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Takahiro Suzuki

Institute of Social Sciences, suzuki@toyo.jp

Kazutoshi Tanabe

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Analysis of Factors Affecting Child Poverty Rates in Prefectures

Takahiro Suzuki*
Kazutoshi Tanabe**

Abstract

The Japanese government enacted “Act to Accelerate Policies for Disadvantaged Kids” in 2013, in the face of a society where one in seven children are in financial difficulties. The enforcement of this law required local governments to formulate and implement measures to address child poverty. However, it is evident that various factors have an impact on the child poverty rate, and the relative impact of these factors is not known yet. Consequently, there are many challenges in the implementation of poverty reduction measures by local governments. In this paper, by applying a non-linear multiple regression analysis that uses the poverty rate of children by prefecture as the target variable and multiple indicators in the population/household, economy/labor, and education/welfare fields, we have tried to conduct a statistical study on exploration and estimation of the relative impact of these factors. As a result, ten kinds of factors that reduce the poverty rate with statistically significant accuracy can be obtained. It has been found that factors like being raised by a single parent, households where there are a large number of children, and the economic and labor factors such as unemployment rate and double-income rate account for about 50% of the total impact. On the basis of the indices of these factors, we have tried to propose an approach for local governments to reduce the child poverty rates.

Keyword: Child Poverty Rates, Prefectural Disparities, Factor Analysis, Nonlinear Multiple Regression Analysis

1. Introduction

Since “the right treaty of the child” to guarantee all children human rights was adopted in the United Nations in 1989, the numbers of the death of the under 5 years old children decreased more than 50% in the world, and the child of the malnutrition was reduced to half. However, violence, the abuse to a child amounts to one billion a year, besides there are many juvenile labor and problems including the poverty of the child, and violence, the abuse to a child remains, and many problems remain for the realization of the idea of the right treaty. The Ministry of Health, Labour and Welfare announced that the child poverty rate in 2006 was 14.2%, which caused a great social reaction in 2009.¹⁾

In recent years, the environment surrounding children has changed dramatically and the appearance of children is also changing. However, to find out when child poverty has been a hot topic, authors searched for the number of newspaper articles in recent years using “child poverty” as a keyword (Fig. 1). Although there are no articles on child poverty before 2000, the number of articles has been rapidly

* Graduate School of Economics, Toyo University
** T.N.K., CEO

increasing since around 2009 announced by the Ministry of Health, Labour and Welfare (the decrease in 2011 is presumed to be due to the effects of the Great East Japan Earthquake).

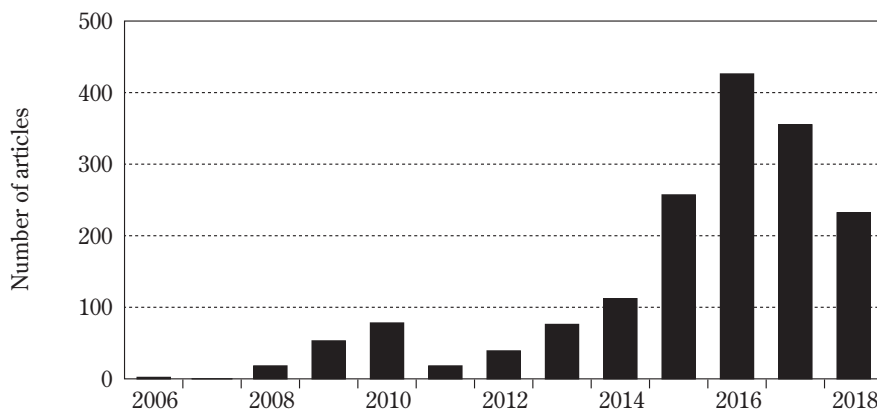


Fig. 1 Number of newspaper articles on “child poverty” (according to Asahi Shimbun DB “Kikuzo”)

