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Structural Changes in the Patterns of Japanese Fertility

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Abstract

The Japanese lower fertility rate has decreased alarmingly since 1970s. We apply the Butz-Ward model to Japanese prefecture-level data for 1965-2015 to investigate changing determinants of the declining fertility, with focus on the role of husband's income and wife's wages. We extend the Butz-Ward model by adding a variable for female marriage rate to avoid omitted variable bias and by conducting the subsample analysis, separately for subperiods, I(1965-1975) and II(1980-2015) to capture the structural change, suggested by a Chow test: the structural change might have taken place due to the rapid development of the industrial sector corresponding increase in husband's income and wife's wages as well as the rise in female marriage rate with gradual decrease in fertility rate in the mid-1970s. The estimation results show that the Butz-Ward model explains subperiod I(1965-1975) well. In contrast, the estimation results for subperiod II(1980-2015) are not consistent with the Butz-Ward model. In addition, the coefficient for female marriage rate is positive and statistically significant for all periods.

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1. Introduction

Japan's fertility rate has been gradually declining since the 1970s, and it reached an alarmingly low rate of 1.26 in the mid-2000s. The low birth rate creates a vicious circle of low economic growth, unemployment, low income and savings, and low fertility among working-age adults. There is a growing concern that the declining fertility rate in Japan will lead to the collapse of the current pay-as-you-go pension system because inequality between the current and future generations in terms of the net pension benefits is increasing in favor of the current generation. To prevent the economic and social woes caused by the low Japanese fertility rate, there is a clear need to identify and address its underlying causes.

A strand of the literature has focused on the role of husbands' and wives' income as possible factors affecting household fertility decision making. In their seminal work, Butz and Ward (1979) develop a theoretical model to highlight the differential role played by husbands' income and wives' wages. Using the baby boom of the 1950s and the baby bust of the 1960s in the U.S. as a case, their model shows that rising male income contributed to the baby boom due to the income effect, while rising female wages explained the baby bust because female wages capture the opportunity costs for females in bearing children. Their model is well supported by empirical results.

Several studies of the fertility movement in Japan base their argument on the Butz-Ward model and examine whether the model fits the fertility pattern in Japan well. The results so far are mixed. Ohbuchi (1982, 1988), Imai (1996, 2001), and Kato (1997) found that the Butz-Ward model could not adequately explain Japanese fertility patterns. On the other hand, Ogawa and Mason (1986), Osawa (1988), Lee and Gan (1989), and Shimizu (2002) concluded that the Butz-Ward model fit the Japanese data. While it is unclear why some studies are for and others are against the theoretical model, we suspect that one of the reasons for this inconsistency is that their observation periods differ, and the sign, magnitude, and relative importance of husbands' income and wives' wages vary with time. In particular, in 1975, Japan experienced a significant change in its industrial structure. Specifically, the shares of economic activities in the manufacturing and service industry rose sharply with the rapid economic growth. Figure 1 displays the relationship between the decreasing total fertility rate (TFR, defined as the average number of children birthed by women aged 15-49, assuming that current age-specific birth rates remain constant) and the increasing income of husbands and wages of wives. Based on this figure, we suspect that a structural change occurred in the fertility movement before and after 1975, and thus, the model predictability changes before and after that period.

Using Japanese prefectural level data from 1965 to 2015, this study aims to examine (1) to what extent the Butz-Ward model can explain Japanese fertility patterns, (2) whether a

