186	0.064	0.050	-0.141	0.217	A、D

ment bonds, the more likely it is that the municipality forms a self-support settlement region with financial support from the central government.

The number of partial-affairs-associations is negative in all models and significant only in model (2). The core cities have fewer administrative associations with other municipalities before the start of the self-support settlement region framework, indicating that the core cities have formed a self-support settlement region, which provides an opportunity for cooperation with surrounding municipalities. The dummy variable of wide-area unions is positive and significant in all analyses. Both the core cities and the surrounding municipalities have formed a self-support settlement region if they are members of the same wide-area union before the start of the self-support settlement region framework. The dummy variable of secondary medical area is positive and significant only in the case of surrounding municipalities. This indicates that surrounding municipalities formed a self-support settlement region if they are in the same secondary medical area as a core city before the start of the framework.

Next, for the medical-related variable for each municipality, the number of hospitals per 10,000 people is positive and significant in Models (3) and (4). In surrounding municipalities, the larger the number of hospitals relative to the population, the more likely the municipality is to form a self-support settlement region. The rate of elderly people at least 65 years old is not significant in all models.

Furthermore, unlike Sugahara (2014), the variables on commuting rates did not yield significant results.[56] Population obtained negative and significant results in models (3) and (4). It suggests a tendency for municipalities with smaller populations to be adjacent to the

② Surrounding municipalities in large sample

Variables	Unit	Observations	Mean	Std. Dev.	Min.	Max.	Data Source
Ordinary balance ratio	%	631	88.584	6.903	60.500	115.100	A
Local allocation tax rate	%	631	48.851	23.256	0.000	87.596	A
Outstanding local government bonds rate	%	631	1.723	0.479	0.097	3.788	A
Partial-affairs-associations	number	631	8.647	3.167	0.000	19.000	A
Dummy variable of wide-area unions	dummy	631	0.162	0.368	0.000	1.000	B
Dummy variable of secondary medical area	dummy	631	0.689	0.463	0.000	1.000	C
Rate of elderly people at least 65 years old	%	631	28.164	6.645	12.844	56.492	D
Number of hospitals per 10,000 people	rate	631	0.738	0.856	0.000	6.079	D、E
Commuting rate to other municipalities	%	631	37.527	17.052	0.000	78.755	F
Commuting rate from other municipalities	%	631	31.748	15.259	2.047	74.907	F
Population	number	631	25,695	33,960	345	483,348	D
Area	km^2	631	193.194	205.135	3.470	1,408	G
Dummy variable of municipal mergers	dummy	631	0.135	0.342	0.000	1.000	H
Dummy variable of self-support settlement region framework	dummy	631	0.410	0.492	0.000	1.000	I、J
Difference of population change rate	points	631	-0.191	0.796	-4.828	5.138	D
Difference of net migration rate	points	631	0.036	0.736	-4.177	4.654	D
Difference of real total expenditure per capita	million yen	631	0.123	0.155	-0.267	1.633	A、D

Note 1: The data excludes Yubari City, specific municipalities affected by the disaster, and merged local municipalities during the analysis period after 2006.
Note 2: A: "Survey of Local Public Finance" by the Ministry of Internal Affairs and Communications; B: "Status of formation of Wide-area Unions" by the Ministry of Internal Affairs and Communications; C: "Survey of Medical Institutions" by the Ministry of Health, Labour and Welfare; D: "Counts of population, vital events and households derived from Basic Resident Registration" by the Ministry of Internal Affairs and Communications; E: "Survey of Public Facility Status" by the Ministry of Internal Affairs and Communications; F: "National Census" by the Ministry of Internal Affairs and Communications; G: "Areas of prefectures and municipalities in Japan" by the Geospatial Information Authority of Japan; H: "Documents of Municipal Mergers" by the Ministry of Internal Affairs and Communications, I: "Status of Efforts to Establish Self-support Settlement Region Framework" by the Ministry of Internal Affairs and Communications J: "Progress of Self-support Settlement Region Framework and Measures Taken by the Ministry of Internal Affairs and Communications" by the Ministry of Internal Affairs and Communications.

core city in a self-support settlement region. The area is positive and significant in model (4). Finally, while the dummy variable of municipal mergers is not significant in models (1) and (2), it is negative and significant in models (3) and (4). It appears that surrounding municipalities that did not merge under the Special Municipal Mergers Law from FY1999 to FY2005 are more likely to try to establish a self-support settlement region to promote cooperation with the core cities.