According to the Ministry of Health, Labour and Welfare, the child poverty rate in Japan rose from 10.9% in 1985 to 14.5% in 2000 and 16.3% in 2012, but according to the latest data in 2015, it was 13.9%.²⁾ UNICEF reports that Japan’s poverty rate of 14.9% in 2009 is the ninth highest among the 35 developed countries.³⁾ In the face of the reality of a society in which the Japan child poverty rate is high compared to other countries and about one in seven children is in an economically difficult situation, the government enacted the “Act on the Promotion of Policy on Child Poverty” in 2013. In response to this law, the guideline sets numerical targets for the percentage of children belonging to welfare households going on to high school, the number of school social workers, and the placement rate of school counselors. In addition, local governments are obliged to formulate and implement measures to combat child poverty by enforcing this law.

However, since various factors are thought to be involved in child poverty, there are many problems in the implementation of measures to combat child poverty by local governments. On the other hand, as shown in the author’s paper⁴⁾, many studies have advanced the elucidation of the factors that greatly affect the poverty rate, but there is little research on the child poverty factor. Besides, these papers are still inadequate to understand the factors that have a significant impact on child poverty rates and their importance. Therefore, to provide useful information for the implementation of measures against child poverty by local governments, this paper conducted a nonlinear multiple regression analysis using a large number of indicators in the three fields of population and households, economy/labor, and education and welfare as explanatory variables with the child poverty rate by prefecture as the objective variable, and attempted to conduct empirical research on the estimation of their relative influence.

2. Data and methods

2.1 Child poverty rate (objective variable)

As for the data on the child poverty rate (hereinafter referred to as the poverty rate) used as the objective variable, the most reliable data from previous studies estimating the poverty rate by prefecture were adopted. There are four such studies: Kensaku Tomuro⁵⁾, Yasuo Nagai⁶⁾, Japan Foundation⁷⁾, and Yuki Sakaguchi⁸⁾, but the estimated poverty rates of these studies differ greatly as shown in Fig. 2. Tomuro calculated the percentage of households with youngest children under the age of 18 whose income is less than or equal to the minimum cost of living for public assistance as the child poverty rate on the basis of custom-made aggregate data from the Basic Survey on Employment Structure. Nagai defined the child poverty rate for the households consisting of married couples and children and households consisting of married couples, children, and parents, using data from the Basic Survey on Employment Structure. In the approach, the poverty households were as households with less than or equal to the minimum cost of living on public welfare.

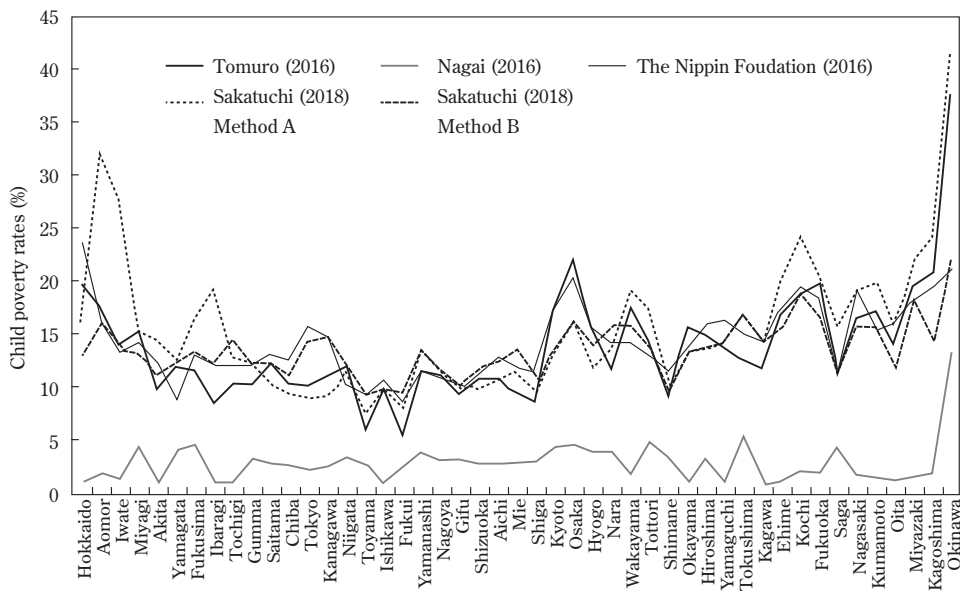


Fig. 2 Estimates of child poverty rates in 47 prefectures based on previous research (see the main text for information on Sakaguchi's A and B methods)