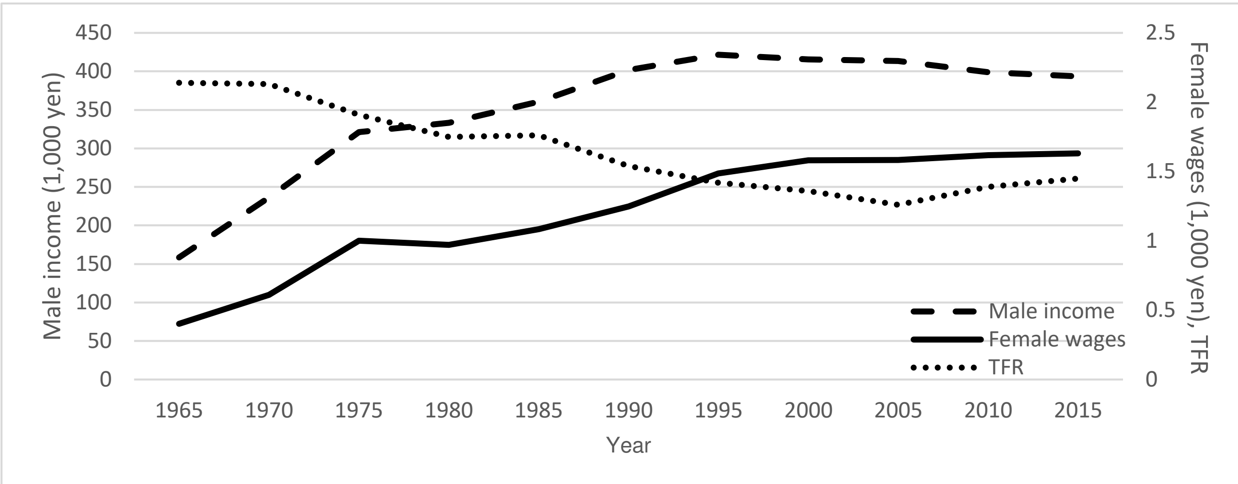

Figure 1. Male income, female wages, and TFR (1965-2015)

Data source: The Basic Survey on Wage Structure (the Ministry of Health, Labour and Welfare) and Vital Statistics (the Ministry of Health, Labour and Welfare)

structural actually occurred shift after 1975, and (3) if so, for which period the Butz-Ward model fits the data better.

While the use of household-level data is generally preferable to the analysis of fertility decisions, we use prefectural data because longitudinal Japanese micro-data are not available. The longitudinal prefectural data allow us to conduct a formal statistical test, i.e., a Chow test, to examine whether a structural shift occurred. This has rarely been done in the current literature using the Butz-Ward model.

Our findings are summarized as follows. First, we conduct a Chow test, and its results show that a structural change occurred between 1975 and 1980. Second, we split the long-term data into two subperiods, I (1965-1975) and II (1980-2015). We find that for subperiod I, the Butz-Ward model fits the data well, whereas for subperiod II, it does not fit the data. This supports our conjecture that the validity of the Butz-Ward model changes if the underlying economic structure changes.

This paper is organized as follows. Section 2 introduces the Butz-Ward model. Section 3 describes the dataset used, and section 4 reports the estimation results. Finally, section 5 presents the conclusions.

2. Model

The Butz-Ward model has demonstrated the effect of both husbands' income and wives' wages on fertility behavior. As noted by Butz and Ward (1979), the probability of a couple having a child in a given year should differ between households with employed wives and households with non-employed wives. The probability of having a child in a household with an employed wife should be a function of the husband's income, the wife's market wage (that is, the opportunity cost associated with her time), and other factors.

On the one hand, the probability of having a child in a household with a non-employed wife should be a function of the husband's income, the wife's opportunity cost, and other factors. The increase in market wages will motivate a non-employed wife to enter the labor market. As a result, she becomes an employed wife, and the household follows the same function as the household with an employed wife.

We use the following model derived by Imai (1996) from the original Butz-Ward model:

$$\begin{aligned} \ln\beta &= \beta_0 + \beta_1 k\ln Y_m + \beta_2(1-k)\ln + \beta_3 k\ln W_f \\ &= \gamma_0 + \gamma_1 k\ln Y_m + \gamma_2 \ln Y_m + \gamma_3 k\ln W_f \end{aligned} \tag{1}$$

where B is the probability that a couple will have a child in a given year, k is the proportion of households in which the wife is employed, Y_m is the husband's income, and W_f is the market wage rate of an employed wife.

The model also hypothesizes that $\beta_1 = \gamma_1 + \gamma_2 > 0$, $\beta_2 = \gamma_2 > 0$ and $\beta_3 = \gamma_3 < 0$: when β_1 and β_2 are positive, it indicates an income effect, and when β_3 is negative, it indicates a substitution effect.

Since the Butz-Ward model has not been successfully applied to Japanese data, we followed the modified Butz-Ward model constructed by Imai (2001). The estimation model is as follows:

$$B = \alpha_0 + \alpha_1 Y_m + \alpha_2 W_f \tag{2}$$

where B is the average number of children whose mothers are married, Y_m is the husband's income, and W_f is the market wage rate of an employed wife. In our model, we utilized the TFR[1] as a proxy for B.

[1] The total fertility rate is obtained from Vital Statistics compiled by the Ministry of Health, Labour and Welfare.

