Family Structure and Children's Academic Achievement in Japan: A Quantile Regression Approach

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This paper examines the influence of single parenthood on children's academic achievement in Japan. While some studies have examined the academic achievement gap associated with family structure, a limitation of existing research is the focus on differences between the mean levels of academic achievement of children in single-parent and two-parent families. Using data from the Programme for International Student Assessment (PISA) conducted by the Organisation for Economic Co-operation and Development (OECD) in 2012, this paper investigates the effects of single parenthood across the entire distribution of children's academic achievement by using quantile regression techniques. The results of quantile regression analyses indicated that the magnitude of the academic achievement gap between children in single-parent and two-parent families was not equal for each quantile of the conditional distribution of children's academic achievement. The negative effect of single motherhood on children's academic achievement was more profound at lower quantiles, whereas the negative effect of single fatherhood was more profound at the median level. Furthermore, the extent to which parents' education levels accounted for the negative effects of single parenthood was not equal for each quantile of the conditional distribution of children's academic achievement. The effects of single parenthood at lower quantiles were not well explained by parents' education levels, and this tendency was especially obvious in the academic achievement of children in single-father families. This result suggests that low academic achievement of children in single-mother families may be caused by the mothers' low education levels and accompanying low income, whereas poor academic achievement of children in single-father families is likely to be mainly due to the absence of mothers rather than the fathers' low education levels. Based on the empirical evidence obtained in this paper, policy implications regarding the significance and limitations of economic support for single-parent families in terms of reducing educational inequality are discussed.

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1. Introduction

In recent decades, divorce rates have risen and the number of children growing up with a single parent has increased in Japan. According to a Comprehensive Survey of Living Conditions conducted by the Ministry of Health, Labour and Welfare, the proportion of single-mother households among all households with children aged less than 18 years nearly doubled from 3.4% in 1988 to 6.8% in 2010. While lower than single-mother households, the proportion of single-father households also increased from 0.6 to 0.8% during the same period. The increase in single-parent families is almost entirely due to the increased number of divorces. Vital statistics compiled by the Ministry of Health, Labour and Welfare indicate that the number of divorces drastically increased from 166,640 in 1985 to 226,215 in 2015. As a result, the proportion of single-mother households formed through divorce increased from 49.1% in 1985 to 80.8% in 2011 (Zhou, 2014).

Single parenthood can seriously affect children, because families play an important role in socialization. Numerous studies have documented that growing up with a single parent is negatively associated with children's educational outcomes in the United States and western European countries (Amato, 2000, 2010; McLanahan & Percheski, 2008; McLanahan & Sandefur, 1994; McLanahan et al., 2013). Because academic achievement is an important determinant of later educational attainment, it is an especially important educational outcome. Academic achievement also plays an important role in the Japanese educational system, which is characterized by selection based on student academic achievement (Kariya & Rosenbaum, 1987).

It is important to examine the influence of family structure on children's academic achievement, because single parenthood is closely associated with poverty. In recent years, children's poverty has received much attention in Japan (Abe, 2008). According to the OECD (Organisation for Economic Co-operation and Development) Family database[1], the child poverty rate—the relative poverty rate among households with children aged less than 18 years—in Japan was 16.3% in 2014, the 10th highest among 33 OECD countries[2] and exceeding the OECD average (13.6%). Although the relatively high child poverty rate is a serious problem, still more important is that single-parent households tend to face serious economic difficulty in Japan. For example, the relative poverty rate among households with children and a single working adult in Japan was 56.0% in 2014, the highest among 33 OECD countries, greatly exceeding the OECD average (23.2%).

The difficult economic circumstances of single-parent households in Japan mainly concerns single-mother households, which make up a large proportion of these households. Furthermore, single-mother households are more likely to be economically challenged than single-father households (Ministry of Health, Labour and Welfare, 2011). For these reasons, earlier research focused on the (negative) impacts of the absence of fathers (father absence) on children's well-being. However, it is now recognized that the absence of mothers (mother

absence) also negatively affects children. Previous studies found that children in single-father families demonstrated low academic performance, as did those in single-mother families (Downey, 1994; Shirakawa, 2010).