The Japan Foundation calculated the total percentage of 15-year-old children in households on public assistance, children in child care institutions, and households with fathers, children, and mothers as the child poverty rate, by using data from the Guardian Survey, the Survey of Children in Child Care Institutions, and the Census. Sakaguchi estimated the percentage of children under the age of 18 who fall below the poverty line calculated from household income and the number of people in households as the child poverty rate, using individual data from the Basic Survey on Employment Structure. At this time, the results of Method A, which estimated the poverty rate by setting the poverty line uniformly throughout the country, and Method B, which estimated the poverty rate by determining the poverty line for each prefecture, were announced.

As described above, there are differences in the poverty rate estimation methods, and since it is considered that they cause the difference in the poverty rate in Fig. 2, we will consider which data among these poverty rates should be adopted. First, Nagai's poverty rate is conspicuously low compared to other households, and as mentioned above, the poverty rate estimation method considers only households consisting of married couples and children, and households consisting of married couples, children and parents, and does not take into account father-child/mother-and-child households with many poor households. Therefore, Nagai's poverty rate cannot be adopted.

Next, when comparing the remaining four prefecture-specific fluctuations, it is noticeable that among them, the poverty rate of Sakaguchi's A method is considerably higher than the other results in the two prefectures of Aomori and Iwate. Since the method of A estimates the poverty rate using a nationwide poverty line, the high poverty rate in the two prefectures of Aomori and Iwate stands out when compared with the method of B, which determines the poverty line for each prefecture, and the results of Tomuro. Thus, the poverty rate of the Sakaguchi A method was also rejected.

For the remaining three methods, Tomuro, Japan Foundation, and Sakaguchi's B method, it can be seen the significant difference in Okinawa Prefecture. The poverty rate in Okinawa Prefecture of 37.5% due to Tomuro method is much higher than that of other prefectures, but the poverty rate in Okinawa Prefecture according to the Japan Foundation and the Sakaguchi's B Act is not so prominent. On the other hand, Okinawa Prefecture has announced that the child poverty rate is as high as 29.9% (although this poverty rate is estimated only for 8 of the 41 municipalities under Okinawa Prefecture).⁹⁾ Therefore, in this paper, it was decided to adopt data on the poverty rate by the method of Tomuro.⁵⁾

2.2 Explanatory variables

The explanatory variables of the multivariate analysis model include various indicators that have been verified in previous studies^{6, 8, 10-13)} that analyze the factors of child poverty rates by prefecture, and have reported effects on poverty rates. In addition to such variables, several new indices that have not been tested as explanatory variables for regression analysis have been selected. As a result, Table 1 shows the employed 47 explanatory variables in the three fields of population and households, economy/labor, and education and welfare. These prefectural data used the latest values from various government statistics, such as the Census. In addition, the unit of the index is different, and for the following sensitivity analysis, each index is normalized so that the minimum and maximum for each prefecture are 0 and 1 and used for analysis.

2.3 Analysis method

Previous studies that have explored the causes of poverty rates have made extensive use of linear multiple regression analysis (OLS). However, linearity does not always exist between poverty rates and individual explanatory variables, and statistically significant results are often difficult to obtain. To solve this problem, a support vector machine (SVM)¹⁰⁻¹²⁾ as a method of nonlinear multiple regression analysis was applied. SVM uses nonlinear functions called kernels for numerical values of explanatory variables to map learning patterns to another space (hyperplane) and perform linear regression in that space. This operation allows for nonlinear regression at the original numerical value of the explanatory variable, resulting in highly accurate regression results for any relationship between the objective and explanatory variables.