Since commuting rates to and from other municipalities are highly correlated, we use

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[56] This may be an effect of the period and subject of the analysis differing from that of Sugahara (2014). In addition, this paper assumes that the spillover effect exists outside of the self-support settlement region, and the commuting rate is constructed by considering the number of commuters in municipalities outside of the self-support settlement region and its candidate municipalities. However, in Sugahara (2014), variables of commuting rates are created as spillover indicators limited to municipalities within the region, which means that assumptions are made that limit the scope of the spillover effect.

Appendix Table 2. Estimation results on the factors for the formation of a self-support settlement region: core cities and surrounding municipalities in large sample

Model	(1)		(2)		(3)		(4)	
Analysis subject	Core cities		Core cities		Surrounding municipalities		Surrounding municipalities	
	coefficient	standard error	coefficient	standard error	coefficient	standard error	coefficient	standard error
Ordinary balance ratio	0.020	0.020	0.013	0.020	-0.015	0.010	-0.020 **	0.010
Local allocation tax rate	0.017 *	0.010	0.023 **	0.009	0.005	0.005	0.008 *	0.004
Outstanding local government bonds rate	-0.307	0.324	-0.114	0.300	0.264 *	0.149	0.303 **	0.146
Number of partial-affairs-associations	-0.040	0.034	-0.062 *	0.034	-0.024	0.020	-0.029	0.019
Dummy variable of wide-area unions	0.905 ***	0.317	0.797 ***	0.303	0.581 ***	0.159	0.568 ***	0.158
Dummy variable of secondary medical area	0.299	0.290	0.326	0.280	0.776 ***	0.149	0.822 ***	0.146
Rate of elderly people at least 65 years old	-0.037	0.039	-0.030	0.037	-0.013	0.014	-0.001	0.013
Number of hospitals per 10,000 people	0.107	0.269	0.161	0.262	0.166 **	0.076	0.181 **	0.074
Commuting rate to other municipalities	-0.013	0.023			-0.010	0.007		
Commuting rate from other municipalities	-0.018	0.025			-0.005	0.009		
Population	0.000	0.000	0.000	0.000	-0.000 ***	0.000	-0.000 ***	0.000
Area	-0.001	0.000	0.000	0.000	0.000	0.000	0.001 **	0.000
Dummy variable of municipal mergers	-0.281	0.236	-0.171	0.229	-0.538 ***	0.196	-0.535 ***	0.195
Constant	-0.275	1.887	-1.250	1.777	1.060	0.942	0.294	0.864
Observations	186		186		631		631	
Pseudo R2	0.168		0.143		0.259		0.252	
log likelihood	-101.553		-104.648		-316.441		-319.583	

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

model (2) for core cities and model (4) for surrounding municipalities in PSM-DID.

(2) Discrimination and Goodness of Fit test for Propensity Scores

Appendix Table 3 shows the discrimination of the propensity score based on the results of the Probit estimation of the factors that lead to the formation of a self-support settlement region. The area under curve (AUC) is around 0.7 to 0.8 in all models. Appendix Table 4 shows the results of the goodness of fit test (Hosmer-Lemeshow) of the propensity score. χ^2 test rejects the null hypothesis that there is no difference between the predicted probability based on the propensity score and the actual probability of forming a self-support settlement region at the 5% level only in model (3) for surrounding municipalities in the small sample, but does not reject the null hypothesis in the other models.

(3) Balance Test after Matching

Appendix Table 5 presents the results of Kernel Matching balance test (t-test). It can be seen that for both core cities and each of the surrounding municipalities, independent variables that were significantly different by the t-test in the unmatched sample (Unmatched) are no longer significant in the matched sample (Matched). Appendix Table 6 also presents the results of the likelihood ratio test (LR test) to verify the reduction of bias before and after matching for each matching method. It can be seen that there is no significant difference after matching for any of the matching methods for both core cities and the surrounding municipalities, although there is a significant difference at the 1% level for the unmatched sample (Unmatched). Bias of the sample is lowest in Kernel Matching for both mean and median except for candidate surrounding municipalities in the large sample, indicating that there is less

