

## Change and Estimation of the Number of Nursery Schools Children in Yamaguchi Prefecture

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### Abstract

This paper aims to clarify the future demand of nursery schools in Yamaguchi Prefecture in both urban and widely rural areas, by studying the change in the number of nursery schools and nursery school children and estimating the number of those children. The results are as follows:

The results show that the number of nursery school children will decrease and that of abolished nursery schools will increase, especially in old towns and villages. So, the future works are factor analysis of abolished nursery schools and considering utilization method of abolished nursery schools.

**Keywords:** Nursery school, Nursery school children, Estimation

### 1. Introduction

A Nursery school was stipulated as the child welfare by introduction of the child welfare law in 1947. Establishment of a nursery school has been advanced since 1948. In recent years, the demand of nursery schools has increased due to the increase of the number of dual-income households and single-parent households, women's empowerment, changes of economic situation and do on. In urban areas, establishment of nursery schools is urgently required, because the children waiting to enter a nursery school increase. On the other hand, the number of nursery school children has decreased and some nursery schools are abolished in rural areas. It is important to solve issues, such as the continued existence of nursery schools for households with children, reorganization and rebuilding of nursery schools, utilization of abolished nursery schools and so on in order to maintain and revitalize local communities in rural areas.

This paper aims to clarify future demand of nursery schools in Yamaguchi prefecture with both urban and wide depopulated areas, by organizing change of the number of nursery schools and nursery school children and estimating the number of nursery school children.

### 2. The number of young children, households, nursery schools and nursery school children

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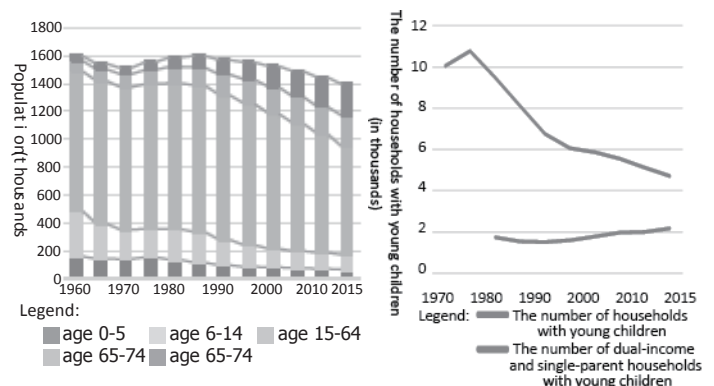


Fig.1 Population in Yamaguchi Prefecture (Left)  
Fig.2 The number of household with young children(Right)

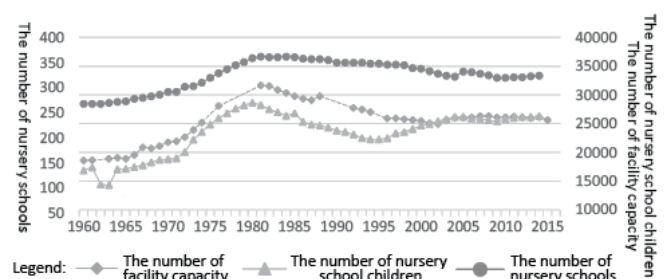


Fig.3 The number of nursery schools, facility capacity and nursery school children

Aging society with child birth rate falling are typically advanced in Yamaguchi Prefecture (Fig. 1). While the number of households with young children has decreased, the number of single-parent and dual-income households with young children has increased since 1990s (Fig. 2).