The SVM software used the regression function (SVR) of LIBSVM ver. 3.11¹³⁾ and the kernel function used RBF. To search for factors among a large number of explanatory variables, it is necessary to optimize the SVM model and explanatory variables. In this paper, for the former, the optimization of the three parameters (g , c , p) of the SVR of LIBSVM was performed by cross-validation method.

For the latter, in regression analysis, if some of the explanatory variables are not valid, the patient falls into an overlearning state, and the error on the training data decreases, but the error on the predicted data increases, so variable selection to extract the minimum necessary explanatory variables is necessary. In this paper, we adopted a sensitivity analysis method as a rapid variable selection method. This sensitivity analysis method calculates the sensitivity of each explanatory variable to the objective variable, optimizes the SVM model while sequentially removing the less sensitive variables, and searches for a combination in which the predicted value of the objective variable and the mean square error of the actual measured value are minimized. The authors demonstrate the usefulness of this sensitivity analysis method in another problem.¹⁴⁾ Thus, the search for the factor was performed by the following procedure.

(1) One prefecture is used as the prediction set and the other 46 prefectures are the learning set, and the optimal conditions of the SVM model parameters (g , c , p) are searched using the data of the training set, and the prediction set data is entered into this optimal model to obtain the predicted value of the poverty rate.

(2) Repeat the operation (1) with the following prefectures or less as the forecast set, and obtain the average error (RMSE) between the predicted poverty rate value and the actual measured value for all prefectures.

(3) In order to obtain the sensitivity of each explanatory variable, a data set set in which the variable remains as an actual numerical value and the other variables are set to the average value of all prefectures is input to the optimal model, the output value is obtained, and a simple regression analysis is performed in which the actual measured value of the variable is an explanatory variable and the output value is a target variable, and the slope of the regression line is used as the sensitivity of the variable.

(4) Remove the variable with the smallest absolute sensitivity among all explanatory variables and repeat the operation (1) ~ (3) to determine that the combination of explanatory variables with the smallest RMSE is a factor in the poverty rate.

Table 1. Explanatory variables for “child poverty rate” and data sources

Field	Explanatory variables	Definition	Data source
Population/ Households	Population density	Population density per habitable area	Social Indicators by Prefecture
	Urbanization	Population Ratio of Population Centers	Social Indicators by Prefecture
	Number of people in the household	Average number of people in a household	National Census
	Number of children	Number of children under 15 years of age per capita	National Census
	Infant households	Percentage of households with children under the age of 6	National Census

	Nuclear family	Percentage of nuclear family households	National Census
	Three-generation household	Percentage of three-generation household	National Census
	Elderly households	Percentage of elderly households	National Census
	Single-mother households	Percentage of single-mother households	National Census
	Out-of-wedlock children	Percentage of children who are not illegitimate	National Census
	Separation rate	Percentage of separated persons per capita	National Census
Economy/ Labor	Labor force	Percentage of the labor force	National Census
	Job openings-to-applicants ratio	Active job openings-to-applicants ratio	Social Indicators by Prefecture
	Employment rate	Percentage of employed persons aged 15 and over	National Census
	Unemployment rate	Percentage of the unemployed per capita of the labor force	Social Indicators by Prefecture
	Large companies	Employment rate at large companies	Economic Census for Business Activity
	Medium-sized companies	Employment rate at medium-sized companies	Economic Census for Business Activity
	Small companies	Employment rate at small companies	Economic Census for Business Activity
	Independent business	Percentage of self-employed people	Employment Status Survey
	Primary Industry	Primary industry employment rate	Employment Status Survey
	Secondary industry	Secondary industry employment rate	Employment Status Survey
	Tertiary industry	Tertiary industry employment rate	Employment Status Survey
	Management and Professions	Employment rate of managers and professionals	Employment Status Survey
	Clerical Positions	Employment rate of clerical positions	Employment Status Survey
	Sales employees	Employment rate of sales employees	Employment Status Survey
	Manufacturing industry	Employment rate in the manufacturing industry	Employment Status Survey
	Lodging and restaurant	Employment rate of the lodging and restaurant industry	Employment Status Survey
	Full-time employees	Percentage of full-time employees	Employment Status Survey

