IJRRE 7 (2021) 29-45 ISSN 2056-9726

International Journal of Research and Reviews in Education
www.bluepenjournals.org/ijrre

Investigating and improving the schoolteacher recruiting system in Japan

doi.org/10.33500/ijrre.2021.07.004

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Article History
Received 14 April, 2021
Received in revised form 12 May, 2021
Accepted 17 May, 2021

Keywords:
Schoolteacher recruiting system, Mathematical model, Cluster analysis, Multivariate regression model.

Article Type:
Full Length Research Article

ABSTRACT

At present, in Japan, the mass retirement of schoolteachers in most public schools requires mass recruitment, with the recent trend that the "competition rate" given by the ratio between the number of applicants and the number of employed schoolteachers has been declining. As a result, ensuring the quality of teachers in Japanese public schools is becoming difficult. We investigated the schoolteacher recruiting system (SRS) in Japan to find regional characteristics related to the numbers of students and schoolteachers in elementary, middle, and high schools, as well as the numbers of applicants and people accepted for the schoolteacher recruiting examination (SRE). Applying a cluster analysis technique, we classified 47 prefectures in Japan into four groups. Then, we applied a multivariate regression modeling approach to explain the number of applicants and the competition rate for those prefectures in each group using various economic and social variables. We aimed to improve the SRS in Japan by deriving facts through various mathematical modeling approaches. We believe it is necessary to increase the number of applicants for the SRE, with the goal of improving the SRS.

INTRODUCTION

At present, approximately 40% of the teachers in Japan's public schools are over 50 years old. Consequently, most of these schoolteachers, who were born during the "baby boom" period between 1946 and 1964, are currently retiring on a large scale. Therefore, a mass recruitment of schoolteachers is necessary to compensate for this mass retirement, especially given the recently declining "competition rate," which we define as the ratio between the total number of applicants and the number of applicants who are hired after passing the teacher recruitment examinations. However, ensuring the quality of teachers in Japanese public schools is becoming increasingly difficult. In this context, we believe that improving the Japanese schoolteacher recruiting system (SRS) could lead to an increase in the number of applicants for the schoolteacher recruitment examinations (SREs).

Compulsory education in Japan is based on the Fundamental Law of Education promulgated in 1947. In the upcoming sections, we describe the Japanese SRS in detail, as it is central to our research design. In particular, we discuss the various issues concerning the structure of the Japanese education system, such as student enrollment, teacher retirement, teacher recruitment, and teacher licensing. Education in Japan is based on a "6-3-3" system. This system advocates compulsory education for nine years, which consists of six years of primary education in elementary schools and three years of lower secondary education in middle schools. The remaining three years of upper secondary education are not compulsory. The majority of elementary and middle schools are publicly financed and are governed by the

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education board of the respective local municipalities. Although it is not mandatory to enroll for upper secondary education, the current enrollment rate is more than 98.8%.

To become a teacher in Japan, one needs to first obtain a teaching license. This is acquired by enrolling in universities or colleges that provide teacher training courses. The required credits for obtaining a teaching license are pre-established by laws and regulations and vary depending on the type of school that is hiring and the subject to be taught. To be employed as a teacher in public schools, it is necessary to pass a hiring examination implemented by the board of education in each of the 47 prefectures of Japan, which consists of 20 designated major cities and a council for teaching personnel (as of July, 2020). This hiring examination for public school teachers comprehensively evaluates the qualification and aptitude of the candidates from multiple perspectives. It generally consists of a written examination in subjects such as liberal arts and other specializations, as well as an interview, an essay, a demonstration lesson, and an evaluation of practical skills. In the case of private schools, a similar recruitment process is implemented by individual schools.

The requirements for taking a teacher recruitment examination are different in each prefecture and designated major city. Often, there is an age limit for taking the examination, but this limitation has been considerably relaxed in recent years. Most of the examinations are conducted between July and September of the following fiscal year, which starts in April. It is important to note that a candidate is not automatically hired after passing the examination. This is because most prefectures and designated major cities hire teachers from a list of registered candidates, where the candidates are listed according to their examination score and then employed based on their rank. Consequently, whenever the number of eligible candidates on this list exceeds the demand for schoolteachers, the candidates ranked lower on the list are not hired. In such cases, the candidates must retake the examination in the following year but are excused from retaking a certain portion of the examination. Designing a proper SRS based on central and local government education policies is a very important issue in any country. Many studies have been conducted on designing schoolteacher recruitment and training systems worldwide.

This issue has been investigated from various aspects, such as the shortage, quality, and performance of teachers, as well as their working conditions, such as salary, class size, school location, student achievement, and student gain. Liu and Johnson (2006) examined the process of hiring new teachers and explored whether this process leads to a good match between the candidates and the schools. Balter and Duncombe (2008) estimated a model that relates a composite measure of teacher qualifications to the level of use of recruitment practices and labor supply and demand factors. Jackson (2012) proposed the following three approaches to improve the effectiveness of teaching: attracting talented individuals to the profession, creating incentives for exerting optimal effort, and providing professional training to help teachers develop the skills required to be more effective. He further emphasized that the total number of applicants for teaching positions is particularly important to ensure the recruitment of an optimum number of high-quality teachers.

Teacher quality can be measured using various parameters, such as performance, value added, and productivity. Hanushek et al. (2019) demonstrated that the skill set of teachers in countries with the highest measured skills (for example, Japan and Finland) exceeded that of adults with a master's or Ph.D. degree in Canada. Ishijima (2018) evaluated Japanese schoolteachers and found that they obtained scores nearly equivalent to those obtained by Canadian schoolteachers with master's or doctoral degrees; hence, the authors concluded that the Japanese SRS was working successfully. Muralidharan and Sundararaman (2011) conducted interviews of teachers and presented their opinions on performance-based pay. They found that more than 80% of the teachers had a favorable opinion toward performance-based pay. Lavy (2020) examined the long-term outcome of performance-based pay for teachers and found that there was a gradual increase in the number of high school students opting for a university education. Kelley (1999) studied the ways in which school-based performance award (SBPA) programs could motivate teachers to modify or improve teaching practices. Goldhaber and Walch (2012) analyzed the implications of performance-based pay systems on student achievement. Nagler et al. (2020) assessed the quality of teachers using value-added measures of impacts on student test scores using the Roy model of occupational choice. Chetty et al. (2014) investigated the impact of teachers on student test scores as a value-added measure of teacher quality.

Improving the quality of education is a matter of utmost concern for parents, educators, and policymakers. It has been shown that the quality of teachers has not only short-term consequences, such as on academic achievement (Hanushek and Rivkin 2010), but also long-term impacts, such as on future income (Chetty et al., 2014). Improving a country's knowledge capital through education investment is key to boosting economic growth (Hanushek and Woessmann 2015). The above findings indicate that improving teacher quality can be an important policy measure to in turn improve the educational and economic outcomes of a country. In this context, researchers and policymakers have long believed that teachers play an important role in determining student outcomes (Hanushek and Rivkin 2010). In this study, we aimed to improve the Japanese SRS by thoroughly investigating the past and recent trends in the relationship between the number of pupils and number of teachers in schools, as well as the relationship between the number of applicants and number of schoolteachers hired after passing the SRE. We also

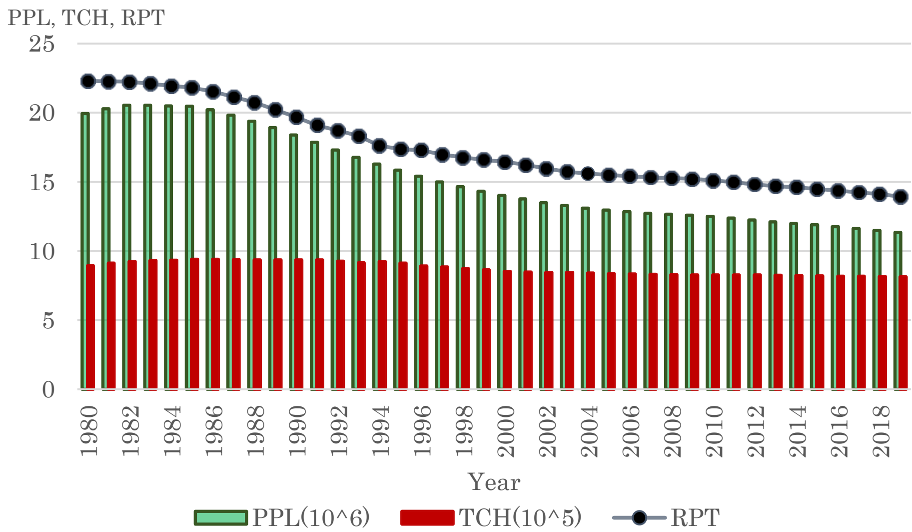

Figure 1. Trends of PPL, TCH and RPT (1980 through 2019).

explored the determinants of teacher supply. To achieve our objective, we examined the empirical relationship between the number of candidates taking the SRE and various socioeconomic factors, both pecuniary and non-pecuniary. We thus attempted to find strategies for facilitating public school teachers to contribute to the cultivation of future human resources in Japan.