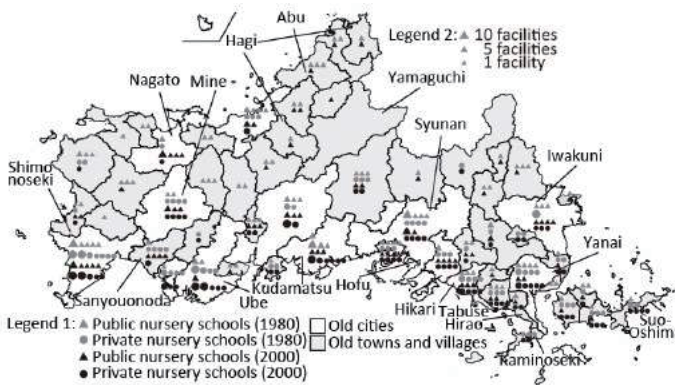


Fig.4 The location of nursery schools in 1980 and 2015

Table.1 Data of estimation

	The number of nursery school children (G)		The number of dual-income households (W)		The number of single-parent households (S)		The number of nuclear family households with young children (F)		The number of nuclear family households (N)	
	Y	C,T	Y	C,T	Y	C,T	Y	C,T	Y	C,T
1980	●	●	●	×	●	●	●	●	●	●
1985	●	●	●	●	●	●	●	●	●	●
1990	●	●	●	●	●	●	●	●	●	●
1995	●	●	●	●	●	●	●	●	●	●
2000	●	●	●	●	●	●	●	●	●	●
2005	●	×	●	×	●	×	●	●	●	●
2010	●	×	●	×	●	×	●	●	●	●
2015	●	×	●	×	●	×	●	●	●	●
2020	×	×	×	×	×	×	×	×	○	×
2025	×	×	×	×	×	×	×	×	○	×
2030	×	×	×	×	×	×	×	×	○	×
2035	×	×	×	×	×	×	×	×	○	×

Legend: ● Data available ○ Data of the estimation number available  
 × No data available Y Yamaguchi Prefecture C,T Old cities and towns and