Appendix Table 3. Results of discrimination degree of propensity scores

Sample	Small				Large			
Model	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Number of observations	158	158	484	484	186	186	631	631
Area under ROC curve	0.757	0.741	0.730	0.725	0.761	0.752	0.819	0.814

Note: Columns (1) - (4) are results using propensity scores derived from Probit estimation for each model. Specifically, they are as follows. (1): The candidate core cities are the analysis subject and the commuting rates to and from other municipalities are added as independent variables; (2): The candidate core cities are the analysis subject and the commuting rates to and from other municipalities are excluded from independent variables; (3): The candidate surrounding municipalities are the analysis subject and the commuting rates to and from other municipalities are added as independent variables; and (4): The candidate surrounding municipalities are the analysis subject and the commuting rates to and from other municipalities are excluded from independent variables.

Appendix Table 4. Results of goodness of fit test (Hosmer-Lemeshow) for propensity scores

Sample	Small				Large			
Model	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Number of observations	158	158	484	484	186	186	631	631
Hosmer-Lemeshow chi2	8.97	8.97	16.51	6.96	3.53	7.96	11.45	8.53
Prob > chi2	0.344	0.345	0.036	0.541	0.897	0.438	0.177	0.384

Note: Same as Appendix Table 3.

bias than in the other matching methods. Therefore, we can see that the sample was randomly assigned to the treatment and control groups in the self-support settlement region by PSM.

V-2. Placebo Test

The placebo test is one in which the same estimating equation of PSM-DID is applied to data for a period or group not covered by the policy to confirm that a policy affects only the treatment group during the policy implementation period, and that the results are not similar to those for the policy implementation period or target. In this paper, in order to confirm whether the self-support settlement region framework is affected only by the period of the start of the framework and the treatment group, we used the placebo test by PSM-DID using data from FY2006 to FY2008, before the start of the framework. Specifically, based on the propensity score matching obtained in Appendix V-1, we verify whether the differences in the rates of population change, net migration, and real total expenditure per capita from FY2006 to FY2008 differ depending on whether or not a self-support settlement region was formed. The results of the analysis are shown in Appendix Tables 7-9. In both the small and large samples, the core cities tend to have significantly higher rates of population change and net migration than the candidate core cities in all matching methods. The net migration

Appendix Table 5. Balance Test (t-test) Results

① Comparison of core cities with candidate core cities in large sample

Variables	Unmatched			t-test	
	Matched	Treated	Control	bias	t
Ordinary balance ratio	U	92.672	91.145	24.90	1.58
	M	92.632	92.931	-4.90	-0.31
Local allocation tax rate	U	40.583	29.643	60.30	3.88 ***
	M	40.243	40.061	1.00	0.06
Outstanding local government bonds rate	U	1.904	1.898	1.40	0.09
	M	1.908	1.888	4.50	0.29
Number of partial-affairs-associations	U	6.309	6.958	-17.90	-1.13
	M	6.303	6.570	-7.40	-0.50
Dummy variable of wide-area unions	U	0.235	0.068	47.70	3.36 ***
	M	0.212	0.197	4.40	0.22
Dummy variable of secondary medical area	U	0.853	0.669	43.80	2.78 ***
	M	0.848	0.852	-0.90	-0.06
Rate of elderly people at least 65 years old	U	26.063	24.427	40.80	2.63 ***
	M	26.049	26.279	-5.70	-0.32
Number of hospitals per 10,000 people	U	0.904	0.779	28.50	1.94 *
	M	0.910	0.880	7.00	0.39
Population	U	98,688	180,000	-40.30	-2.37 **
	M	100,000	80,668	9.80	1.44
Area	U	442.770	437.480	1.60	0.10
	M	448.020	412.990	10.70	0.61
Dummy variable of municipal mergers	U	0.294	0.339	-9.60	-0.63
	M	0.303	0.286	3.70	0.21

rate of the surrounding municipalities is significantly positive only for Nearest Neighbor Matching in the small sample, but the other results are not significant. Appendix Table 9 shows that there is no significant difference in real total expenditure per capita before the start of the self-support settlement region between the municipalities of the region and candidates, but in Table 15, we confirm that real total expenditure per capita tends to be significantly higher in the surrounding municipalities than in the candidates for those municipalities analyzed by PSM-DID using the small sample.