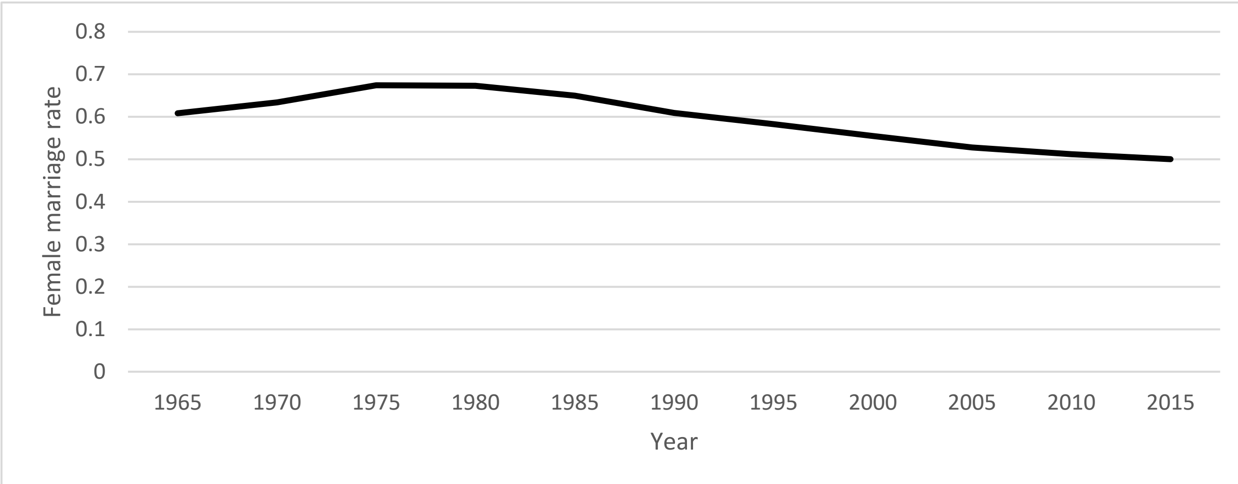

Figure 2. Female marriage rate (1965-2015)

Data source: The Census (Ministry of Internal Affairs and Communications)

Okinawan data for 1960-1970 were not available.

One potential concern is related to an omitted variable. Specifically, we are concerned that the female marriage rate, which is omitted, can significantly affect fertility because couples tend to have children after marriage; this behavior is indeed traditional in Japan. Figure 2 shows the female (aged 15-49) marriage rate[2] for 1965-2015. This rate peaks between 1975 and 1980, after which it decreases. This change in marriage patterns, along with the possible structural change in the economy in 1975, may affect the model predictability. Therefore, we added a variable for the female marriage rate to the model (eq. (2)) to control for this effect.

3. Data

In this section, we discuss the prefecture-level data used in our model and its sources. We use time-series data from 46 prefectures for the model in this paper[3]. The descriptive statistics for

[2] We calculate the female marriage rate as follows:

$$\text{Female marriage rate} = \frac{\text{Population of married females}}{\text{Population of females}}.$$

We obtained data on the population of married females and the population of females from the census conducted by the Ministry of Internal Affairs and Communications.

[3] We exclude Okinawan data primarily because the Okinawan TFR is an outlier (Appendix Figure A1). In addition, Okinawan data were not compiled for 1965 and 1970 because Okinawa

every 5 years within the period 1965-2015 are shown in Appendix (Table A1).

To determine the TFR, we use Vital Statistics collected by the Ministry of Health, Labour and Welfare.

One of the primary sources of data for our analysis is the Basic Survey on Wage Structure[4] conducted by the Ministry of Health, Labour and Welfare. Male income and female wages are calculated as follows:

$$\text{Male income} = \text{Contractual cash earnings(monthly)} + \text{Special cash earnings(monthly)}$$ [5]

$$\text{Female wages} = \frac{\text{Contractual cash earnings(monthly)} + \text{Special cash earnings(monthly)}}{\text{Actual working hours (monthly)}}$$ [6]

More specifically, contractual cash earnings and annual special cash earnings are the weighted average for males and females aged 15-49. These values are measured in real terms using the 2015 Consumer Price Index published by the Ministry of Internal Affairs and Communications (2015 is the base year). To obtain female wages, we divide female income (which is calculated by adding special cash earnings (monthly) to contractual cash earnings (monthly)) by actual working hours (monthly). The actual working hours are also calculated as the weighted average for females aged 15-49.