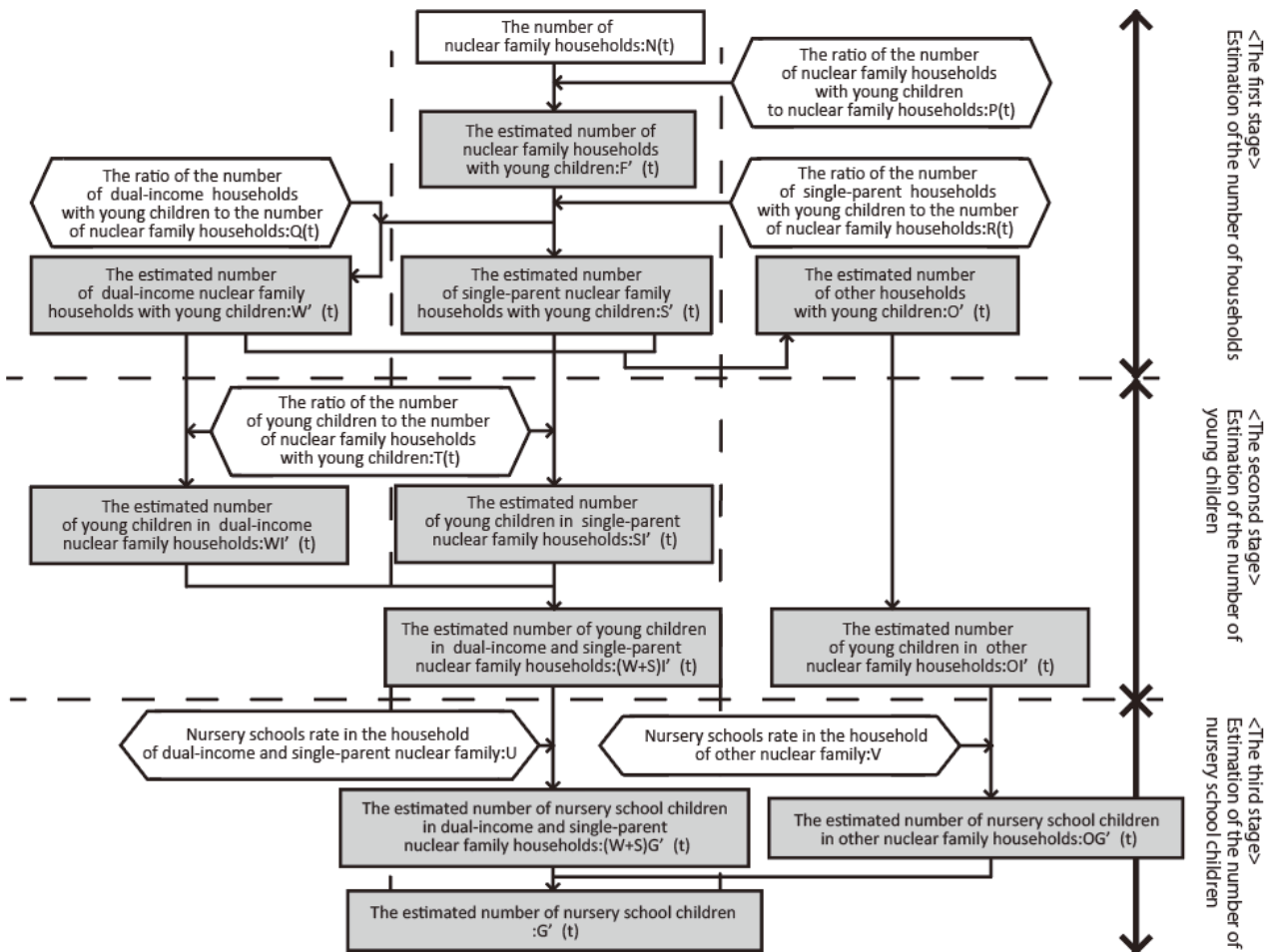


Fig.5 The flow of estimation

There were 268 nursery schools, facility capacity of 19,000 users and 17,000 nursery school children in 1960 when the childcare system was promoted (Fig. 3). The number of nursery school children increased after 1971 with increase of nursery schools, in addition they increased more by the second baby boom. On the other hand, the

number of nursery school children decreased from 1980 to 1994 due to decrease of young children, but they increased again after 1995 in spite of decrease of nursery schools.

It is because that dual-income and single-parent

households with young children increase. The number of nursery school children was on the same level with facility capacity after 1995, and the number of nursery school children exceeded the number of facility capacity in some years.

Figure 4 shows the location of nursery schools in 1980 and 2015. In the old cities, the number of private nursery schools increase, but the number of public nursery schools tends to decrease. This trend is remarkable especially in Ube and Hofu city. In the old towns and villages, the number of public

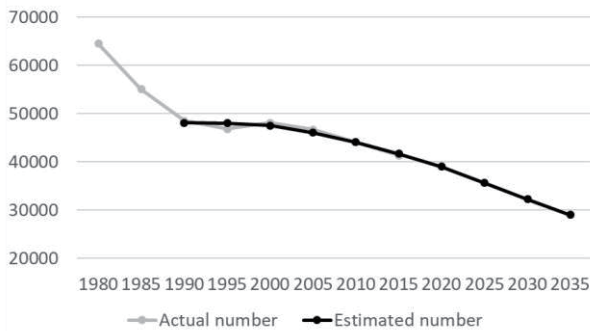


Fig.6 Estimated result of nuclear family households with young children

nursery schools decreases greatly, but the number of private nursery schools has remained almost flat. This trend is remarkable especially in Shimonoseki city and Suo-Oshima town.

### 3. Future estimation of the number of nursery school children (2020-2035)

#### 3.1. Structure of the estimation model

The basic structure of the estimation model of the number of nursery school children consists of three stages (Fig.5). Firstly, we obtain the ratio of dual-income, single-parent and other household with young children to nuclear family households with young children and estimate future these households. Secondly, we calculate the number of young children belong to these households. Thirdly, we obtain the ratio of the nursery school children belong to each household and estimate the number of the nursery school children.

#### 3.2. Data used for estimation

Table 1 shows the list of data used for estimation of the number of nursery school children. Firstly, we have estimated the future number of nuclear family households with young children by using the number of nuclear family households with young children (1980-2015) and the future number of nuclear family households (2020-2035) which is published by population problem research institute. Secondly, we have estimated the future number of dual-income, single-parent and other households in nuclear family households with young children by using the number of dual-income, single-parent and other households in nuclear family households with young children (1980-2015 or 1985-2015). Finally, we have estimated the number of young children in these households by using the number of young children in nuclear family households with young children and have estimated the number of nursery school children by using the results.