V-3. *Panel Data Analysis*

(1) Descriptive Statistics

The descriptive statistics for each variable used in the panel data analysis are shown in

② Comparison of surrounding municipalities with candidate surrounding municipalities in large sample

Variables	Unmatched			t-test	
	Matched	Treated	Control	bias	t
Ordinary balance ratio	U	87.485	89.349	-27.50	-3.36 ***
	M	87.776	88.647	-12.90	-1.36
Local allocation tax rate	U	59.103	41.713	81.70	9.93 ***
	M	58.067	57.848	1.00	0.12
Outstanding local government bonds rate	U	1.815	1.659	33.10	4.08 ***
	M	1.797	1.808	-2.40	-0.23
Number of partial-affairs-associations	U	8.842	8.511	10.50	1.29
	M	8.885	8.826	1.90	0.22
Dummy variable of wide-area unions	U	0.259	0.094	44.20	5.65 ***
	M	0.250	0.248	0.60	0.05
Dummy variable of secondary medical area	U	0.892	0.548	82.70	9.84 ***
	M	0.885	0.907	-5.30	-0.80
Rate of elderly people at least 65 years old	U	30.7	26.399	68.70	8.43 ***
	M	30.538	30.677	-2.20	-0.24
Number of hospitals per 10,000 people	U	0.896	0.628	30.30	3.91 ***
	M	0.763	0.807	-5.00	-0.50
Population	U	13,400	34,256	-68.90	-7.95 ***
	M	13,986	14,364	-1.30	-0.29
Area	U	234.480	164.450	33.90	4.28 ***
	M	211.100	194.020	8.30	0.93
Dummy variable of municipal mergers	U	0.073	0.177	-31.80	-3.80 ***
	M	0.078	0.086	-2.40	-0.31

Note 1: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.
Note 2: U indicates Unmatched and M indicates Matched.
Note 3: These are the results of Kernel matching.

Appendix Table 10 below. The 28 municipalities[57] that belong to more than one self-support settlement region are excluded from the panel data because it is not possible to assign variables (such as the number of municipalities) to the region. Thus, the sample sizes of the core cities and surrounding municipalities in the matched sample are 1,092 and 3,606, respectively.

(2) Parallel Trend Assumption
    The results of the event study are shown in Appendix Table 11. When using the rate of population change as the dependent variable in the core cities, the dummy variable of the three periods before the formation of self-support settlement region are significant at the

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[57] For example, Esashi Town, Hamatonbetsu Town, and Nakatombetsu Town belong to the region with Wakkanai City as the core city and to the region with Nayoro City and Shibetsu City as the core cities.

Appendix Table 6. Results of Balance Test (LR-test)

Sample	Analysis object	Matching	LR chi2	p>chi2	MeanBias	MedBias
Small	Core Cities	Unmatched	30.09	0.002	22.6	21.3
		Nearest Neighbor Matching	6.04	0.871	9.2	6.8
		Radius Matching	3.20	0.988	7.8	7.1
		Kernel Matching	0.68	1.000	3.9	3.7
	Surrounding municipalities	Unmatched	90.34	0.000	29.8	32.3
		Nearest Neighbor Matching	10.87	0.454	6.5	4.2
		Radius Matching	3.70	0.978	5.1	6.9
		Kernel Matching	6.60	0.830	4.8	3.5
Large	Core Cities	Unmatched	34.95	0.000	28.8	28.5
		Nearest Neighbor Matching	14.93	0.186	11.1	12.5
		Radius Matching	7.75	0.735	12.5	13.1
		Kernel Matching	2.99	0.991	5.5	4.9
	Surrounding municipalities	Unmatched	215.24	0.000	46.7	33.9
		Nearest Neighbor Matching	13.65	0.253	6.5	5.4
		Radius Matching	4.840	0.939	3.6	2.2
		Kernel Matching	4.740	0.943	3.9	2.4