SRS in Japan

In Japan, "normal schools" were established in 1872 to train elementary school teachers, and "higher normal schools" were established in 1886 to train secondary school teachers. The traditional normal school system in Japan was abolished in 1949 and the present teacher training system was established following the introduction of a new higher education system based on post-World War II education reforms. With the aim of producing diverse human resources with a broad outlook and highly specialized knowledge and skills, at least one national university with a faculty of education or one teacher training college was established in each prefecture. These universities and colleges were approved to offer teacher training courses. In addition, it was decided that any national, public, or private university could be equally involved in offering teacher training, provided their courses are accredited by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). In such an open system, universities can offer classes to their students that provide the requisite number of credits to acquire teaching certificates. Yamasaki (1998) explained the evolution of the Japanese SRS using data from 1980 to 1995.

MEXT conducts annual surveys to evaluate the status of public SREs for elementary, middle, and high schools. These surveys are conducted by the board of education in each of the 47 prefectures and 20 designated major cities, and they collect data on public SREs, including the number of candidates and recruits. As of May 1, 2008, it was found that 582 out of 729 universities (79.8%; which includes 47 out of 73 national universities), 423 out of 597 graduate schools (70.9%), and 277 out of 385 junior colleges (71.7%) offered teacher training courses. Thus, more than 70% of the higher-educational institutions appear to offer teacher training courses.

Figure 1 shows the trends in the number of pupils (PPL), the number of teachers (TCH), and the ratio between these two (RPT; given by PPL/TCH) between the years 1980 and 2019. We observe that PPL decreases monotonically from 19.9 million in 1980 to 11.3 million in 2019 and RPT decreases from 22.3 to 13.9 during the same period; however, TCH remains nearly constant during this period at approximately 0.8 to 0.9 million.

Figure 2 shows the trends in the total number of applicants (APP), the number of applicants who passed and were subsequently accepted (ACC), and the ratio between these two (RPC; given by APP/ACC) between the years 1980 and 2019. We observe that APP decreases rapidly from 231,000 in 1980 to 111,000 in 1992 (that is, during the first subperiod 1980–1992), then starts to increase slowly to 181,000 in 2013 (that is, during the second subperiod 1992–2013), and finally decreases to 148,000 in 2019 (that is, during the final subperiod 2013–2019). However, ACC was found to decrease from 45,700 to 11,000 during the 20-year period between 1980 and 2000, and then increase to 35,000 between 2000 and 2019. Note that the decrease in ACC from 1980 to 2000 resulted from the decrease in both PPL and the number of

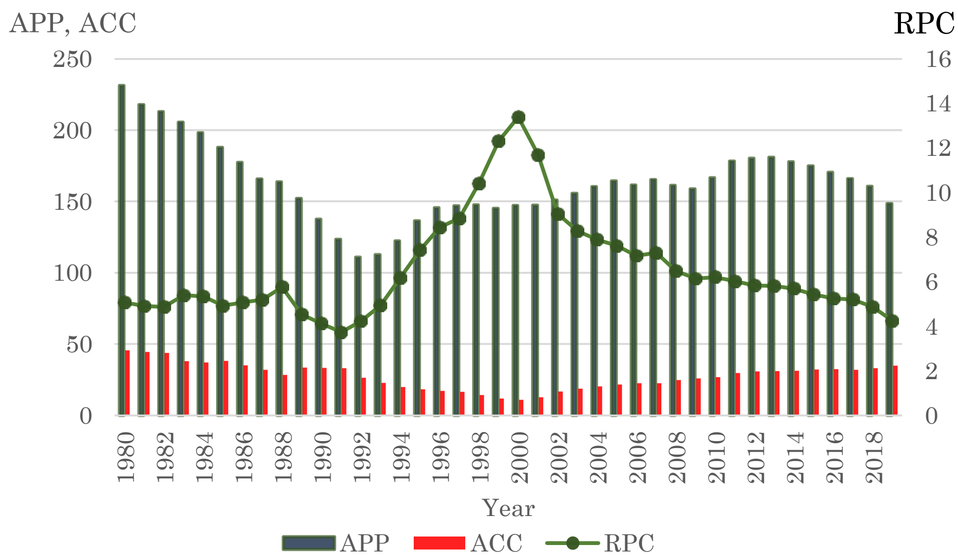

Figure 2. Trends of APP, ACC and RPC (1980 through 2019).

retiring schoolteachers during this period (Yamasaki, 2003). In addition, Yamasaki (2003) pointed out that ACC varies periodically in an approximately 30-year cycle in Japan due to changes in both PPL and the number of retiring schoolteachers. Finally, the competition rate (that is, RPC) was found to remain nearly constant at approximately 5.0 during the first subperiod (1980–1993), following which it increased rapidly peaking at approximately 13.4 in the year 2000. Following the peak in 2000, RPC decreased drastically during the next few years and then continued to decrease at a nearly constant rate during the final 15 years. The present national average of RPC is 4.2, which is the lowest in the last 30 years.

As seen in Figure 2, APP to the Japanese SRS remained between 140,000 and 180,000, while decreasing monotonically between the years 2013 and 2019. Although ACC increased between 2009 and 2013, RPC has been decreasing since 2001. Consequently, RPC for the SREs was 4.2 in the year 2019, which is the lowest recorded RPC during the 2000s.

Figure 3 shows the trend in the distribution of RPT by prefecture between the years 1980 and 2019. We observe a smooth decreasing trend in the average RPT during this period. We also found that RPT is consistently distributed across the 47 prefectures during the 30-year period. Moreover, the RPT data were found to be more widely and sparsely distributed above the median. This implies that significantly more data points are distributed about and below the median rather than above it; in other words, the higher (lower) data points lying above (below) the median are more sparsely (densely) distributed. Furthermore, we found that the gap between the highest and lowest values of RPT becomes slightly smaller during this period.

Figure 4 shows the distribution of RPC by prefecture between the years 1980 and 2019. We observe that the RPC data are much more widely and sparsely distributed above the median. Again, this implies that significantly more data points are distributed about and below the average rather than above it. Additionally, we found that the gap between the highest and lowest values of RPC is exceptionally large in some years (that is, 1988, 1999, and 2006). However, this gap has decreased during the final 20 years of the study period. Moreover, the competition rate or RPC varies greatly across prefectures, with an average value of 4.2. The highest RPC (8.9) was recorded in OKW and the lowest RPC (2.2) in NGT in the year 2019. Note that the competition rate for educational recruitment examinations differs by year among the different prefectures. For example, OKW, which had the highest competition rate in 2019, showed a large increase in APP but a decrease in ACC between 2001 and 2011, and its RPC has been approximately 10 since 2012. Conversely, NGT, which had the lowest competition rate in 2019, had a competition rate that was higher than the national average between 2014 and 2017; however, the rate dropped significantly in 2018 and 2019. In Tokyo (TKY), the competition rate has fallen below the national average on several years during the last two decades. It is interesting to understand the reason behind these regional differences in the competition and turnover rates, as well as the fluctuations in the time series data. Therefore, in this study we examined the factors that affect the competition rate in teacher recruitment in various prefectures from both economic and non-economic perspectives. To this end we propose the following hypotheses.