While not much research focused on the educational attainment of children in single-parent families until the early 2000s in Japan, recent studies negatively associate growing up with a single parent with children's educational attainment (Inaba, 2011; Yoda, 2012). Existing research suggested that the low educational attainments of those who grew up with a single parent can be (at least partially) attributed to their poor academic achievement. Additionally, since microdata of larger-scale student assessments such as the Programme for International Student Assessment (PISA) has become available, a few empirical studies on the relationship between family structure and children's academic achievement have been conducted (Park, 2007; Shirakawa, 2010; Uzuki & Suetomi, 2015).

Using data from PISA 2000, Park (2007) revealed that as in other countries (Hong Kong, South Korea, Indonesia, Thailand, and the United States), tenth-grade students in single-parent families in Japan demonstrated significantly lower reading performance. Shirakawa (2010) examined the effects of father absence and mother absence on students' reading literacy using data from PISA 2000, finding that children in single-father families demonstrated particularly low academic achievement in Japan. Furthermore, he determined that while a substantial portion of the negative effect of father absence on children's academic achievement was attributed to the economic disadvantages of single-mother families, the shortage of both economic and interpersonal resources did not account for the low academic achievement of children in single-father families. Because of data limitations, these earlier studies did not fully control for students' socioeconomic background when analyzing the effects of single parenthood on children's academic achievement. However, Uzuki & Suetomi (2015) analyzed data from the National Assessment of Academic Ability conducted by the Ministry of Education, Culture, Sports, Science and Technology in 2013, indicating that the economic condition of households and single parenthood have independent negative effects on the academic achievement of sixth- and ninth-grade students in Japan.

One limitation of existing studies is the focus on differences between the mean levels of academic achievement of children in single-parent and two-parent families. With the exception of a special case where the dependent variable is normally distributed with constant variance, OLS regression analysis does not fully capture the relationship between dependent and independent variables. However, it is not reasonable to assume that the academic achievement of children in single-parent families is always normally distributed. Rather, the distribution of the academic achievement of children in single-parent families may be right skewed, because many single-parent families lack economic, interpersonal, or other resources associated with children's educational outcomes (Abe, 2008, Raymo et al., 2014; Shirakawa, 2010; Uzuki & Suetomi 2015).

2. Research Questions

The present study was undertaken to describe how children growing up with a single parent are disadvantaged in terms of their academic achievement. Drawing on data from PISA 2012, this paper examines the effects of single parenthood on children's academic

achievement. While previous studies focused on the achievement gap between children in single-parent and two-parent families in terms of the mean level of academic achievement, this paper investigates the effects of single parenthood across the entire distribution of children's academic achievement by using quantile regression techniques. The research question addressed in this paper is as follows: "*How does the effect of single parenthood vary at different points in the distribution of children's academic achievement?*"

Furthermore, it is important to consider selection bias when estimating the effect of single parenthood on children's educational outcomes (McLanahan & Percheski, 2008). One possible confounding variable is parents' education level, because a lower level of education is associated with divorce (McLanahan, 2004; Raymo et al., 2004, 2013), and parents' education levels are closely associated with children's academic achievement (Sirin, 2005; Kawaguchi, 2011). Thus, another research question addressed in this paper is as follows: "*To what extent are the effects of single parenthood at different points in the distribution of children's academic achievement explained by controlling for parents' education levels?*" By investigating these two research questions, this paper contributes to a better understanding of the educational inequality associated with family structure in Japan.

3. Method

3.1. Data

Data used for this study came from the PISA conducted by OECD in 2012. The PISA has been conducted every three years since 2000 to assess the reading literacy, mathematical literacy, and scientific literacy of 15-year old students. About 510,000 students from 65 countries participated in PISA 2012. This paper uses Japan's PISA 2012 dataset. About 6,400 students in tenth grade (the first year of high school) from 191 schools participated in PISA 2012 in Japan. To identify samples, a two-stage stratified random sampling procedure[3] was employed (National Institute for Educational Policy, 2013). First, schools were randomly selected from all parts of the country. Second, about 35 students were randomly drawn from each chosen school.

Because the PISA 2012 data are based on a two-stage stratified sampling design, it has a multilevel structure wherein students are nested in schools. In a clustered sample such as this, error terms could be correlated within each cluster (i.e. school), which leads to biased standard errors (Snijders & Bosker, 2012). This paper used 80 replicate weights to obtain correct standard errors (OECD, 2014).