Appendix Table 7. Placebo Tests (Rate of population change)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	0.046	-0.061	0.106	0.053	2.00 **
		Nearest Neighbor Matching	0.048	-0.141	0.189	0.079	2.40 ***
		Radius Matching	0.086	-0.122	0.208	0.068	3.04 ***
		Kernel Matching	0.048	-0.102	0.150	0.063	2.37 ***
	Large	Unmatched	0.046	-0.053	0.099	0.048	2.05 **
		Nearest Neighbor Matching	0.027	-0.194	0.221	0.076	2.90 ***
		Radius Matching	0.016	-0.131	0.147	0.064	2.28 **
		Kernel Matching	0.027	-0.154	0.181	0.057	3.17 ***
Surrounding municipalities	Small	Unmatched	0.059	-0.071	0.130	0.069	1.90 *
		Nearest Neighbor Matching	0.015	-0.127	0.141	0.099	1.42
		Radius Matching	0.001	-0.128	0.129	0.083	1.55
		Kernel Matching	0.015	-0.103	0.118	0.080	1.47
	Large	Unmatched	0.055	-0.089	0.144	0.057	2.54 ***
		Nearest Neighbor Matching	0.029	-0.051	0.079	0.104	0.77
		Radius Matching	0.037	-0.086	0.123	0.079	1.56
		Kernel Matching	0.029	-0.074	0.102	0.072	1.43

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Appendix Table 8. Placebo Tests (Rate of net migration)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	0.115	-0.005	0.120	0.053	2.27 **
		Nearest Neighbor Matching	0.116	-0.098	0.213	0.081	2.63 ***
		Radius Matching	0.150	-0.058	0.208	0.070	2.96 ***
		Kernel Matching	0.116	-0.054	0.170	0.063	2.70 ***
	Large	Unmatched	0.115	-0.003	0.119	0.048	2.48 ***
		Nearest Neighbor Matching	0.094	-0.109	0.203	0.076	2.69 ***
		Radius Matching	0.079	-0.052	0.131	0.065	2.02 **
		Kernel Matching	0.094	-0.089	0.184	0.056	3.28 ***
Surrounding municipalities	Small	Unmatched	0.142	0.013	0.129	0.068	1.91 *
		Nearest Neighbor Matching	0.105	-0.058	0.163	0.093	1.76 *
		Radius Matching	0.077	-0.033	0.110	0.081	1.35
		Kernel Matching	0.105	-0.001	0.106	0.078	1.35
	Large	Unmatched	0.140	-0.019	0.160	0.056	2.86 ***
		Nearest Neighbor Matching	0.119	0.046	0.073	0.102	0.71
		Radius Matching	0.125	0.019	0.105	0.077	1.37
		Kernel Matching	0.119	0.038	0.081	0.070	1.16

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Appendix Table 9. Placebo Tests (Real total expenditure per capita)

Analysis subject	Sample	Matching	Treated	Controls	Difference	S.E.	T-stat
Core Cities	Small	Unmatched	-0.005	0.003	-0.008	0.006	-1.36
		Nearest Neighbor Matching	-0.003	-0.008	0.005	0.007	0.69
		Radius Matching	-0.003	-0.005	0.002	0.007	0.21
		Kernel Matching	-0.003	-0.002	-0.001	0.007	-0.18
	Large	Unmatched	-0.005	0.004	-0.009	0.005	-1.73
		Nearest Neighbor Matching	-0.005	0.006	-0.011	0.010	-1.17
		Radius Matching	-0.004	0.004	-0.008	0.007	-1.06
		Kernel Matching	-0.005	0.002	-0.007	0.006	-1.13
Surrounding municipalities	Small	Unmatched	-0.003	0.007	-0.011	0.011	-0.97
		Nearest Neighbor Matching	0.003	0.024	-0.021	0.015	-1.40
		Radius Matching	0.000	0.014	-0.013	0.012	-1.14
		Kernel Matching	0.003	0.010	-0.007	0.011	-0.60
	Large	Unmatched	-0.005	0.004	-0.009	0.009	-1.01
		Nearest Neighbor Matching	0.003	-0.004	0.007	0.014	0.54
		Radius Matching	0.005	0.003	0.003	0.010	0.28
		Kernel Matching	0.003	0.005	-0.002	0.010	-0.20

Note: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively.