The first hypothesis is related to the salary scales of the

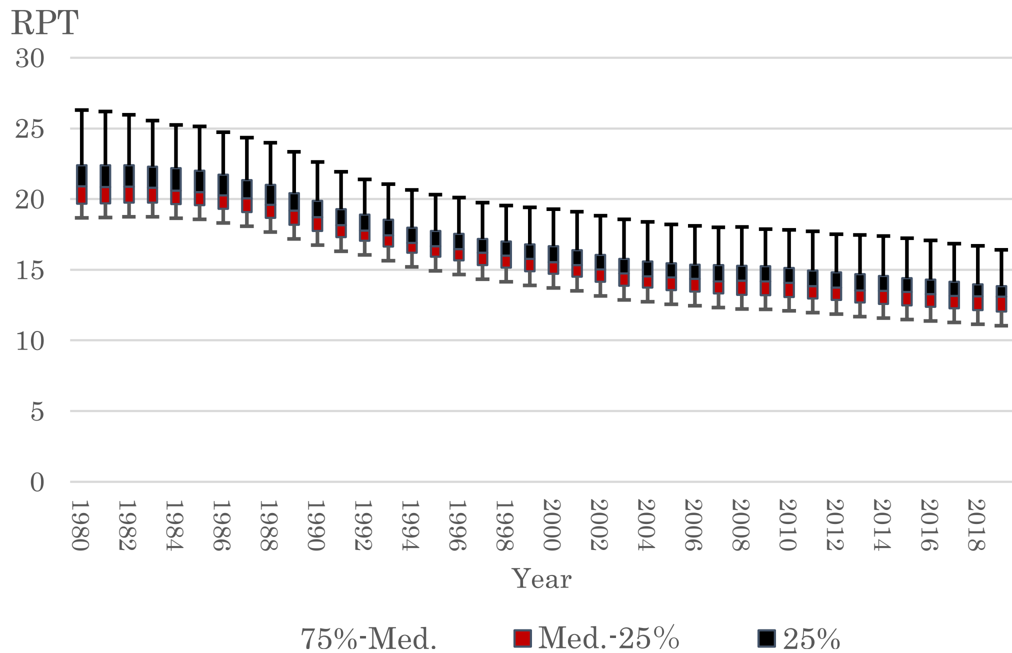

Figure 3. Distribution of RPT by prefecture (1980 through 2019).

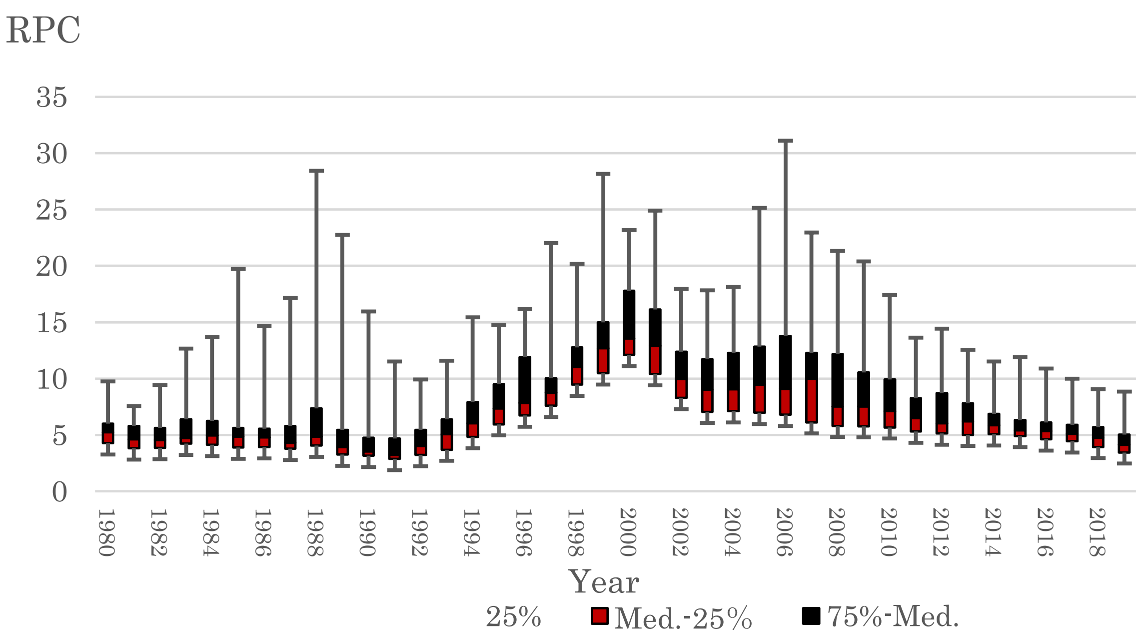

Figure 4. Distribution of RPC by prefecture (1980 through 2019).

teachers. Hanushek et al. (2019) showed that Japanese schoolteachers are paid approximately 12% more per hour compared to people in other jobs. Public school teachers are also likely to be affected by the private economy. Unlike in the private sector, the relative wages of public school teachers vary from region to region, and prospective candidates in regions with higher relative wages may be more likely to compete in education recruitment examinations. The second hypothesis is that the working environment of schools varies by prefecture.

Table 1. Dependent and independent variables for each model.

Model	Dep. Var.	Indep. Var.
I	APP	ACC, SLR, NEP, GEM, DM_1, DM_2, DM_3, CNS
II	APP	GRD, RSL, RTM, RPC, DM_1, DM_2, DM_3, CNS
III	APP	GRD, RSL, RTM, RPC, FPI, CAB, CNS
IV	APP	GRD, RSL, RTM, RPC, FPI, CAB, DM_1, DM_2, DM_3, CNS
V	RPC	ACC, SLR, NEP, GEM, DM_1, DM_2, DM_3, CNS
VI	RPC	ACC, GRD, RSL, RTM, DM_1, DM_2, DM_3, CNS
VII	RPC	ACC, GRD, RSL, RTM, FPI, CAB, DM_1, DM_2, DM_3, CNS

Dep. Var.: Dependent variable; Indep. Var.: Independent variable.

Hori et al. (2019) reported that 41.7% of the male and 44.0% of the female Japanese schoolteachers were diagnosed with insomnia because they spent a considerable amount of time preparing for lectures. Additionally, the results of multivariate logistic regression analyses have shown that long working hours, long commuting times, and the urbanicity of schools are significantly associated with insomnia.

METHODOLOGY AND DATA

Regional characteristics of SRS in Japan

We used the data on the number of pupils and schoolteachers enrolled in the public primary, middle, and high schools of Japan between 1980 and 2019. In addition, we used the data on the number of applicants for the SREs and the candidates who were accepted by the public primary, middle, and high schools after they passed the SREs during the same period. We performed cluster analysis on two cases, which we denote as CA1 and CA2. Three sets of variables were used for each case. The reason for performing cluster analysis was to find the regional characteristics of a set of prefectures in Japan, as it is an important factor in determining the number of applicants for the SREs.

(1) CA1 is characterized by the data on PPL and TCH collected the public primary, middle, and high schools in each prefecture in Japan, and RPT, which is defined as PPL/TCH,
(2) CA2 is characterized by the data on APP and ACC collected from the SREs, and RPC, which is defined as APP/ACC.

Regression model analyses for improving the SRS in Japan

We attempted to construct a multivariate regression model to quantitatively characterize the two dependent variables APP and RPC and measure the impact of various factors on these two variables. We selected different sets of independent variables to understand the behavior of the two dependent variables. We defined seven multivariate regression models, in four of which APP is the dependent variable and in the remaining three RPC is the dependent variable.