## 4. Estimation of Yamaguchi Prefecture

### 4.1 Estimation of the first stage

(a) Estimation flow of the number of nuclear

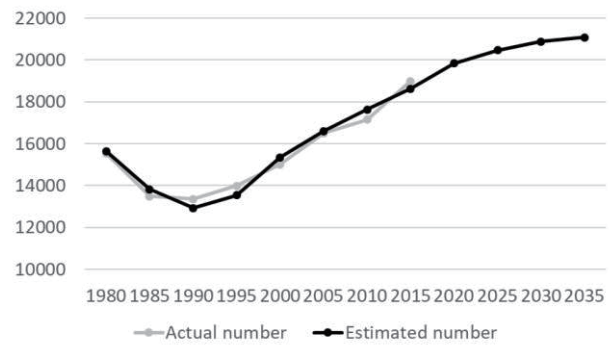


Fig.7 Estimated number of dual-income households

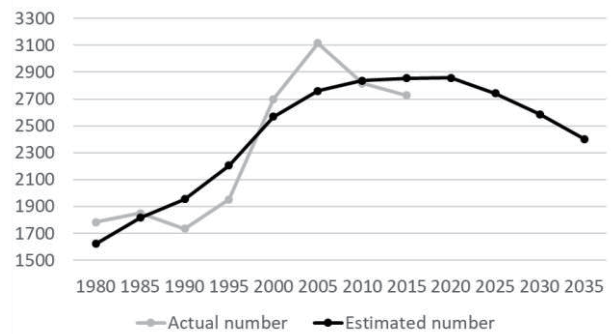


Fig.8 Estimated number of single-parent households

family households with young children

The number of nuclear family households is defined as  $N(t_1)$  and the number of nuclear family households with young children is defined as  $F(t_1)$  in 1980-2015. We obtained  $P(t_1)$ , which is the ratio of the number of nuclear family households with young children to nuclear family households (equation (1)) and obtain the time series regression equation (equation (2)). The correlation coefficient is 0.963. We obtained  $F'(t_2)$  that is the estimated number of nuclear family households with young children by multiplying  $P(t_1)$  and  $N'(t_2)$  that is nuclear family households in 2020-2035 (fig.6, equation (3)).

$$P(t_1) = F(t_1) / N(t_1) \quad \dots (1)$$

$t_1: 1980-2015$

$$P(t_1) = 2014283.31261 \times e^{-0.00825 t_1} \dots (2)$$

$$F'(t_2) = N'(t_2) \times P_1(t_2) \quad \dots (3)$$

(b) Estimation flow of nuclear Family households with young children

The number of dual-income nuclear family households with young children in 1980-2015 is defined as  $W(t_1)$ , and the number of households of single-parent nuclear family with young children in 1985-2015 is defined as  $S(t_1)$ . We obtain  $Q(t_1)$  and  $R(t_1)$ , which are the ratio of the number of

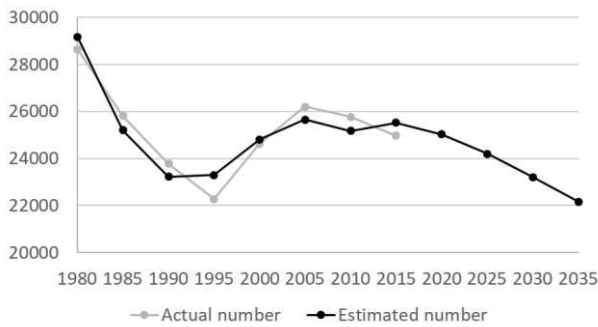


Fig.9 Estimated number of nursery school children in Yamaguchi Prefecture

Table.2 The estimation accuracy of the number of nursery school children in Yamaguchi Prefecture