Appendix Table 10. Descriptive Statistics (Matched Sample)

① Core cities

Variables	N	Mean	Std. Dev.	Min.	Max.
Rate of population change	1,092	-0.428	0.884	-2.006	8.492
Rate of net migration	1,092	-0.079	0.674	-1.462	7.671
Real total expenditure per capita	1,092	0.463	0.106	0.272	1.025
Real total expenditure per capita, excluding social assistance expenses, etc.	1,092	0.310	0.077	0.185	0.798
Dummy variable of self-support settlement region framework	1,092	0.252	0.434	0	1
Number of elapsed years	1,092	0.731	1.478	0	6
Number of the municipalities in the area	1,092	0.965	2.615	0	19
Population size of the municipalities	1,092	0.236	0.425	0	1

② Surrounding municipalities

Variables	N	Mean	Std. Dev.	Min.	Max.
Rate of population change	3,606	-0.851	1.204	-5.207	17.263
Rate of net migration	3,606	-0.238	0.852	-3.729	14.673
Real total expenditure per capita	3,606	0.637	0.383	0.245	5.508
Real total expenditure per capita, excluding social assistance expenses, etc.	3,606	0.470	0.313	0.153	4.885
Dummy variable of self-support settlement region framework	3,606	0.267	0.442	0	1
Number of elapsed years	3,606	0.771	1.512	0	6
Number of the municipalities in the area	3,606	1.795	4.175	0	19
Population size of the municipalities	3,606	0.037	0.190	0	1

Appendix Table 11. Event Study Results

Analysis subject	Core cities				Surrounding municipalities			
Dependent Variable	Population change	Net migration	Real total expenditure per capita		Population change	Net migration	Real total expenditure per capita	
			Total	excluding social assistance expenses, etc.			Total	excluding social assistance expenses, etc.
Formation of self-support settlement region "-3 years"	-0.0119	-0.0104	-0.0144	-0.0174	-0.0165	-0.0186	0.0465	0.0482
	[-1.767]*	[-1.591]	[-0.107]	[-0.137]	[-1.339]	[-1.508]	[0.491]	[0.551]
Formation of self-support settlement region "-2 years"	-0.0007	0.0000	-0.0743	-0.0680	-0.0167	-0.0220	-0.0352	-0.0527
	[-0.125]	[0.004]	[-0.646]	[-0.623]	[-1.577]	[-2.077]**	[-0.433]	[-0.701]
Formation of self-support settlement region "-1 year"	-0.0076	-0.0062	0.0148	0.0174	-0.0069	-0.0110	-0.0331	-0.0285
	[-1.558]	[-1.303]	[0.153]	[0.189]	[-0.735]	[-1.180]	[-0.460]	[-0.430]
Dummy variable of self-support settlement region framework	-0.0056	-0.0038	-0.0213	-0.0186	0.0150	0.0125	-0.0035	0.0099
	[-1.278]	[-0.906]	[-0.246]	[-0.227]	[1.836]*	[1.523]	[-0.055]	[0.171]
Formation of self-support settlement region "+1 year"	-0.0057	-0.0047	-0.0820	-0.0654	0.0001	-0.0010	-0.0004	0.0391
	[-1.218]	[-1.034]	[-0.878]	[-0.738]	[0.013]	[-0.109]	[-0.006]	[0.633]
Formation of self-support settlement region "+2 years"	0.0015	0.0011	0.0211	0.0233	0.0040	0.0046	0.0840	0.1016
	[0.320]	[0.233]	[0.223]	[0.259]	[0.433]	[0.503]	[1.198]	[1.569]
Formation of self-support settlement region "+3 years"	0.0068	0.0068	0.0578	0.0441	0.0004	0.0021	0.0444	0.0474
	[1.373]	[1.413]	[0.591]	[0.476]	[0.038]	[0.222]	[0.616]	[0.713]
Observations	1,092	1,092	1,092	1,092	3,606	3,606	3,606	3,606
Year effects	YES	YES	YES	YES	YES	YES	YES	YES
Fixed effects	YES	YES	YES	YES	YES	YES	YES	YES

Note 1: We omitted fixed effects and year effects.
Note 2: ***, **, and * indicates significance at the 1%, 5%, and 10% levels, respectively. Figures in [ ] are t-values.

10% level, but the rest of the periods are not statistically significant, thus satisfying the parallel trend assumption. When studying the rate of net migration as the dependent variable in the surrounding municipalities, the dummy variable of the two periods before the formation of the region are significant at the 5% level, but the rest of the periods are not statistically significant, indicating that the parallel trend assumption is satisfied.

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