We use data from the Basic Survey on Wage Structure every 5 years beginning in 1965 because other census data are collected every 5 years by the Ministry of Internal Affairs and Communications.

Another primary data source for the model is the census conducted by the Ministry of Internal Affairs and Communications every 5 years. We use data for females aged 15-49 and the population of married females aged 15-49 to calculate the marriage rate for females aged 15-49 as follows:

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was occupied by the U.S. from 1965 to 1972.

[4] In the 1965 Basic Survey on Wage Structure, data for the monthly actual number of hours worked and annual special cash earnings were not compiled by age group, so we use the total data for enterprises of all sizes.

[5] The Basic Survey on Wage Structure contains special cash earnings on an annual basis, so we divide it by 12 (months) to determine the monthly base for both males and females.

[6] Actual working hours (monthly) are calculated by adding the actual number of scheduled hours worked (monthly) to the actual number of overtime hours worked (monthly). This calculation is applied from 1980 to the present; for 1965, 1970, and 1975, actual working hours (monthly) were compiled in the Basic Survey on Wage Structure by the Ministry of Health, Labour and Welfare, so we use those data.

$$\text{Female marriage rate} = \frac{\text{Population of married females}}{\text{Population of females}}$$

4. Estimation Results

4.1. Estimation Results of the Chow Test

We examine whether a structural shift occurred between 1975 and 1980 based on the F-value of the Chow test. The results show supporting evidence of the occurrence of the structural change, with an F-value of 64.61 (p-value 0.000). Given that, we show the separate regression results for the subperiods in the following analysis.

4.2. Estimation Results of Fertility for 1965-2015, 1965-1975, and 1980-2015

Table I presents the estimation results for 1965-2015, subperiod I (1965-1975), and subperiod II (1980-2015). The regression model is the Butz-Ward model, and the results are reported in Columns A1, B1, and C1.

In Columns A1 and B1, for 1965-2015 and 1965-1975, the effect of female wages is negative and statistically significant, which is consistent with the Butz-Ward model. Female wages are associated with opportunity costs of rearing children, so increasing female wages causes a decrease in the fertility rate. On the other hand, in Column C1, the sign of the coefficient of female wages is positive. This implies that the income effect might outweigh the substitution effect. In Columns B1 and C1, the effect of male income is positive and statistically significant for 1965-1975 and 1980-2015, which is consistent with the Butz-Ward model. On the other hand, in Column A1, its sign is negative, and it is statistically significant. There are three possible interpretations for the negative sign: first, children might be assumed to be inferior goods; second, couples might choose to spend a greater amount of money on human capital for fewer children; third, the substitution effect outweighs the income effect. The last possibility is that a husband spends more time on child rearing than ever before. Columns A2, B2, and C2 show the estimation results with the addition of the variable of the female marriage rate and the cross-term of female wages and the female marriage rate. In Column B2, the effect of female wages is negative and statistically insignificant, which is consistent with the Butz-Ward model.

Table I. Results of the Butz-Ward Model for 1965-2015, 1965-1975, and 1980-2015
The dependent variable is the TFR.

	1965-2015 (A1) Fixed	1965-2015 (A2) Fixed	1965-1975 (B1) Fixed	1965-1975 (B2) Fixed	1980-2015 (C1) Fixed	1980-2015 (C2) Fixed
Female wages	-0.215**	0.0668	-0.733***	-1.088	0.0673	0.207**
	(0.0881)	(0.130)	(0.226)	(0.718)	(0.0682)	(0.100)
Male income	-0.681*	-1.975***	2.891***	1.817	0.528*	-0.237
	(0.334)	(0.332)	(1.030)	(1.271)	(0.295)	(0.288)
Female marriage rate		2.725***		1.137		2.025***
		(0.393)		(1.241)		(0.328)
Female wages x Female marriage rate		-0.157		0.436		-0.146
		(0.215)		(1.015)		(0.169)
Constant	2.369***	0.841***	2.011***	1.525**	1.575***	0.427**
	(0.0374)	(0.221)	(0.117)	(0.665)	(0.0894)	(0.199)
No.of Obs.	506	506	138	138	368	368
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2 (within)	0.945	0.955	0.699	0.714	0.945	0.954
R^2 (between)	0.395	0.441	0.0038	0.0326	0.452	0.187
R^2 (overall)	0.889	0.883	0.27	0.306	0.523	0.721

Notes: Standard errors are given in parentheses.