	1980	1985	1990	1995
The	0.981778	0.976459	0.976449	0.954475
estimation	2000	2005	2010	2015
accuracy	0.992906	0.97893	0.976846	0.977549

dual-income and single-parent households to the number of nuclear family households in 1980-2015 (equation (4)(5)) and obtain the time series regression equation (equation (6)(7)). The correlation coefficients are 0.989 and 0.926. We obtain  $W'(t2)$  and  $S'(t2)$  that are the estimated number of dual-income and single-parent nuclear family with young children by multiplying  $Q(t1)$  and  $F'(t2)$  that is the number of the households with young children in 1980-2015 (equation (8)(9)). And, the households that subtract  $W'(t2)$  and  $S'(t2)$  from  $F'(t2)$  is defined as  $O'(t2)$  that is ] and we obtained that (equation (10)).

$$Q(t1) = W(t1)/F(t1) \quad \dots (4)$$

$$R(t1) = S(t1)/F(t1) \quad \dots (5)$$

$$Q(t1) = 0.000142687 t^2 - 0.564083809t + 557.739923917 \quad \dots (6)$$

$$R(t1) = -0.00001035 \times t^2 + 0.04261438t - 43.76465450 \quad \dots (7)$$

$$W'(t2) = F'(t2) \times Q(t2) \quad \dots (8)$$

$$S'(t2) = F'(t2) \times R(t2) \quad \dots (9)$$

$$O'(t2) = F'(t2) - (W'(t2) + S'(t2)) \quad \dots (10)$$

#### 4.2 Estimation of the second stage

(a) Estimation flow of the number of young children

The number of young children in 1980-2015 is defined as  $I(t1)$ . We obtained the ratio of  $T(t1)$  that is the number of young children to the number of nuclear family households with young children in each year (equation (11)) and obtained the time series regression equation (equation (12)). The correlation coefficient is 0.963.

$$T(t1) = I(t1) / F(t1) \quad \dots (11)$$

$$T(t1) = 0.00004396t^2 - 0.17797405t +$$

$$181.46446871 \quad \dots (12)$$

(b) Estimation flow of the number of young children by each category of households

$T(t1)$  that is the number of young children for the number of nuclear family households with young children assumes that it is possible to use the ratio of the number of young children to the number of the households in all category, and we obtained  $WI'(t2)$ ,  $SI'(t2)$  and  $OI'(t2)$  that are the estimated number of young children in dual-income, single parent and other nuclear family households multiplying  $T(t2)$  and each  $W'(t2)$ ,  $S'(t2)$  and  $O'(t2)$  (equation (13)(14) (15)).  $(W + S)I'(t2)$  that is the number of young children in dual-income and single-parent nuclear family households is defined as combination of  $WI'(t2)$  and  $SI'(t2)$  (fig.7, equation (16)).

$$WI'(t2) = W'(t2) \times T(t2) \quad \dots (13)$$

$$SI'(t2) = S'(t2) \times T(t2) \quad \dots (14)$$

$$OI'(t2) = O'(t2) \times T(t2) \quad \dots (15)$$

$$(W + S)I'(t2) = WI'(t2) + SI'(t2) \quad \dots (16)$$

#### 4.3 Estimation of the third stage

The number of young children in dual-income and single-parent nuclear family households is defined as  $(W + S)I(t1)$  in 1980-2015, and the number of young children is defined as  $OI(t1)$  in 1980-2015.  $U$  that is nursery schools rate in the household of dual-income and single-parent nuclear family in 1980-2015 was calculated to be 0.803 and  $V$  that is nursery schools rate in the household of other nuclear family was calculated to be 0.090 by multiple regression analysis. We obtained  $(W+S)G'(t2)$  that is the estimated number of nursery school children in dual-income and single-parent nuclear family households and  $OG'(t2)$  that is the estimated number of nursery school children in other nuclear family households. And, we obtained  $G'(t2)$  that is the estimated number of nursery school children in addition to them. (Fig. 8, equation (17)).

$$G'(t2) = U \times (W + S)I'(t2) + V \times OI'(t2) \quad \dots (17)$$

#### 4.4 Results of estimation

Fig.8 shows results of estimation and estimation accuracy of the number of nursery school children. The estimation accuracy in 1995 is low, but we can obtain good estimation results, because estimation accuracy of higher than 0.95 in other years. The estimated number of nursery schools will peak with 25,000 in 2020 and decrease after 2020. And it will decrease to 22,000 in 2035. The decrease is due to decreasing the estimated number of nuclear family households.