3.2. Variables
Dependent Variable
The dependent variable is students' academic achievement. Because PISA 2012 was conducted with a focus on mathematical literacy, this paper used students' mathematics score as a measure of their academic achievement. In PISA, each participating student completed only a subset of items. Therefore, the item response theory (IRT) was used to estimate students' mathematical literacy. This paper used five plausible values, randomly drawn values from a student's posterior distribution of mathematical literacy, to obtain unbiased estimates and standard errors (OECD, 2014).

Table 1 Family structure and parents' education level

	Higher education	High school or below	Missing	Total
Two-parent families	3,341 (63.4%)	1,804 (34.2%)	124 (2.4%)	5,269 (100%)
Single-father families	43 (40.2%)	54 (50.5%)	10 (9.4%)	107 (100%)
Single-mother families	265 (41.9%)	351 (55.5%)	17 (2.7%)	633 (100%)
Total	3,649 (60.7%)	2,209 (36.8%)	151 (2.5%)	6,009 (100%)

Independent Variable

The main independent variable is children's family structure, which is classified according to the following three categories: *two-parent family* (87.7%), *single-mother family* (10.5%), and *single-father family* (1.8%). Because this paper aims to compare the academic achievement of children in single-parent families and those in two-parent families, the first one is used as the reference category in the regression analyses. Therefore, the regression coefficients of two dummy variables indicating children in single-mother families and those in single-father families represent the academic achievement gap with children in two-parent families.

The control variables are students' gender and parents' education level. Gender consists of *girls* (47.8%) and *boys* (52.2%), and the latter is used as the reference category. Parents' education level is classified in the following three categories: *higher education* (60.7%), *high school or below* (36.8%), and *missing* (2.5%), and the second one is treated as the reference category. For two-parent families, the highest education level attained by either parent was used. As shown in Table 1, the proportion of "missing" is relatively large among respondents in single-father families (9.4%). To avoid reducing the sample size, "missing" is included in the following analyses as a category of parents' education level.

Recent research concerned with estimating the causal effect of parental divorce on children's educational outcomes has highlighted the possibility of spurious correlation caused by selection factors (Amato, 2010; McLanahan et al., 2013). If unobserved factors influence parental divorce and children's academic achievement, the estimated coefficients of single parenthood on academic achievement can be biased. To deal with this selection bias, this paper uses parents' education level as a control variable.

Because the main objective of this paper is to examine the net effect of family structure on children's academic achievement, possible mediator variables are not used. For example, while parents' occupations are also available from the PISA 2012 dataset, it is difficult to identify whether that is a mediator or confounder when examining the effect of family structure on children's academic achievement, because PISA data have no information on parents' occupations before parental divorce or death occurred, and occupations may change over time[4].

3.3. Quantile Regression Approach

This paper examines the effects of family structure across the entire distribution of children's academic achievement by applying quantile regression models (Koenker & Bassett, 1978). While sociological studies on education have rarely applied this technique, Hao & Naiman (2007) contend that quantile regression is a powerful tool for studies on various types of inequality. This paper applies this technique to investigate the academic achievement gap caused by family structure.

In contrast to OLS regression, which estimates conditional differences in the mean, quantile regression estimates conditional differences in each quantile (or percentile). Quantile regression uses the least absolute value estimation to estimate conditional differences in quantiles in the distribution. In this paper, two models (Model 1 and 2) of quantile regression with different set of independent variables were estimated. For the θth quantile (θ can take any value between 0 and 1), Model 2 (full model) is expressed by:

$$Math\ Score_i = \beta_0^{(\theta)} + Girl_i\ \beta_1^{(\theta)} + Single\ Mother_i\ \beta_2^{(\theta)} + Single\ Father_i\ \beta_3^{(\theta)}$$
$$+ Higher\ Education_i\ \beta_4^{(\theta)} + Missing_i\ \beta_5^{(\theta)} + u_i^{(\theta)}$$

where **Math Score** of individual i is a function of **Girl** (1:girls; 0:boys), **Single Mother** (1: children in single-mother families; 0: others), **Single Father** (1: children in single-father families; 0: others), **Higher Education** (1: children whose parents completed higher education; 0: others), **Missing** (1: children whose parents' education level are missing; 0: others), and u is the error term with mean of zero. $\beta_0^{(\theta)}$ denotes the intercept, θth quantile of the dependent variable when all independent variables are equal to zero.