	Non-regular employees	Percentage of non-regular employees	Employment Status Survey
	Dual Work	Percentage of dual-income households	Social Indicators by Prefecture
	Part-timer	Part-time employment rate	Social Indicators by Prefecture
	Short-term employees	Percentage of short-term employees	National Census
	NEET	Percentage of young unemployed	National Census
	College graduate unemployed	Percentage of unemployed new university graduates	Social Indicators by Prefecture
	Minimum wage	Minimum wage hourly amount by region	Wage Structure Basic Statistical Survey
	Working hours	Prescribed actual working hours	Wage Structure Basic Statistical Survey
	Overtime	Overtime hours	Wage Structure Basic Statistical Survey
Education/Welfare	Education Expenses	Percentage of household living expenditure on education	Social Indicators by Prefecture
	Junior high school graduates	Percentage of those whose final educational background is junior high school graduates	Social Indicators by Prefecture
	High school graduate	Percentage of those whose final educational background is high school graduates	Social Indicators by Prefecture
	Junior college and university graduates	Percentage of students whose final educational background is junior college, technical college, or university graduate	Social Indicators by Prefecture
	Child Welfare Expenses	Child welfare expenditure per capita	Social Indicators by Prefecture
	Child Welfare Facilities	Number of child welfare facilities per capita	Social Indicators by Prefecture
	Nursery school	Number of childcare centers per preschool child	Social Indicators by Prefecture
	Nursery Teacher	Number of childcare workers per preschooler	The Status of Childcare Centers
	After-school daycare center	Number of daycare centers for school children per child in the lower grades	National Liaison Council for Childcare for School Children
	Welfare commissioner	Number of Civilian Commissioners per Population	Social Indicators by Prefecture

Table 2. Key child poverty factors, sensitivity to poverty rate and its estimation error, and contribution rate

	Factors	Field	Sensitivity			Contribution Rate (%)
			Risk factors	Deterrent factors	Error	
1	Single-mother households	Population/ Households	0.202		0.037	25.1
2	Number of children	Population/ Households	0.142		0.035	12.4
3	Unemployment rate	Economy/ Labor	0.141		0.031	12.3
4	Manufacturing industry	Economy/ Labor		- 0.140	0.025	12.1
5	Dual Work	Economy/ Labor		- 0.132	0.019	10.7
6	Large companies	Economy/ Labor		- 0.124	0.018	9.5
7	Lodging and restaurant	Economy/ Labor	0.092		0.016	5.2
8	After-school daycare center	Education/ Welfare		- 0.087	0.015	4.6
9	Nursery school	Education/ Welfare		- 0.081	0.013	4.0
10	Junior college and university graduates	Education/ Welfare		- 0.080	0.008	4.0

3. Results and discussions

3.1 Factors contributing to the poverty rate

As a result of searching for factors among 47 explanatory variables by the above method, RMSE between the predicted poverty rate value and the measured value was minimized when 10 explanatory variables were used, and the regression coefficient (R^2) at that time was 0.867, and the risk factor of 1% was judged to be significant. Therefore, these 10 explanatory variables are key factors in the poverty rate of 47 prefectures.