#### 5. Estimation in old cities and towns and villages

We have estimated the number of nuclear family households by old cities and towns and villages by using the number of nuclear family households in

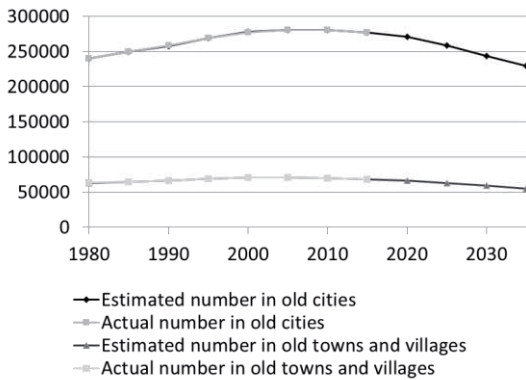


Fig.10 Estimated number of nuclear family households

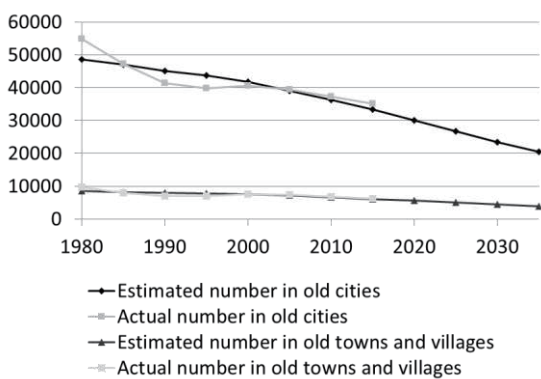


Fig.11 Estimated number of nuclear family households with young children

Yamaguchi Prefecture. It is because that the number of nuclear family households isn't published by old cities and towns and villages. And, we estimate the number of nuclear family households with young children by using the results. The following estimation method is the same with Yamaguchi Prefecture.

### 5.1 Estimation of the first stage

(a) Estimation flow of nuclear family households by old cities, towns and villages

The number of nuclear family households in 1980-2015 is defined as  $N(t_1)$ , and the number of nuclear family households in the old cities, towns and villages is defined as  $N_c(t_1)$  and  $N_r(t_1)$ . We obtained  $X_c(t_1)$  and  $X_r(t_1)$  that are the ratio of  $N_c$

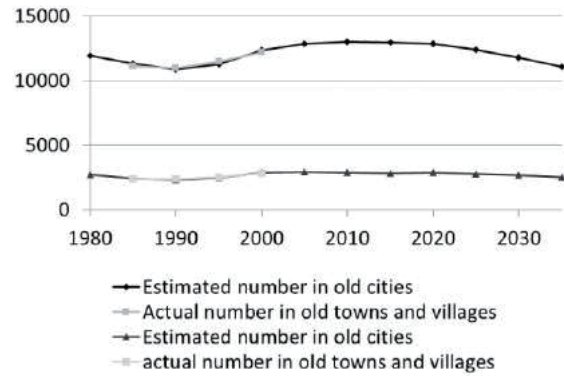


Fig.12. Estimated number of dual-income household

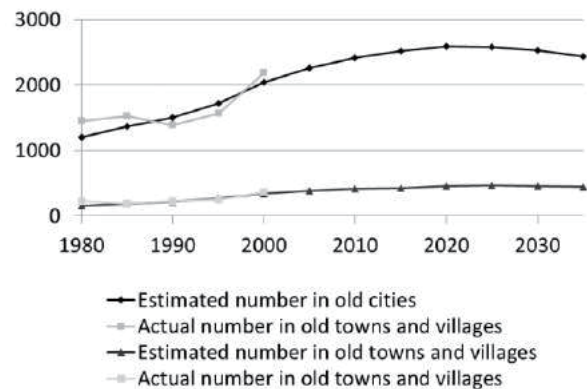


Fig.13 Estimated number of single-parent households

( $t_1$ ) and  $N_r(t_1)$  to  $N(t_1)$  and the time series regression equation. We obtained  $N_c'(t_2)$  and  $N_r'(t_2)$  multiplying  $N'(t_2)$  and  $X_c, X_r$ .