An important feature of quantile regression is that the effects of independent variables, given by $\beta^{(\theta)}$, may differ over quantiles. This paper estimated the quantile regressions at the 0.10 quantile (10th percentile), 0.25 quantile (25th percentile), 0.50 quantile (median), 0.75 quantile (75th percentile), and 0.90 quantile (90th percentile). In other words, five regression lines with different slope and intercept were estimated, which enabled a comparison of the regression coefficients of single parenthood (and other independent variables) in each quantile of the conditional distribution of children's academic achievement.

4. Results

Table 2 provides the descriptive statistics of children's academic achievement (mathematics score), indicating that the mean level of children's academic achievement varied

Table 2 Descriptive statistics of the mathematics score of children

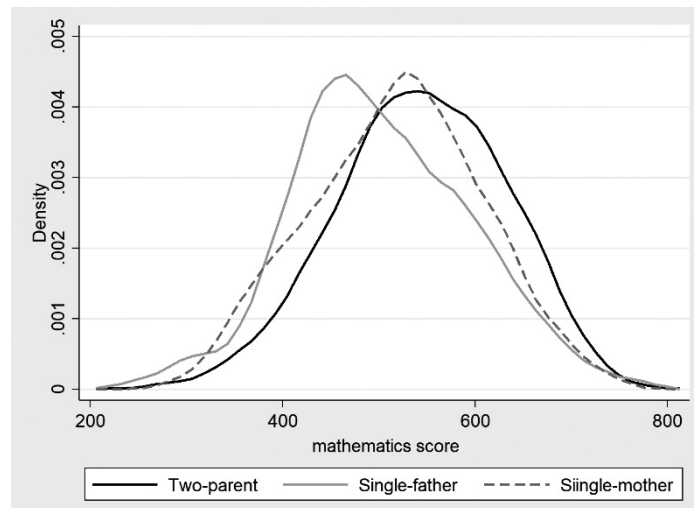|	mean	s.d.	median	skewness	kurtosis
Two-parent families (N=5,269)	543.76	91.20	545.51	-0.16	2.87
Single-mother families (N=633)	517.72	91.35	520.99	-0.05	2.64
Single-father families (N=107)	500.98	90.32	493.81	-0.19	3.01
Total (N=6,009)	540.25	91.69	541.74	-0.14	2.83

Figure 1 Estimated kernel density of the mathematics score

across their family structure. That is, children in single-parent families were disadvantaged in terms of the mean level of academic achievement. The average mathematics score of children in two-parent families was 543.76, the highest among the three family structure groups. The mean mathematics scores of children in single-mother and single-father families were 517.72 and 500.98 respectively. Consistent with Shirakawa (2010), who analyzed data from PISA 2000, children in single-father families were the most disadvantaged in terms of the mean level of academic achievement in Japan.

Table 2 also reports the standard deviations, skewness, and kurtosis of children's mathematics scores. While the differences in standard deviations among the three groups were not that large, the differences in skewness and kurtosis indicated that the shapes of the conditional distribution of the mathematics score varied across children with different types of family structure. Figure 1 graphically represents the kernel density estimations of children's mathematics scores for each family structure group. The distribution of the mathematics scores of children in two-parent families was skewed to the left. In contrast, the distribution of the mathematics scores of children in single-father families was skewed to the right, and that of children in single-mother families was almost symmetrically distributed. The different shapes of the conditional distribution of the mathematics scores suggest that it is not enough to focus only on the mean level of academic achievement when a detailed understanding is needed of the academic achievement gap between children in two-parent, single-mother, and single-father families.