Our multivariate regression models aim to identify the main determinants of the two important variables, namely, the number of applicants (APP) for the SREs and the ratio (RPC) of the number of applicants (APP) to the number of accepted applicants (ACC). The multivariate regression model can be expressed as follows: Let the index sets *I*, *J*, *K* and *T* denote sets of prefectures, independent variables, dummy variables and years, respectively.

$$y_{it} = a_o + \sum_{j\in J} a_j x_{ijt} + \sum_{k=1}^{3}\sum_{t\in T} b_{kt}\, DM_{kt} + u_i + v_t + e_{it} \qquad i\in I,\ t\in T$$

Where $a_o, \{a_j, j \in J\}$ and $\{b_k, k \in K\}$ are parameters and $\{e_{it}, i \in N,\ t \in T\}$ is the error term. Assuming that $\{e_{it}, i \in I,\ t \in T\}$ is normally distributed, we apply the ordinary least squares (OLS) method.

With either APP or RPC as the dependent variable, we chose a set of independent variables for each regression model from I to VII, as shown in Table 1. We defined the dependent variable $\mathrm{y_i}$ to be APP for models I to IV and RPC for models V to VII. The independent variables $\{\mathrm{DM}_k, k = 1,2,3\}$ are dummy variables corresponding to the elements in each cluster denoted by $k \in \{1,2,3\}$, as discussed in Section 4. Note that the dummy variables $\{\mathrm{DM}_k, k = 1,2,3\}$ indicate the impacts of the prefectures included in cluster *k* relative to those in cluster 4, which contains the largest number of prefectures among all the clusters.

We considered the following independent variables in our multivariate regression model, as shown in Table 1: APP; ACC; RPC; the average number of people expected

Table 2. Number of elements and their percentages (CA1).

Cluster	1980	1985	1990	1995	2000
			Size (%)		
1	2 (4.26)	3 (6.38)	5 (10.64)	5 (10.64)	8 (17.02)
2	7 (14.89)	6 (12.77)	4 (8.51)	5 (10.64)	3 (6.38)
3	17 (36.17)	14 (29.79)	15 (31.91)	16 (34.04)	15 (31.91)
4	21 (44.68)	24 (51.06)	23 (48.94)	21 (44.68)	21 (44.68)
Total	47 (100)	47 (100)	47 (100)	47 (100)	47 (100)
Cluster	**2005**	**2010**	**2015**	**2018**	
			Size (%)		
1	5 (10.64)	5 (10.64)	5 (10.64)	5 (10.64)	
2	4 (8.51)	5 (10.64)	5 (10.64)	5 (10.64)	
3	16 (34.04)	15 (31.91)	15 (31.91)	16 (34.04)	
4	22 (46.81)	22 (46.81)	22 (46.81)	21 (44.68)	
Total	47 (100)	47 (100)	47 (100)	47 (100)	

( ): Percentages (%).

to be newly employed (NEP); the average number of people employed annually (GEM); the number of university graduates (GRD); the initial monthly salary (SLR); the ratio (RSL) of SLR to the initial monthly salary of university graduates (USL); the ratio (RTM) of GEM to the average number of people applying for jobs (GJB); fiscal power index (FPI); current account balance (CAB); and certain constant terms (CNS).

RESUTS AND ANALYSES

Clustering results to PPL–TCH data

First, we present the results for case CA1, where we performed *K*-means clustering on the actual related data collected during the period between 1980 and 2019. Table 2 shows the size (that is, number of elements) and percentage of each cluster for each year. Table 3 shows the coordinates of the center of gravity (CGV) of each variable for each year and each cluster of CA1.

Table 2 shows that clusters 1 and 2 mostly consist of 9–11 elements (that is, prefectures), which is approximately 20% of the 47 prefectures in Japan, for all the years between 1980 and 2019. Table 3 shows that cluster 1 has the largest average CGV for all the variables (that is, PPL, TCH, and RPT) for all years. Cluster 2 has the second largest average CVG for all years, as seen in Table 3. From Table 1, we see that the prefectures in clusters 1 and 2 are stable and nearly the same for all years, that is, HKD, STM, CHB, TKY, KNW, ACH, OSK, HGO, and FKK, except in 2000, when only IBK and SZK are seen to occur in cluster 2. The prefectures contained in clusters 1 and 2 are the most urbanized prefectures in Japan, as they include the most populated designated cities, such as Sapporo, Saitama, Tokyo, Yokohama, Nagoya, Osaka, Kobe, and Fukuoka. Cluster 3 contains the prefectures MYG, FKM, IBK, TCG, GNM, NGT, NGN, GFU, MIE, KYT, OKM, HRM, KMT, and KGM, for all the years between 1980 and 2019; moreover, these are the second most urbanized prefectures in Japan following those in clusters 1 and 2. Cluster 3 nearly always consists of 15–17 elements during the above period. Finally, we see that cluster 4 always consists of approximately 20–22 elements during the concerned period, including the most remote and rural prefectures located in the Tohoku, Hokuriku, Shikoku, and Kyushu regions of Japan.

Table 3 shows the average CGV values of each variable in each cluster. We observe that the CGV values in clusters 1 and 2, especially those of PPL and TCH, are significantly larger than those in clusters 3 and 4, although the CGV value of the variable RPT does not show a large variation (compared to the CGV values of PPL and TCH). This is because PPL and TCH in the prefectures in clusters 1 and 2 are much larger than those in the other clusters, while the gap in RPT between the first (clusters 1 and 2) and second (clusters 3 and 4) groups is much smaller compared to PPL and TCH. In conclusion, we can say that the clustering for case CA1 is mainly based on the degree of urbanization of the 47 prefectures in Japan. By estimating the distance between the CGVs of each cluster, we found that the distance between clusters 1 and 2 and that between clusters 3 and 4 are small, while the distance between cluster groups {1, 2} and {3, 4} is large, for nearly all the years. This implies that clusters 1 and 2 are close and so are clusters 3 and 4; however, cluster groups {1, 2} and {3, 4} are farther apart. In other words, we can say that there exists a large gap between cluster groups {1, 2} and {3, 4}.

Table 3. CGV for each variable and each cluster (CA1).

Cluster	1980			1985		
	PPL	**TCH**	**RPT**	**PPL**	**TCH**	**RPT**
1	1,582,844	64,319	24.605	1,432,504	60,207	23.901
2	964,388	40,104	24.150	974,208	42,168	23.179
3	361,498	16,942	21.251	392,547	18,403	21.237
4	184,705	9,400	19.603	201,601	10,315	19.489
Cluster	**1990**			**1995**		
	PPL	**TCH**	**RPT**	**PPL**	**TCH**	**RPT**
1	1,118,341	51,889	21.649	925,205	49,489	18.841
2	815,303	40,285	20.417	660,245	36,605	18.235
3	356,532	18,523	19.165	292,349	17,242	16.948
4	182,315	10,280	17.686	154,222	9,805	15.712
Cluster	**2000**			**2005**		
	PPL	**TCH**	**RPT**	**PPL**	**TCH**	**RPT**
1	754,962	42,649	17.738	801,889	45,349	17.723
2	453,311	25,643	17.606	564,937	35,903	15.894
3	251,730	15,955	15.803	248,520	16,667	14.857
4	135,301	9,288	14.533	123,284	9,056	13.560
Cluster	**2010**			**2015**		
	PPL	**TCH**	**RPT**	**PPL**	**TCH**	**RPT**
1	809,393	46,816	17.322	795,110	48,143	16.558
2	511,687	33,261	15.580	489,676	33,096	14.948
3	225,725	15,789	14.291	210,749	15,440	13.629
4	113,904	8,643	13.114	104,525	8,319	12.483
Cluster	**2018**					
	PPL	**TCH**	**RPT**			
1	780250	48676	16.055			
2	475025	32896	14.570			
3	198564	14896	13.323			
4	96546	7991	12.022			

Figures 5, 6, and 7 show the trends in the CGV values of the three variables of CA1 (that is, PPL, TCH, and RPT, respectively) between the years 1980 and 2019. From Figure 5, we observe that clusters 1 and 2 show decreasing trends in the CGV value of PPL during the period between 1980 and 2000, following which the CGV value remains stable until 2018, whereas the CGV value of PPL in clusters 3 and 4 remains nearly stable during the entire period.