* Denotes significance at the 10 % level, ** denotes the 5 % level, and *** denotes the 1 % level.

On the other hand, in Columns A2 and C2, the effects of female wages are positive. This could be because the income effect might be stronger than the substitution effect. With the rapid economic growth, the number of women receiving higher education and getting jobs has increased, and female wages have also increased. This circumstance might have caused the positive effect of female wages on fertility. In Column B2, the effect of male income is positive and is insignificant, which is consistent with the Butz-Ward model. On the other hand, in Columns A2 and C2, the effects of male income are negative. We infer that these effects show that children might be assumed to be inferior goods, and couples might choose to spend a greater amount of money on human capital for fewer children. In addition, husbands might spend more time on child rearing than ever before. In Columns A2, B2, and C2, the female marriage rate is positive. This is another dominant factor that might have affected fertility. The other variable, the cross-term of female wages and the female marriage rate, has negative signs in Columns A2 and C2, whereas it has a positive sign in Column B2. Looking at the effects of female wages and the female marriage rate, a negative sign is expected. If females get married and work, their wages negatively affect their fertility. However, in Column B2, the sign is the opposite of what we expected.

5. Conclusions

We estimated fertility in Japan using aggregate data for 1965-2015. We also tested for structural changes using a Chow test, and the results indicated that a structural change occurred from 1975-1980. Based on these results, we separated 1965-2015 into two subperiods: 1965-1975 and 1980-2015. We then estimated Japanese fertility for 1965-2015 these two subperiods using a fixed-effects model.

Our results show that the patterns of Japanese fertility in subperiod I (1965-1975) are consistent with the model developed by Butz and Ward: female wages have a negative impact on fertility via the substitution effect, and male income has a positive impact on fertility via the income effect. The results for subperiod II (1980-2015) are not consistent with the Butz-Ward model. The effect of female wages is positive, and the effect of male income is either positive or negative. In addition, for 1965-2015, the effect of female wages tends to negatively affect fertility, but when the cross-term for female wages and female marriage rate is included, the effect becomes positive. The effect of male income has a negative impact on fertility.

As the estimation results for subperiod II (1980-2015) show, the effects of female wages and male income on fertility are different from the prediction of the Butz-Ward model. However, the positive sign of female wages implies that the increase in female wages has caused the income effect to outweigh the substitution effect, whereas the negative sign of male income shows that increasing male income has caused the substitution effect to outweigh the income effect. In particular, the estimation results for subperiod II have policy implications, indicating that it might be better for females and males to balance work inside the home and work outside the home. Flexible work hours should be considered one policy for regular workers.

For future research, the analysis of the marriage market would be important because the increase in the number of unmarried females could be an important factor explaining the decrease in the fertility rate. In our estimation results, the female marriage rate variable was positively related to fertility during all periods: 1965-2015, subperiod I (1965-1975), and subperiod II (1980-2015). Future research should focus on the determinants of female marriage behavior to analyze the patterns of Japanese fertility. In addition, if long-term micro-data were available, we could analyze more deeply what factors affect fertility.

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Appendix

Table A1. Descriptive Statistics for 1965–2015

	1965		1970		1975	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
TFR	2.174	0.135	2.092	0.115	1.987	0.102
Female Wages (monthly)(1,000yen)	0.402	0.041	0.610	0.075	1.002	0.114
Male Income (monthly)(1,000yen)	158.451	13.701	236.300	24.208	321.136	27.362
Female Marriage Rate	0.609	0.025	0.634	0.022	0.674	0.025
Female Income (monthly)(1,000yen)	79.102	7.624	119.584	13.760	187.490	17.852
Female Contractural Cash Earnings (monthly)(1,000yen)	66.758	6.113	99.390	10.512	147.929	12.956
Male Contractural Cash Earnings (monthly)(1,000yen)	128.152	10.807	190.807	19.124	246.658	19.670
Female Special Cash Earnings (monthly)(1,000yen)	12.344	1.953	20.194	3.468	39.561	5.041
Male Special Cash Earnings (monthly)(1,000yen)	30.299	3.700	45.494	5.717	74.479	8.141
Female Actual Working Hours (monthly)	197.022	2.603	196.249	2.570	187.520	3.757
Population of Married Females	361603.4	318203.5	402348.4	369401.9	438977.4	408074.6
Population of Females	607452.2	577563.1	642609.3	621041.5	655539.5	632729.9