Results of the quantile regression analyses

Table 3 provides the estimation results of the quantile regression analyses[5]. Model 1 does not include parents' education level, while Model 2 includes this as an independent variable. Therefore, the estimation results for Model 2 demonstrate the effects of family structure on children's academic achievement after controlling for parents' education levels. Moreover, the differences between Models 1 and 2 for the regression coefficients of single parenthood indicate the extent to which the effects of single parenthood on children's academic achievement can be explained by controlling for parents' education level[6]. The magni-

Table 3 Quantile regression analyses of the mathematics score (non-standardized regression coefficients)

Model 1 (N=6,009)	q=0.10		q=0.25		q=0.50		q=0.75		q=0.90		OLS	
Gender	-2.91		-13.76	*	-24.71	***	-27.20	***	-28.09	***	-19.97	***
= girl	(7.17)		(5.42)		(5.15)		(6.05)		(6.24)		(4.16)	
Family structure	-33.84	**	-28.56	***	-23.90	***	-25.19	**	-26.23	***	-25.24	***
= single-mother family	(10.47)		(8.29)		(6.24)		(7.49)		(6.76)		(5.16)	
Family structure	-27.18		-43.90	***	-57.66	***	-47.42	***	-41.24	†	-44.41	***
= single-father family	(18.09)		(11.43)		(15.68)		(13.68)		(20.79)		(11.23)	
Intercept	426.87	***	489.63	***	558.01	***	620.21	***	673.03	***	553.22	***
	(6.59)		(5.40)		(5.10)		(5.85)		(5.31)		(4.49)	

Model 2 (N=6,009)	q=0.10		q=0.25		q=0.50		q=0.75		q=0.90		OLS	
Gender	-6.37		-14.08	**	-23.65	***	-27.61	***	-30.08	***	-20.13	***
= girl	(5.84)		(5.28)		(4.55)		(5.13)		(6.82)		(3.93)	
Family structure	-20.10	†	-20.07	*	-13.77	*	-13.12	*	-12.95	†	-15.53	**
= single-mother family	(9.99)		(9.49)		(6.42)		(5.17)		(7.12)		(4.67)	
Family structure	-25.83	†	-38.60	*	-43.04	**	-34.57	†	-17.11		-33.15	**
= single-father family	(15.37)		(17.48)		(14.98)		(20.61)		(24.19)		(11.08)	
Parents' education level	47.39	***	47.23	***	45.26	***	47.39	***	46.10	***	46.54	***
= higher education	(7.90)		(6.23)		(5.34)		(5.44)		(6.27)		(4.67)	
Parents' education level	-8.62		-7.24		2.18		-0.03		2.87		-2.24	
= missing	(17.16)		(18.82)		(11.58)		(14.52)		(18.34)		(9.97)	
Intercept	403.42	***	461.86	***	528.28	***	589.02	***	640.31	***	523.70	***
	(7.75)		(6.92)		(5.52)		(4.88)		(5.42)		(4.67)	

*** p<0.001   ** p<0.01   * p<0.05   † p<0.10

Note: 1) Standard errors in parenthesis.
  2) The reference category for family structure is *two-parent family*.
  3) The reference category for parents' education level is *high school or below*.
  4) R^2s were not calculated for quantile regression using plausible values. OLS R^2s for Model 1 and 2 were 0.02 and 0.08 respectively.

tudes of the academic achievement gap between children in single-parent and two-parent families (the absolute values of the regression coefficients of single motherhood and single fatherhood) are shown in Figure 2 and Figure 3.

Academic achievement gap between children in single-mother and two-parent families

The estimation result of Model 2 shows that the effects of single motherhood (contrasted with two-parent families) were -20.10 at the 0.10 quantile, -20.07 at the 0.25 quantile, -13.77 at the 0.50 quantile (median), -13.12 at the 0.75 quantile, and -12.95 at the 0.90 quantile respectively. The negative effects of single motherhood on children's mathematics score were statistically significant for every quantile. Table 3 also shows the OLS estimate (-15.53), which refers to the difference between children in single-mother and two-parent families for the conditional mean of the mathematics score. Regarding the academic achievement gap between children in single-mother and two-parent families, the difference for the conditional median (13.77) was slightly different from the difference for the conditional mean (15.53), whereas the negative effects of single motherhood at lower quantiles seemed larger than its effects at the central location (i.e. mean and median) of the conditional distribution of children's mathematics score.