This is because PPL predominantly decreases in the highly urbanized prefectures belonging to clusters 1 and 2 until the year 2000. Figure 6 shows a similar trend to that in Figure 5, except that cluster 2 remains mostly stable during the entire period. Figure 7 shows a monotonically decreasing trend in the corresponding CGV values for all the clusters, similar to the trend exhibited by the original RPT data.

Clustering results to APP–ACC data

In this segment, we present the results for case CA2, where we performed cluster analysis on the actual data collected from Japan between 1980 and 2019. Table 4 shows the size (or number of elements) and percentage of each cluster for each year. Table 5 shows the coordinates of the CGV of each variable by year and cluster for CA2.

From Table 4, we observe that clusters 1 and 2 primarily contain 8–13 elements for all the years except 1980, which corresponds to only five elements. The number of elements in cluster 3 varies in the range 7–18, while that in cluster 4 (which has the largest number of elements among the four clusters) varies in the range 18–34.

From Table 5, we observe that the elements contained in cluster 1 correspond to the largest average CGV values of both the variables APP and ACC for all years; however,

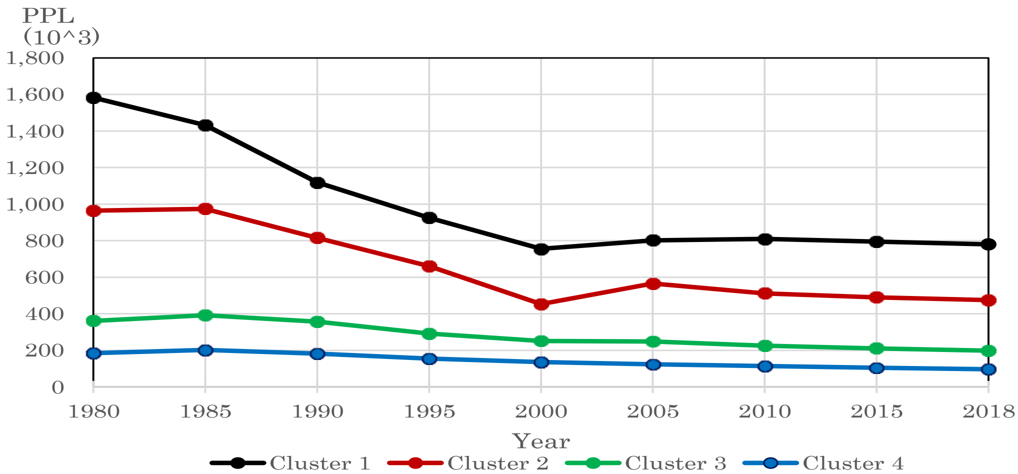

Figure 5. Trends of the CGV for the variable PPL (1980 through 2018).

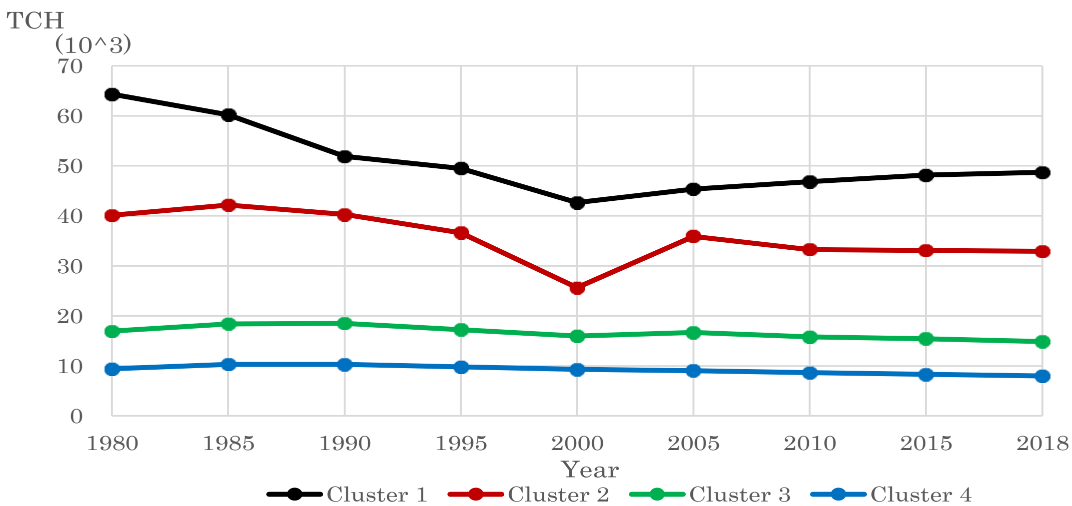

Figure 6. Trends of the CGV for the variable TCH (1980 through 2018).

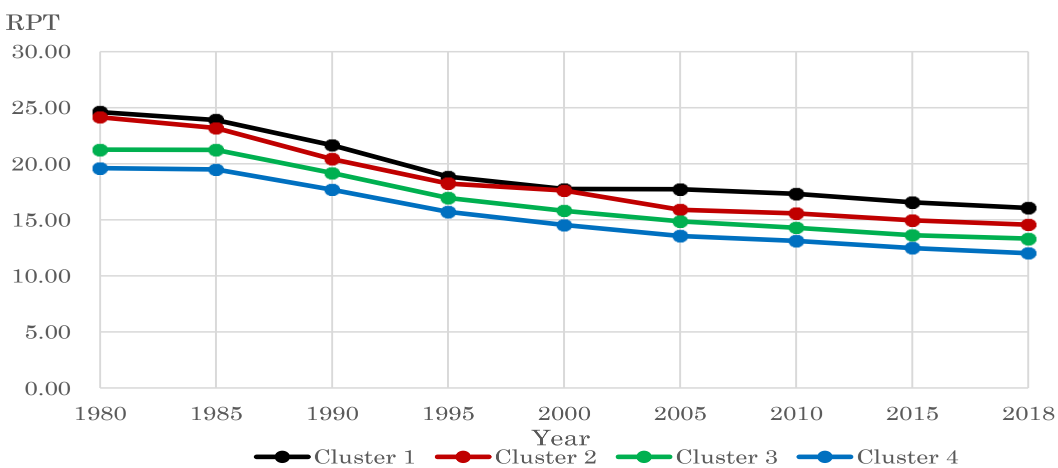

Figure 7. Trends of the CGV for the variable RPT (1980 through 2018).

Table 4. Number of elements and their percentages (CA2).

Cluster	1980	1985	1990	1995	2000
			Size (%)		
1	1 (2.13)	2 (4.26)	3 (6.38)	7 (14.89)	2 (4.26)
2	4 (8.51)	6 (12.77)	6 (12.77)	6 (12.77)	8 (17.02)
3	8 (17.02)	7 (14.89)	17 (36.17)	16 (34.04)	18 (38.30)
4	34 (72.34)	32(68.09)	21 (44.68)	18 (38.30)	19 (40.43)
Total	47 (100)	47 (100)	47 (100)	47 (100)	47 (100)
Cluster	**2005**	**2010**	**2015**	**2018**	
		Size (%)			
1	5 (10.64)	3 (6.38)	3 (6.38)	3 (6.38)	
2	6 (12.77)	6 (12.77)	6 (12.77)	5 (10.64)	
3	18 (38.30)	13 (27.66)	16 (34.04)	16 (34.04)	
4	18 (38.30)	25(53.19)	22 (46.81)	23 (48.94)	
Total	47 (100)	47 (100)	47 (100)	47 (100)	

Table 5. CGV for each variable and each cluster (CA2).