To consider the relative influence of each factor on the poverty rate, the contribution rate C_i to the poverty rate was estimated by the following equation from the sensitivity S_i of factor i :

$$C_i (\%) = \frac{S_i^2}{\sum_{i=1}^{10} S_i^2} \times 100 \quad \dots\dots\dots (1)$$

Table 2 shows the contents of the 10 factors, the sensitivity to the poverty rate and its estimation error, and the contribution rate. The sensitivity of each factor obtained in the sensitivity analysis is derived from the change in the poverty rate when the other variables are fixed to the mean value and just the variable is changed in the numerical value, so that the net influence of the factor on the poverty rate is expressed. Therefore, the four factors with positive sensitivity can be interpreted as risk factors that contribute to an increase in the poverty rate, and the six factors with a negative sensitivity can be interpreted as the restraining factors that contribute to the reduction of the poverty rate, respectively. These results are consistent with the predicted direction of the impact on the respective poverty rates. In addition, the error in the sensitivity of the obtained factors was estimated from the variation in the sensitivity values during the sensitivity analysis process, but looking at the magnitude, it is considered that the sensitivity of each factor is estimated with reliable accuracy.

3.2 Interpretation of factors

When the contribution rates of the 10 types of factors obtained are aggregated by sector, the population and household sectors accounted for 28.7% of the four factors, the economy and labor sectors 52.5% for the eight factors, and the education and welfare sectors accounted for 18.8% of the two factors, with the largest influence of factors in the economic and labor sectors, and the degree of influence of more than half of the total. It can be seen that the two fields of population and households, and education and welfare, also have a considerable impact.

On the other hand, there are six previous studies on the analysis of the causes of child poverty: Nagai⁶⁾, Sakaguchi⁸⁾, Akiko Oishi¹⁵⁾, Tomohiro Saito¹⁶⁾, Yaka Akasaka et al.¹⁷⁾, and Kensaku Tomuro¹⁸⁾. Nagai conducted a linear regression analysis using six explanatory variables such as the single-parent household rate and the non-regular employment rate to search for factors. Sakaguchi used 19 explanatory variables such as the number of children, educational background, and employment status, and Oishi searched for factors using 13 explanatory variables such as annual household structure, marital status, and the number of children. Saito used 20 types of explanatory variables such as single-mother households, occupations, and educational backgrounds, Akasaka et al. used 16 explanatory variables such as the age of the child, parents' educational background, and employment status, and Tomuro used seven explanatory variables such as the three-generation rate, the two-person working rate, and the non-regular rate.

However, the explanatory variables used in these previous studies are very limited compared to the 47 explanatory variables used in this paper, and the reliability of the factors explored by linear regression analysis remains questionable. On the other hand, the 10 factors obtained by searching by nonlinear regression analysis using a large number of explanatory variables in a wide range of fields in this paper are considered to be more reliable factors of child poverty rate than previous studies. In addition, the relative impact of these 10 factors on the poverty rate can be obtained, and it is thought that it will be possible to provide useful information for the implementation of measures against child poverty by local governments.

Table 3. Minimum and maximum values of factors and index values and risk ranking for Fukui and Okinawa prefectures

Factors	Sensitivity	Minimum		Maximum		Fukui		Okinawa	
	sign	values	prefecture	values	prefecture	values	rank	values	rank
Single-mother households	+	1.14	Tokyo	3.07	Okinawa	1.30	37	3.07	1
Number of children	+	10.3	Akita	17.2	Okinawa	13.2	9	17.2	1
Unemployment rate	+	2.9	Shimane	6.3	Okinawa	3.3	45	6.3	1
Manufacturing industry	-	4.9	Okinawa	26.7	Shiga	21.7	39	4.9	1
Dual Work	-	17.8	Tokyo	36.1	Fukui	36.1	47	22.4	6
Large companies	-	15.7	Yamagata	47.1	Tokyo	28.2	23	21.5	8
Lodging and restaurant	+	4.6	Ibaraki	7.8	Okinawa	5.3	29	7.8	1
After-school daycare center	-	27.1	Kanagawa	65.2	Shimane	60.8	45	41.8	14
Nursery school	-	0.75	Kanagawa	6.16	Shimane	3.50	41	3.38	39
Junior college and university graduates	-	18.5	Akita	39.8	Kanagawa	26.0	23	26.0	23