Comparing the estimation results of Models 1 and Model 2, 30–50% of the negative effects of single motherhood were explained by controlling for mothers' education. For example, 42.4% (= (23.90 - 13.77) / 23.90) of the effects of single motherhood at the 0.50 quantile were explained by controlling for mothers' education level. This result indicates that
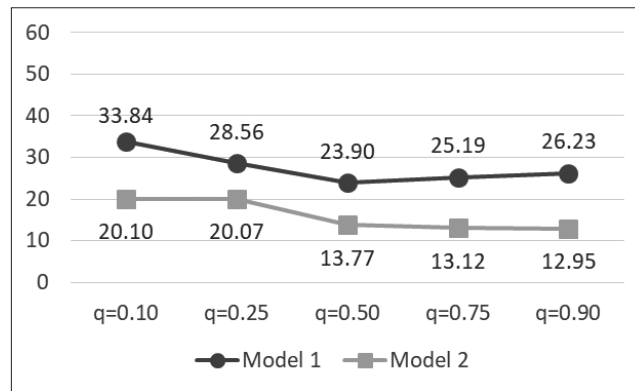
Figure 2 Achievement gap between single-mother and two-parent families
(Note: The vertical axis indicates the absolute value of the regression coefficient of single-mother families from Table 3)

lower academic achievement of children in single-mother families could be partially due to the tendency that women with a lower level of education are more likely to divorce (Raymo et al., 2004, 2013). However, the effect of single motherhood was statistically significant across every quantile even after controlling for mothers' education level, suggesting that the absence of fathers had independent negative effects on children's academic achievement. Furthermore, the effects of single motherhood were comparatively poorly explained by controlling for mothers' education at lower quantiles. The extent to which mothers' education accounted for the effects of single motherhood was the lowest at the 0.25 quantile (29.7%), followed by the 0.10 quantile (40.1%). This suggests that the larger achievement gaps at lower quantiles are closely associated with the absence of fathers.

Academic achievement gap between children in single-father and two-parent families

According to the estimation result of Model 2, the effects of single fatherhood (contrasted with two-parent families) were -25.83 at the 0.10 quantile, -38.60 at the 0.25 quantile, -43.04 at the 0.50 quantile (median), -34.57 at the 0.75 quantile, and -17.11 at the 0.90 quantile respectively. The negative effects of single fatherhood were statistically significant for every quantile except the uppermost (0.90) quantile[7]. The OLS estimate of the effect of single fatherhood (-33.15) refers to the difference between children in single-father and two-parent families for the conditional mean of the mathematics score. The difference between children in single-father and two-parent families for the conditional median of the mathematics score (43.04) differed considerably from the difference for the conditional mean (33.15), indicating that the shapes of the distribution of the mathematics score differed significantly between children in single-father and two-parent families.

The extent to which fathers' education level accounted for the negative effects of single fatherhood varied greatly for each quantile of the conditional distribution of children's mathematics score. Comparing the results of Model 1 and Model 2, 58.5% of the negative effects of single fatherhood could be explained by controlling for fathers' education level at the 0.90 quantile. This suggests that lower academic achievement of children in single-father families at the uppermost quantile is mainly caused by fathers' low education level, rather than the absence of mothers. On the other hand, the negative effects of single fatherhood at lower
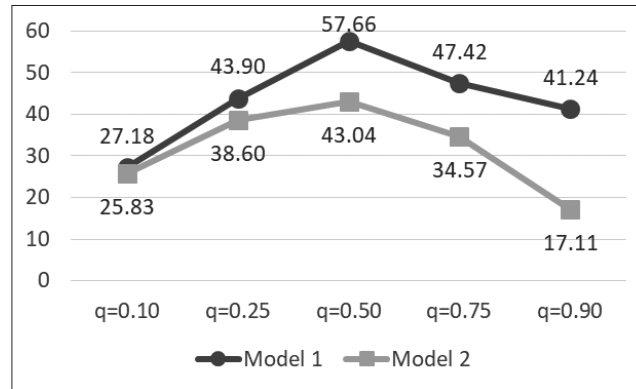
Figure 3 Achievement gap between single-father and two-parent families
(Note: The vertical axis indicates the absolute value of the regression coefficient of
single-father families from Table 3)

quantiles were almost unexplained, even after controlling for fathers' education level. Only 5.0% of the effect of single fatherhood at the lowest (0.10) quantile was explained by controlling for fathers' education[8]. This result suggests that the larger achievement gap at lower quantiles of the conditional distribution of the mathematics score is not due to selection bias, but single fatherhood (or parental divorce), which impacts children's academic achievement.