Cluster		1980			1985	
	APP	ACC	RPC	APP	ACC	RPC
1	20,944.0	3,501.0	5.982	14,146.0	2,197.5	6.460
2	14,861.3	2,934.5	5.146	8,557.3	1,632.7	5.267
3	7,719.0	1,571.4	5.077	4,603.6	1,039.0	4.527
4	2,626.2	524.7	5.252	2,379.9	524.2	5.282
Cluster		**1990**			**1995**	
	APP	**ACC**	**RPC**	**APP**	**ACC**	**RPC**
1	8,616.7	1,195.7	9.174	6,731.9	846.4	9.807
2	5,516.3	1,430.0	3.991	3,817.3	447.2	9.144
3	2,718.2	716.4	4.123	2,555.4	385.2	7.332
4	1,546.1	429.4	3.863	1,424.3	202.0	7.535
Cluster		**2000**			**2005**	
	APP	**ACC**	**RPC**	**APP**	**ACC**	**RPC**
1	9,746.0	876.5	11.642	10,349.2	1,762.8	6.636
2	5,671.8	398.9	15.338	5,493.3	760.5	8.172
3	2,976.6	214.7	14.515	2,973.4	321.4	9.981
4	1,508.1	114.8	14.207	1,453.7	135.8	12.264
Cluster		**2010**			**2015**	
	APP	**ACC**	**RPC**	**APP**	**ACC**	**RPC**
1	13,808.3	2,769.0	4.975	14,394.0	2,746.7	5.354
2	7,417.3	1,347.3	6.174	8,215.8	1,569.7	5.288
3	3,217.5	416.3	8.830	3,181.7	550.0	6.281
4	1,559.6	203.3	8.524	1,436.0	263.0	5.866
Cluster		**2018**				
	APP	**ACC**	**RPC**			
1	12802.3	2391.0	5.420			
2	8326.4	1785.8	4.794			
3	3052.4	624.4	5.270			
4	1539.6	371.0	4.250			

the variable RPC does not always have the largest CGV value, especially post 2000. The largest average CGV values occur in cluster 1 between 1980 and 1995 and again in 2018, whereas the smallest CGV values occur after 2000. The largest average CGV values occur in cluster 2 in 2000, in cluster 4 in 2005, and in cluster 3 in 2010, 2015, and 2019. The CGV values of the variables APP and ACC for cluster 2 are the second largest for all years, whereas the CGV value of the variable RPC is the third or fourth largest for all years except 2000, when it is the largest. The average CGV values of all the variables for cluster 4, which contains the largest number of elements, are the smallest among all the clusters for all years.

We also observe that there is a large gap in the value of APP between the cluster groups {1, 2} and {3, 4}, which is not true for the variable ACC, although both the variables exhibit a decreasing trend with year. This implies that the variables APP and ACC are much larger in the highly populated urban prefectures than in other prefectures. However, the variable RPC appears to be larger in the rural and remote prefectures. This implies that the largest CGV values occur in clusters 2, 3, and 4. Moreover, we found that the distance between the CGVs of clusters 1 and 2 and that between clusters 3 and 4 are small, while the distance between the CGVs of cluster groups {1, 2} and {3, 4} is large. This implies that clusters 1 and 2 are close, and so are clusters 3 and 4, while cluster groups {1, 2} and {3, 4} are farther apart. Thus, there is a large gap between cluster groups {1, 2} and {3, 4}.

We find that prefectures such as HKD, STM, CHB, TKY, KNW, ACH, OSA, HGO and FKK are mostly in clusters 1 and 2 during the entire period between 1980 and 2019, except that HGO and FKK are in cluster 3 in one year, CHB in two years, and HKD in three years. MYG, FKM, IBK, NGT, NGN, SZK, MIE, KYT, OKM, HRM and OKW most frequently appear in cluster 3 between 1980 and 2019. Cluster 4 includes all other 16 to 34 prefectures in Japan, which are located in rather remote and rural areas, including the northern Tohoku area (AKT and YGT), the central Chubu-Hokuriku area (YMN, GFU, SHG, NRA, WKM, IKW, and FKI) and the western Chugoku-Shikoku-Kyushu area (TKM, KGW, EHM, KCH, SGA, NGS, and OIT).

Figures 8, 9, and 10 show the trends in the CGV values of the three variables of CA2 (that is, APP, ACC, and RPC, respectively) between 1980 and 2019. Figure 8 shows that all the clusters exhibit a decreasing trend in the CGV value between 1980 and 1995, following which the CGV value exhibits an increasing trend for clusters 1 and 2 and remains stable for clusters 3 and 4. This implies that the decreasing trend in the CGV value of APP between 1980 and 1995 results from the decreasing trend in APP exhibited by nearly all the prefectures during the above period. Furthermore, we have seen that post 1995, prefectures belonging to clusters 1 and 2 show an increasing trend in APP, while APP in the prefectures belonging to clusters 3 and 4 remains stable. From Figure 9, we observe that the CGV value of ACC exhibits almost the same trend as the CGV value of APP except in the years post 2000—cluster 1 shows a decreasing trend after 2010, while clusters 3 and 4 show a small increase. Figure 10 shows the trend in the CGV value of RPC between 1980 and 2018. As mentioned above, cluster 1 does not exhibit the largest CGV values between 2000 and 2015. This in turn implies that the prefectures belonging to cluster 1 do not have the highest RPC post 2000. We also found that the gap between the lowest and highest values of RPC decreases with year, as seen in Figure 4; hence, the prefectures belonging to clusters 2 and 4 exhibit a higher RPC in the recent years.

DISCUSSION

Strategic analyses for improving the SRS in Japan

One of the important factors governing the demand for teachers is student enrollment. The declining birth rate in Japan has resulted in a corresponding decline in the number of students over the past few decades. Student enrollment in public schools (elementary, middle, and high schools) has declined by approximately 9 million between 1980 and 2019.

By investigating the relationship between the salary and quality of teachers, Hanushek et al. (1999) concluded that teacher mobility is more affected by the characteristics of the students (that is, income, race, and achievement) than by salary schedules. Loeb and Page (2000) studied the relationship between teacher salaries and student outcomes and estimated that raising teacher wages by 10% could reduce high school dropout rates by 3 to 4%. Jackson (2014) proposed that either teachers are less influential in high schools than in elementary schools or test scores are a weak measure of teacher quality at the high school level.

Falch et al. (2009), using a large panel of Norwegian local governments between 1981 and 2002, find a sizeable negative relationship between teacher shortages and the regional unemployment rate. Jacob (2007), examining challenges faced by urban districts in staffing their schools with effective teachers, suggests that policies to enhance teacher quality must be evaluated in terms of their effect on student achievement. Hanushek and Rivkin (2012), evaluating teachers according to the learning gains of students, show large variations within schools as opposed to between schools. Thus, the underlying statistical modeling based on the direct use of value-added measures has become the subject of intense research in policy discussions. Efforts to improve education quality and raise student learning levels in Latin America and the

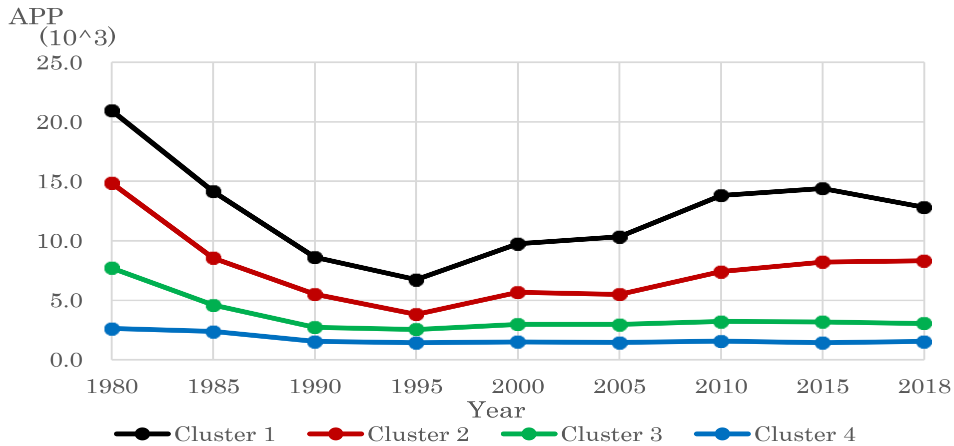

Figure 8. Trends of the CGV for the variable APP (1980 through 2019).