1980		1985		1990		1995		2000	
Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1.817	0.108	1.815	0.104	1.609	0.116	1.517	0.125	1.465	0.124
0.970	0.124	1.084	0.146	1.248	0.155	1.487	0.164	1.582	0.160
333.134	36.602	360.856	42.698	401.811	45.512	421.617	38.619	415.672	39.248
0.673	0.025	0.649	0.025	0.609	0.027	0.583	0.028	0.555	0.029
183.952	19.356	204.012	22.963	232.696	24.686	263.235	25.900	276.065	25.924
148.195	14.014	163.830	16.636	186.334	18.300	209.327	18.814	223.363	19.590
263.111	26.218	284.584	30.276	314.858	32.046	330.928	26.868	334.320	27.952
35.758	5.476	40.182	6.464	46.362	6.651	53.908	7.383	52.702	6.748
70.023	10.635	76.271	12.701	86.953	13.797	90.689	12.025	81.352	11.961
190.072	4.149	188.618	4.157	186.803	3.602	177.269	2.465	174.617	1.871
439128.9	404793.9	422858.1	390460.7	399973.4	367599.2	376617.1	341009.5	338205.6	309479.8
659580.8	635599.4	664353.0	650942.8	675908.0	666947.0	667363.7	650415.0	629406.7	619686.3

2005		2010		2015	
Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1.347	0.110	1.463	0.120	1.520	0.115
1.584	0.163	1.618	0.159	1.631	0.181
413.633	47.166	398.715	42.940	393.455	45.221
0.528	0.028	0.512	0.027	0.500	0.022
275.147	26.139	279.609	25.996	281.292	28.962
230.870	20.773	237.206	20.802	237.139	22.369
339.905	33.728	333.728	31.479	324.698	32.494
44.277	5.739	42.403	5.623	44.153	7.039
73.729	13.797	64.988	12.078	68.757	13.298
173.794	2.093	172.900	1.716	172.603	2.008
308375.0	296395.3	290960.7	298749.7	274021.8	295458.3
599525.1	611548.7	580558.3	626638.5	555106.3	619077.1

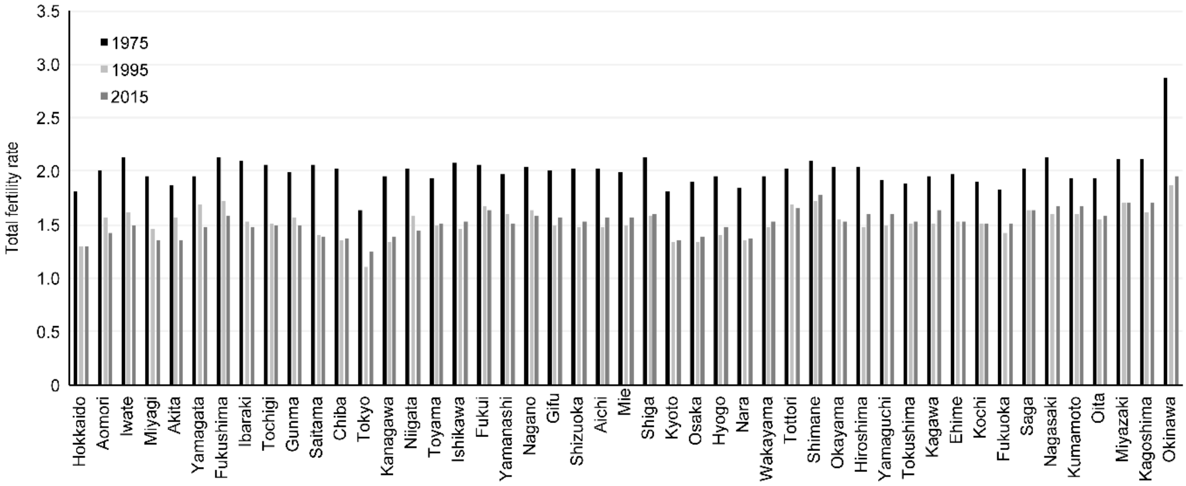

Figure A1. Total Fertility Rate (1975, 1995, 2015)

Data source: Vital Statistics (Ministry of Health, Labour and Welfare)