3.3 Essay discussion on measures to eliminate the child poverty

Finally, based on the results of this paper, we will consider the possibility of providing information that contributes to measures against child poverty in the region. If we take Okinawa Prefecture, which has the highest poverty rate in Japan, and Fukui Prefecture, which has the lowest poverty rate in Japan, as the target areas, the domestic ranking of the 10 factors in both prefectures is shown in Table 3. Here, the risk degree ranking of each factor is the descending order of the index values for risk factors with a positive sign of sensitivity, and the ascending order for factors with negative stimulants. Looking at this table, it can be seen that Fukui Prefecture has a low risk ranking overall, and the poverty rate is the lowest in Japan. On the other hand, Okinawa Prefecture has many factors with a high degree of risk, and it is clear that single-mother households, the number of children, the unemployment rate, and the manufacturing industry, which are particularly highly affected, contribute greatly to the highest poverty rate in Okinawa Prefecture in Japan.

Based on the results of Table 3, when considering measures to alleviate child poverty in Okinawa Prefecture, the most effective measures might be to reduce single-mother households and the number of children with a high contribution rate. There are many reasons for the large number of single-mother households in Okinawa Prefecture, including U.S. military bases, divorce, low income, and young marriages. In addition, the large number of children seems to be largely due to the laid-back prefectural

character and warm climate in Okinawa. However, many single-mother households in Okinawa Prefecture are economically unstable and have various living problems. In order to solve these problems, government and local support are indispensable.

Next, a reduction in the unemployment rate in the economic and labor sectors and an increase in the manufacturing sector might be effective. The three major sources of income in Okinawa Prefecture have been said to be the 3K economy of “tourism”, “bases” and “public works”, so far. However, Okinawa Prefecture formulated the “Okinawa Prefecture Asian Economic Strategic Initiative” in 2015 with the aim of developing a self-sustaining economy by linking with the Asian economy by taking advantage of Okinawa’s geographical superiority located in the center of a huge Asian market. Under these circumstances, the prefecture is promoting the “Five Priority Strategies” that will be the linchpin of driving the Okinawan economy in the future. In addition, Okinawa Prefecture announced the “Okinawa Prefectural Plan to Combat Child Poverty” in 2016, setting 34 indicators and setting priority measures for the time being that should be addressed to solve the problem of child poverty. As the economy of Okinawa mentioned above becomes more active, the employment rate will improve significantly, and the child poverty rate can be expected to be on par with that of the mainland.

4. Conclusions

With the aim of providing useful information for local measures against child poverty, we analyzed the child poverty rates of 47 prefectures in the three fields of population and households, economy/labor, and education and welfare as explanatory variables by applying a non-linear multiple regression analysis of support vector machine. As a result, 10 factors that reproduce the poverty rate with statistically significant accuracy were obtained, among which factors such as single-mother households and the number of children were highly influenced, and economic and labor factors such as the unemployment rate and the double-income employment rate accounted for about 50% of the total influence. In addition, based on the index values of Okinawa Prefecture, which has the largest poverty rate, and Fukui Prefecture, which has the lowest poverty rate, measures to improve the child poverty rate in regional municipalities were examined.

As a future challenge, since the method used in this paper is ecological research, there is the problem of ecological fallacy. In other words, the factors obtained from the analysis of poverty rates by prefecture are not related to individual poverty, but merely explain the difference in poverty rates between prefectures. To get more useful information on local poverty countermeasures, it is necessary to conduct comprehensive analysis using various types of data, such as time-series data at the municipal level and micro data on an individual basis. It should also be noted that the poverty rate used here does not indicate the proportion of the poor below the income threshold (the “absolute poverty rate”), as we assume against the concept of “poverty”, but rather the relative proportion of the poor within the assumed group (in the case of the child poverty rate, the whole child, or the entire household with children).

The revised Child Poverty Countermeasures Act was enacted in the Diet in June 2019. The amended Act aims to alleviate current poverty and requires municipalities to make efforts to develop support plans that will help stabilize and improve the work of guardians and increase income. This would lead to nationwide development of measures to combat child poverty.

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