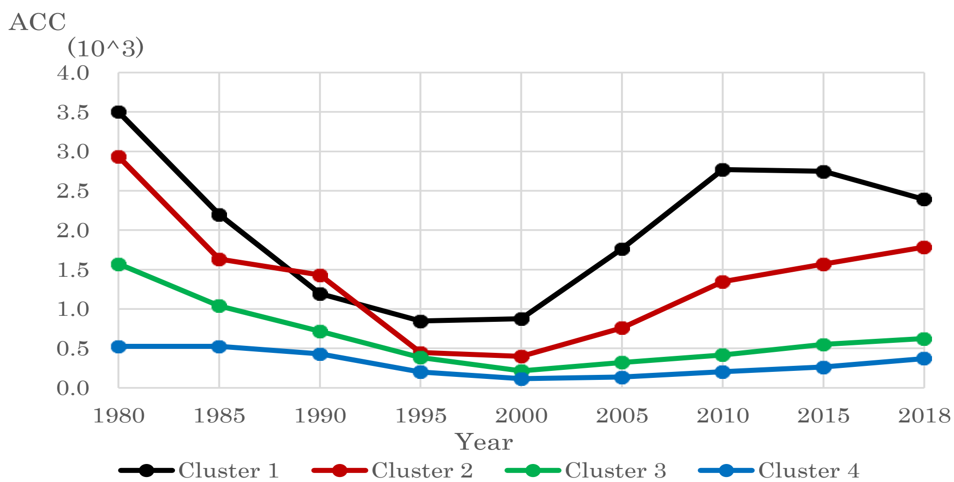

Figure 9. Trends of the CGV for the variable ACC (1980 through 2019).

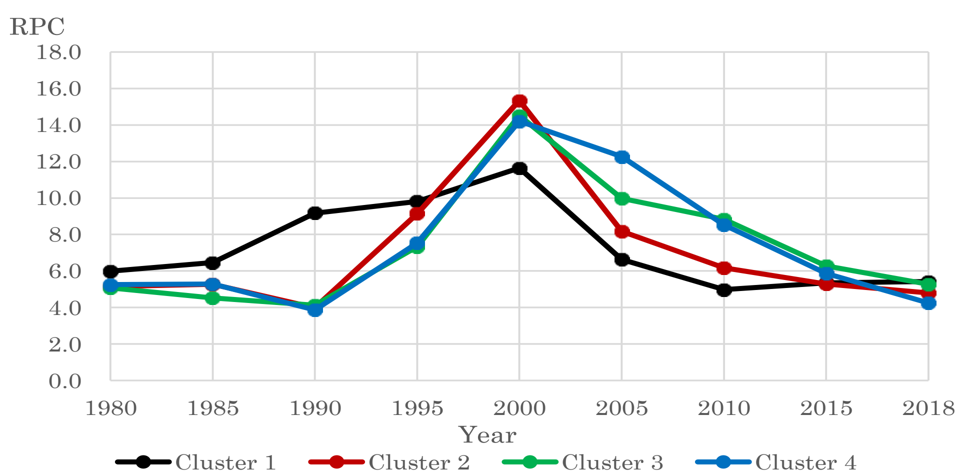

Figure 10. Trends of the CGV for the variable RPC (1980 through 2019).

Caribbean are described in Bruns and Luque (2014). Rose and Sonstelie (2010) present a public choice theory to test the bargaining power of teachers' unions.

Ladd (2007), comparing policies based on survey data in the US, notes that in high-salary countries such as Germany, Japan, and Korea, only 4% of teachers are underqualified, compared to more than 10% in the United States. Vegas (2007) surveys various strategies used by the world's developing countries to fill their classrooms with qualified teachers. Levin et al. (2005) focus on the contractual staffing rules governing "voluntary transfers" and "excessed teachers." Koski and Horng (2007) focus on the legal, policy, and contractual structures in California that are designed to place highly qualified teachers in low-income, high-minority schools. Fowler (2003) examines a nationally prominent program for new teachers in Massachusetts.

We agree that quality teachers and school principals are among the most important requirements for a successful school, defined as the ability of the school to raise its students' achievements. Clotfelter et al. (2006) raised the question concerning the quality of the teachers and principals in high-poverty schools in North Carolina. Reed et al. (2006) investigate the effects of two policies intended to improve induction programs and compensation on retention. Ingersoll (2004) considers teacher shortage problems with other related factors, such as the most disadvantaged and neediest schools serving rural and urban low-income communities. Rosenblatt (2001) investigates the mediating effect of teachers' skill flexibility on the relationship between extra teaching school roles and work attitudes (for example, burnout, tendency to quit, and organizational commitment). Henson and Hall (1993) evaluate reform programs from various viewpoints. Brunner and Imazeki (2010) conclude that there is virtually no empirical evidence on how tenure affects teacher labor markets. They find that the relationship between probation length and wages is stronger for experienced teachers and in districts that engage in collective bargaining. Jackson et al. (2014) review the most recent findings in economics on the importance of teachers and on teacher-related policies aimed at improving educational production.

Tables 6 and 7 show the regression results for the years 2008 and 2018, respectively. We observe that the R^2 value, which indicates the goodness of fit of a model, is higher for models I to IV ($R^2 \geq 0.9$) than for models V to VII (R^2 in the range 0.4–0.5). In addition, we found that for models I to VII, the parameter estimates of the dummy variable $DM_{k,}$ (k= 1, 2, 3) are always highly significant. This implies that clustering plays an extremely important role in determining the dependent variables APP and RPC. Furthermore, cluster 1 has the highest impact, which only includes the TKY prefecture, followed by clusters 2 and 3.

Note that cluster 4 has zero (that is, reference) impact. Thus, we believe that the prefectures belonging to cluster 4 need to be considered to increase APP and RPC, as its impact is much less than the other clusters. In addition, we found that the parameter estimates of $DM_{k,}$ for 2018 are larger than those for 2008. This implies that the impact due to the differences between different clusters has increased during the last ten years. We believe that these differences should be considered more carefully when designing policies to promote the SREs. In addition, we believe that these differences are important for improving the recent declining trends observed in both APP and RPC in Japan.

The results of model I show that the coefficient of ACC was 2.362 in 2008 compared to 1.242 in 2018. This implies that the unit increase in ACC caused the increase in 2008 more than double that in 2018; thus, a unit increase in ACC cannot cause a large increase in APP. Interestingly, in 2008, the variables NEP and GEM were on average significant; however, they were not significant in 2018. The results of models II and III indicate that the effect of GRD is positively significant with respect to APP but is not very large; moreover, we found that the impact of GRD in 2018 (0.018) is larger than that in 2008 (0.013). This implies that GRD has become an important factor for increasing APP in the last ten years. The effect of RTM was found to be positive and large in 2018, implying that the number of newly employed people is an important factor. Additionally, the results show that FPI is always more effective and positively significant with respect to APP than CAB. This implies that FPI, which is an economic factor, can be an effective indicator of APP and can also be used to increase it. The results of model IV show that the variables RTM and FPI were both positively significant in 2008 but were not significant in 2018. This implies that their impacts have declined during the last ten years, at least with respect to influencing the variable APP. In conclusion, we can say that strategic solutions for increasing APP have become more challenging now than they were ten years ago. This is mainly because the estimates of the positively significant variable coefficients are smaller in 2018 than in 2008.

Models V to VII provide the estimates of the dependent variable RPC. We observe that the variable ACC is always negatively significant and not very large, implying that increasing ACC causes RPC to decrease slightly. Regarding the effects of other independent variables, we found that RSL, which corresponds to the salary difference between schoolteachers and people in other jobs, was negatively significant except in 2018; in addition, CAB was found to more effective and positively significant. These results imply that the impact of salary-related variables has decreased during the last ten years, while the impact of the fiscal condition of the local government (that is, CAB) on RPC has increased.

Economical approaches have been applied to address the recruiting system for schoolteachers relative to job markets. Loeb and Béteille (2008) show that there is adequate space to describe labor market dynamics, developing and substantiating theories about the mechanisms, driving the trends and relationships

Table 6. Regression results (2008).