$$X_{cr}(t_1) = N_{cr}(t_1) / N(t_1) \quad \dots (18)$$

$$X_c(t_1) = 0.000261516 \times t_c + 0.274717372 \dots (19)$$

$$X_r(t_1) = -0.000261516 \times t_r + 0.725282628 \dots (20)$$

$$N_{rc}'(t_2) = N'(t_2) \times X_{rc}(t_2) \quad \dots (21)$$

(b) Estimation flow of nuclear family households with young children

The number of nuclear family households with young children by old cities, towns and villages in 1980-2015 is defined as  $F_c(t_1)$  and  $F_r(t_1)$ . We calculated the ratio of  $P_c(t_1)$  and  $P_r(t_1)$  that is the number of nuclear family households with young

Table.3 The time series regression equation

Parameter value	The time series regression equation	CORRELATION FUNCTION	Equation number
$P_c$	$P_c(t) = 1533465957265.02 \times e^{-0.014976850 t}$	0.874	22
$P_r$	$P_r(t) = 1211947214.05392 \times e^{-0.011579642 t}$	0.768	23
$Q_c$	$Q_c(t) = 8.631237986 \times \log(t) - 65.300257090$	0.97	24
$Q_r$	$Q_r(t) = 9.730912807 \times \log(t) - 73.585743805$	0.95	25
$R_c$	$R_c(t) = 0.001420946 \times t - 2.791493540$	0.845	26
$R_r$	$R_r(t) = 0.001471068 \times t - 2.896366112$	0.954	27
$T_c$	$T_c(t) = 0.0000510496 \times t^2 - 0.2062520458 \times t + 209.65685309$	0.913	28
$T_r$	$T_r(t) = 0.0000108396 \times t^2 - 0.0457166310 \times t + 49.4584426565$	0.946	29

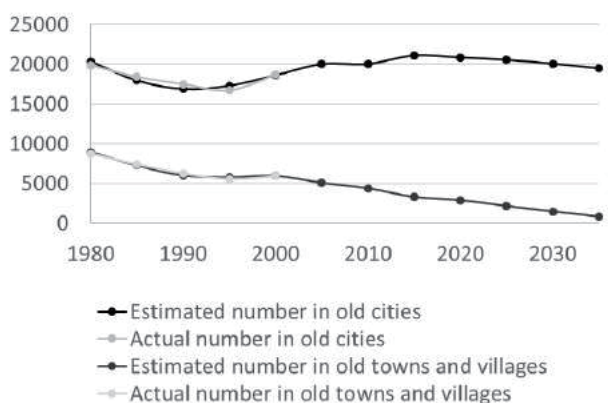


Fig.14 Estimated number of nursery school children in old cities and towns and villages

Table.4 The estimation accuracy in old cities and towns and villages

The estimation accuracy in old cities	1980	1985	1990	1995	2000
	0.975745	0.976103	0.966256	0.965636	0.994659
The estimation accuracy in old towns and villages	1980	1985	1990	1995	2000
	0.98063	0.980613	0.955949	0.960998	0.998019

children to the number of nuclear family households in the old cities, towns and villages and obtained the time series regression equation (Table 2, equation (1)). We calculated  $F_c'(t_2)$ ,  $F_r'(t_2)$  that is the estimated number of nuclear family households with young children by old cities, towns and villages (equation (3)).