5. Discussion

Using data from PISA 2012, this paper examined the effects of single parenthood on tenth-grade students' academic achievement in Japan. In addition to the well-known relationship between family structure and the mean level of children's academic achievement, this paper demonstrated that the effects of single parenthood were not equal for each quantile of the conditional distribution of children's academic achievement. The negative effect of single motherhood on children's academic achievement was more profound at lower quantiles, whereas the negative effect of single fatherhood was more profound at the median level.

Furthermore, the extent to which parents' education level accounted for the effects of single parenthood was not equal for each quantile of the conditional distribution of children's academic achievement. The effects of single parenthood at lower quantiles were not well explained by parents' education, and this tendency was especially obvious for the academic achievement of children in single-father families. This result suggests that the cause of poor academic achievement is not the same for children in single-mother and single-father families. About 40% of the negative effect of single motherhood at the lowest quantile was explained by controlling for mothers' education. This implies that the poor academic achievement of children in single-mother families is partially due to the economic deprivation associated with low educational backgrounds, because single mothers with a low level of education are more likely to fall into poverty (Ministry of Health, Labour and Welfare, 2011). On the other hand, the negative effect of single fatherhood at the lowest quantile was almost unexplained when controlling for fathers' education, indicating that poor academic achievement of children in single-father families would be mainly due to the absence of mothers

rather than fathers' low education level[8].

Policy implications derived from this paper relate to the importance and limitations of economic support for single-parent families. That is, economic support for single-parent families can reduce the achievement gap between children in single-parent and two-parent families in terms of the differences in the central location (mean or median) and upper quantiles of the conditional distribution of academic achievement, but would have little effect for overcoming poor academic achievement of children in single-father families. As mentioned in this paper, the differences in the mean levels of academic achievement are only one aspect of educational inequality between children in single-parent and two-parent families. This paper provides an empirical evidence indicating that reducing the differences in the mean or median level of academic achievement does not necessarily imply reducing the educational inequality associated with family structure. As well as the discussion about the impact of economic support for single-parent families, policy debate and educational research on academic achievement testing also need to focus on the entire distribution of children's academic achievement, not only on average test scores.

By applying the quantile regression approach, this paper contributes to a better understanding of the relationship between family structure and children's academic achievement. However, there are some limitations. First, given the focus on the net effect of family structure on children's academic achievement, this paper has not empirically investigated the causal mechanisms of the influence of single parenthood on children's academic achievement. To better understand how and why growing up with a single parent negatively influences children's academic achievement, it is necessary to examine the effects of economic, cultural, and interpersonal resources within the quantile regression framework. Additionally, the relationship between the academic achievement gap associated with family structure and children's educational aspirations and expectations is also an important issue. Second, because of data limitations, this paper did not distinguish widowed and divorced single-parent families. In future research, the differential effects of parental death and divorce on children's educational outcomes must also be examined (Biblarz & Gottainer, 2000).

Notes

 1 URL: http://www.oecd.org/els/family/database.htm (Retrieved September 5, 2017).
 2 South Korea is excluded, because data is missing.
 3 High schools were divided into four strata: academic public schools, vocational public schools, academic national/private schools, and vocational national/private schools.
 4 Empirical studies in Japan demonstrated that a large proportion of women experienced a change in employment status (Fujiwara, 2007) and an increase in individual income (Murakami, 2009) after divorce.
 5 In the results of regression analyses shown in Table 3, asterisks attached to the intercepts simply mean that the intercepts are significantly different from zero.
 6 While this paper regards parents' education as a confounding variable, the differences between Models 1 and 2 for the regression coefficients of single parenthood can be interpreted in the same way as mediation analysis, because mediation and confounding are (while conceptually different) statistically identical (MacKinnon et al., 2000).
 7 The statistically insignificant effect of single fatherhood at the 0.90 quantile could be attributed to insufficient statistical power, because the number of children in single-father families employed in the regression analyses was not large (N=107).
 8 In the estimation result of Model 1, the effect of single fatherhood on children's academic

achievement was not statistically significant at the 0.10 quantile. However, it is assumed that this result is mainly due to the large standard error, not the magnitude of regression coefficient. Future studies can reexamine this issue using a larger sample.

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