Model	**I**	**II**	**III**	**IV**
Dep. Var.	**APP**	**APP**	**APP**	**APP**
ACC	2.362**(0.0)			
GRD		0.013**(0.055)	-0.005(0.709)	0.000(0.961)
SLR	-8.098(0.492)			
NEP	0.454**(0.0)			
GEM	-0.162**(0.0)			
RSL		-2167.63(0.326)	-4192.96(0.276)	-2384.85(0.214)
RTM		1442.23*(0.020)	-4730.98**(0.0)	2546.11**(0.0)
RPC		-22.203(0.492)	-36.138(0.545)	8.966(0.766)
FPI			12595.50**(0.0)	4906.60**(0.0)
CAB			197.10*(0.001)	14.264(0.655)
DM_1	5262.66**(0.0)	9811.73**(0.0)		7695.65**(0.0)
DM_2	2877.28**(0.0)	4410.26**(0.0)		3616.93**(0.0)
DM_3	I954.34**(0.0)	1406.41**(0.0)		926.54**(0.0)
CNS	2374.06(0.301)	5443.90(0057)	-7903.89(0.178)	3559.95(0.259)
Adj. R^2	0.984	0.963	0.887	0.973
Model	V	VI	VII	
Dep. Var.	RPC	RPC	RPC	
ACC	-0.003**(0.0)	-0.004**(0.0)	-0.004**(0.0)	
GRD		0.000*(0.033)	0.000(0.358)	
SLR	-0.027(0.375)			
NEP	0.000(0.865)			
GEM	0.000(0.830)			
RSL		-3.961(0.179)	-6.149*(0.035)	
RTM		-1.984*(0.022)	-1.734(0.105)	
RPC				
FPI			2.184(0.368)	
CAB			0.136*(0.011)	
DM_1	6.257**(0.0)	6.541**(0.0)	4.031**(0.006)	
DM_2	4.248**(0.0)	4.294**(0.0)	3.594**(0.0)	
DM_3	1.480**(0.0)	1.553**(0.0)	1.164**(0.002)	
CNS	10.63(0.073)	12.146**(0.005)	4.122(0.396)	
Adj. R^2	0.39	0.506	0.572	

Figures in parentheses are *P*-values.

Table 7. Regression results (2018)

Model	**I**	**II**	**III**	**IV**
Dep. Var.	**APP**	**APP**	**APP**	**APP**
ACC	1.242**(0.005)			
GRD		0.018**(0.007)	0.016(0.281)	0.012(0.091)
SLR	-33.108(0.131)			
NEP	0.328(0.150)			
GEM	-0.109(0.165)			
RSL		-1927.38(0.386)	-1025.38(0.858)	-1430.72(0.597)
RTM		-701.56(0.074)	-2470.5**(0.005)	-762.19(0.064)
RPC		68.634(0.354)	63.407(0.704)	43.413(0.593)
FPI			11688.1**(0.0)	1763.86(0.190)

Table 7. Contd.

CAB			140.570*(0.034)	45.007(0.182)
DM_1	7994.29**(0.0)	9830.14**(0.0)		8558.60**(0.0)
DM_2	4938.41**(0.0)	6377.62**(0.0)		5761.00**(0.0)
DM_3	1264.30**(0.0)	1538.83**(0.0)		1322.39**(0.0)
CNS	7554.28(0.097)	4621.13(0.130)	-7721.32(0.327)	299.970(0.934)
Adj. R^2	0.98	0.97	0.862	0.972
Model	V	VI	VII	
Dep. Var.	RPC	RPC	RPC	
ACC	-0.005**(0.0)	-0.004**(0.0)	-0.004**(0.0)	
GRD		0.000*(0.015)	0.000(0.125)	
SLR	-0.139**(0.005)			
NEM	0.000(0.438)			
GEM	0.000(0.461)			
RSL		3.648(0.344)	-3.860(0.376)	
RTM		1.899**(0.006)	-1.036(0.121)	
RPC				
FPI			-2.379(0.261)	
CAB			0.161**(0.002)	
DM_1	8.301**(0.0)	7.199**(0.0)	5.489**(0.003)	
DM_2	6.674**(0.0)	5.229**(0.0)	4.794**(0.0)	
DM_3	2.278**(0.0)	1.814**(0.0)	1.848**(0.0)	
CNS	34.215**(0.001)	4.046(0.461)	1.228(0.834)	
Adj. R^2	0.385	0.416	0.535	

Figures in parentheses are *P*-values.

observed, developing instruments for measurement, and evaluating programs. They provide an overview of what they know about teacher labor markets in the United States. Focusing on teacher labor markets in the United States, Loeb and Myung (2020) identify common policy approaches for advancing recruitment and retention goals, summarize the current research, and discuss the effectiveness of these policies.

SUMMARY AND CONCLUSIONS

In this paper, we briefly described the current SRS in Japan using data from the period between 1980 and 2019. We pointed out that the declining trend in both the number of applicants for schoolteachers and the competition rate in Japan is a pressing problem that needs to be addressed. We briefly explained the SRS in Japan, and we performed cluster analysis to identify regional characteristics in the PPL–TCH–RPT and APP–ACC–RPC datasets. Next, we applied multivariate regression models to analyze the two variables APP and RPC. This finally led to the development of strategic policies for improving the SRS in Japan.

We used the historical data from 1980 to 2019 and performed cluster analysis with seven different combinations of ten variables for two cases. We found that the clustering results were very stable and consistent during the last 40 years. We defined two cases: one consisting of the number of pupils, number of teachers, and their ratio; and the other consisting of the number of applicants, number of accepted applicants, and their ratio. We found a total of four clusters, each of which contained nearly the same number of prefectures with similar characteristics. Clusters 1 and 2 mostly consisted of urbanized prefectures, while clusters 3 and 4 mainly consisted of remote prefectures.

We constructed seven multivariate regression models, defined two dependent variables APP and RPC, and introduced dummy variables corresponding to each cluster. We found that clustering is very effective in determining the impact of the independent variables listed in Table 5. Our cluster analysis classified the 47 prefectures in Japan into four clusters, which were mostly stable and consistent during the period between 1980 and 2019 for both the cases CA1 and CA2 (particularly CA1). We found that the order of clusters 1 to 4 corresponds to the degree of urbanization of the prefectures in Japan, with cluster 1 having the highest order and cluster 4 the lowest. We would like to emphasize that, to the best of our knowledge the results presented in this work are novel, as no previous study has quantitatively analyzed such a large public dataset. We would also like to highlight the new approach explored in this work, which is a combination of clustering and multivariate regression models. Yamasaki (1998, 2003) investigated various factors that determine the number of accepted candidates (ACC) among those who passed the SRE. He found three main factors: (i) variance of the number of pupils, (ii) number of retired teachers, and (iii) correlation between the number of pupils and number of retired teachers. In contrast, the present study focused on the determinant factors for APP and RPC. Our results showed that both social and economic factors have an impact on APP and RPC.

The results of our regression analysis showed how to effectively increase the value of APP or RPC by controlling the independent variables listed in Table 7. We believe that the differences between different cluster groups should be considered when designing policies to promote SREs, which would also encourage people to take these examinations. In addition, these differences are crucial for improving the recent declining trends in both APP and RPC seen in Japan.

Tables 6 and 7 show that the order of the clusters is very important; thus, increasing the order of a cluster, for example, from 4 to 3 or from 3 to 2, can be quite effective. In addition, increasing NEP and GEM, that is, increasing the number of people newly employed in a school or in the job market in general, can also be effective. Furthermore, we found that the variables RTM and FPI are quite important, where the former corresponds to the ratio of newly employed people to the average employment, and the latter indicates the fiscal condition of a prefecture.

The numerical results of models V to VII correspond to the dependent variable RPC. We found that the variable ACC is very effective (similar to that in models I to IV) in addition to clustering. Moreover, we found that in 2018, the variables RTM and CAB became more effective compared to in 2008. This implies that increasing the number of newly employed people in the society and improving the CAB of the local government in each prefecture are important factors.

ACKNOWLEDGEMENTS

This research was supported partially by the Japan’s Grants-in-Aid for Scientific Research System (Basic Research (C) 19K04901) sponsored by the Ministry of Education, Culture, Sports, Science and Technology of Japan. We also would like to express our sincere thanks to reviewers for their invaluable comments and suggestions.

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