(c) Estimation flow of nuclear family dual-income, single-parent and other households

The number of dual-income nuclear family households with young children in 1980-2015 is defined as  $W(t_1)$ , and the number of single-parent nuclear family households with young children in 1980-2015 is defined as  $S(t_1)$ . We obtained  $Q_{cr}(t_1)$  and  $R_{cr}(t_1)$  that are the ratio of the number of dual-income and single-parent nuclear family households with young children and the time series regression equation (table 2, equation (4)(5)). And, we obtained  $Q_{cr}$  and  $R_{cr}$  by equation (8), (9) and  $W_{cr}'(t_2)$  and  $S_{cr}'(t_2)$  that are the ratio of the number of dual-income and single-parent nuclear family households with young children by old cities, towns and villages. And we obtained  $O_{cr}'(t_2)$  to the estimated number of other households with young children by old cities, towns and villages.

## 5.2 Estimation of the second stage

(a) Estimation flow of the number of young children

The number of young children by old cities, towns and villages is defined as  $I_c(t_1)$  and  $I_r(t_1)$  and is calculated by equation (11). We obtained  $T_c(t_1)$  and  $T_r(t_1)$  that are the ratio of the number of young children to the number of nuclear family

households with young children by old cities, towns and villages and the time series regression equation (table 2).

(b) Estimation flow of the number of young children by each category of households

We obtained  $W_{Icr}'(t_2)$ ,  $S_{Icr}'(t_2)$  and  $O_{Icr}'(t_2)$  that are the estimated number of young children in dual-income, single-parent and other nuclear households by using  $T_{cr}(t_1:1980-2015)$  that is the ratio of the number of young children to the number of nuclear family by old cities, towns and villages (equation (13)(14)(15)). We obtained  $(W+S)_{Icr}'(t_2)$  that is the number of young children by using  $W_{Icr}'(t_2)$  and  $S_{Icr}'(t_2)$  (equation (16)).

## 5.3 Estimation of the third stage

The number of young children in dual-income and single-parent nuclear family households by old cities, towns and villages in 1980-2015 is defined as  $(W+S)_{Icr}(t_1)$ , and the number of young children in other nuclear family households is defined as  $O_{Icr}(t_1)$ .  $U_c$  and  $U_r$  that are nursery school rates in the household of dual-income and single-parent nuclear family by old cities, towns and villages in 1980-2015 were calculated to be 0.833 and 0.788, and  $V_c$  and  $V_r$  that are nursery school rates in the household of other nuclear family by old cities, towns and villages were calculated to be 0.050 and 0.238 by multiple regression analysis. We obtained  $(W+S)_{Gcr}(t_1)$  that is the estimated number of nursery school children in dual-income and single-parent nuclear family and  $O_{Gcr}(t_1)$  that is the estimated number of nursery school children in other nuclear family households. And, we obtained  $G_{cr}'(t_1)$  that is the estimated number of nursery school children calculated by equation (19).

## 5.4 Results of estimation

In old cities, we can get good estimated results, because estimation accuracy is higher than 0.96 in most of years. The number of nursery school children peaked in 2015 and will decrease after 2020. And it will decrease to 19,477 in 2035. The decrease is due to decreasing the number of nuclear family households. In old towns and villages, we can get good estimated results, because estimation accuracy is higher than 0.95 in most of years. The number of nursery school children will decrease after 2020 and decrease to 849 in 2035. The decrease is due to decreasing the number of nuclear family households in spite of the increase of the number of dual-income and single-parent households until 2035.

## 6. Conclusions

1) The number of nursery schools increased by 1980, but it is decreasing after 1995. On the other hand, the number of nursery school children is increasing, because the dual-income and

single-parent households increase. The facility capacity of private nursery schools increases in old cities before merger in the Heisei era. The nursery schools and facility capacity of public nursery schools decrease in old towns and villages.

2) The future nursery school children were estimated by based on Households Projections for Japan and Prefectures published by National Institute of Population and Social Security Research. The nursery school children will continue decrease to 22,161 people in Yamaguchi prefecture. And the number of nursery school children will be constant in old cities, and decrease in old towns and villages. In addition, estimation accuracy is very high, so good results are obtained.

From the above, the number of nursery school children will decrease, and abolished nursery schools will increase especially in old towns and villages. So, the future works are factor analysis of abolished nursery schools and considering utilization method of abolished nursery schools.

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