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How does income distribution affect economic growth?
－Evidence from Japanese prefectural data－

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How does income distribution affect economic growth?
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Abstract

There have been various empirical researches on the effects of income distribution on economic growth. Although studies using cross-country data used to be common, recent researches started to use regional panel-data within one country. This paper uses Japanese prefectural panel data to analyze how income distribution affects economic growth.

The measures of the income distribution used in the estimations are the income share of the third quintile and the Gini indices. In the fixed effects estimations and the GMM estimations, the income share of the third quintile has positive and statistically significant effects on five-year economic growth rates. On the other hand, the Gini indices have positive and statistically significant effects on both of the five-year and ten-year economic growth rates in the fixed effects estimations, and negative effect on the five-year growth rate in the GMM once. These results are the similar to one of the existing literatures and can be explained with the modified median voter theory.

JEL Classification Codes: O40, C33, J01

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1. Introduction

There have been various empirical and theoretical researches on this topic. According to Weil (2013), income equality affects economic growth through four channels. These four channels are the accumulation of physical capital, the accumulation of human capital, government redistribution policy, and sociopolitical instability.

In recent Japan, active discussion on the possibility of increase in income inequality was conducted (Otake 2005, Tachibanaki 2004, 2006), and the increase of inequality people felt became social problem for several years. In addition, recent increase of the maximum rate for income taxes and increase of inheritance taxes can be considered as the increase of government's income redistribution. Such increase or decrease in income inequality can affect economic growth, and that effect is estimated in this research.

In the figure 1, the transition of the Gini index in the Survey on the redistribution of income and the National Survey of family income and expenditure are shown. The red line shows the Gini index on the income before redistribution, and it has been increasing sharply. However, the income after redistribution shown by the blue line increased more slowly during 1980-2002 and did not show constant increase after 2003. Also, if we

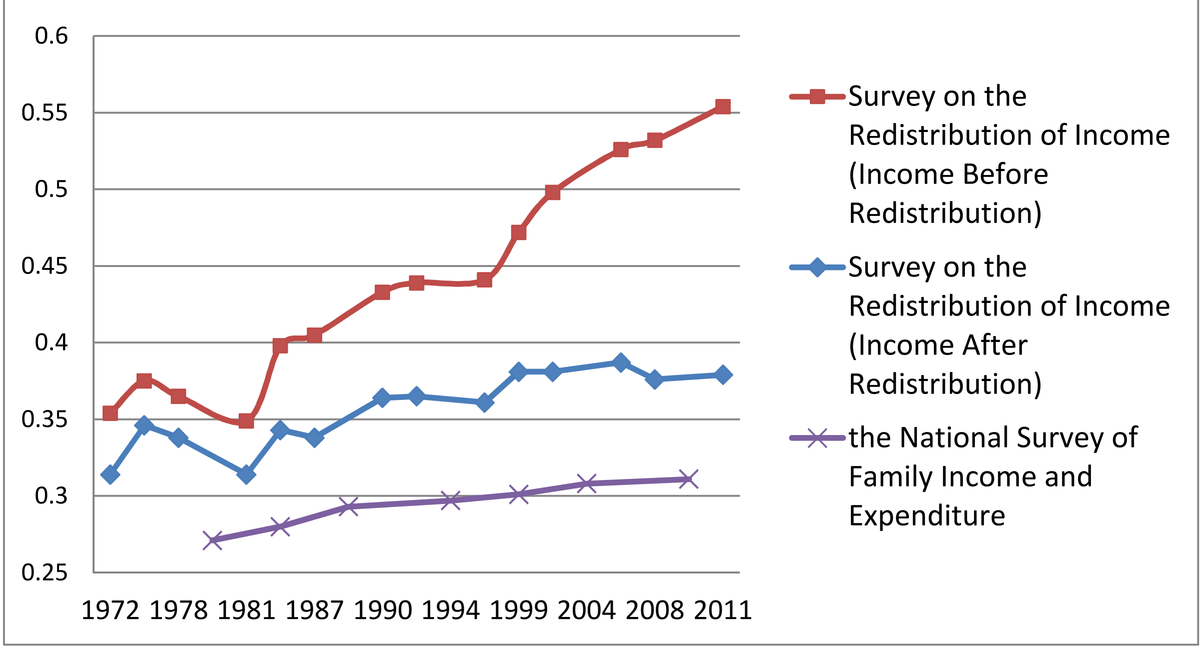


Figure１ Gini coefficients in Japan

look at the violet line which shows the Gini index of the National Survey of family income and expenditure, it is low but increasing since 1979.

In the existing empirical researches, the effects of income distribution on economic growth are different, depending on data and estimation methods. Persson and Tabellini (1994) found that equality has positive and significant effects on growth, using historical panel data and post-war cross-country data. Perotti (1996) used cross-country data and also found that equality has positive effect on growth. Forbes (2000) and Li and Zou (1998) used cross-country panel data and found opposite evidence that equality decreases growth.

Weil (2013) explains the reason why it is difficult to find out the effect of income distribution on economic growth is that the effect may depend on a county's stage of growth, as well as other factors such as whether a country is open to capital flows from abroad.

On the other hand, recently, Panizza (2002), Partridge (1997), Atems (2013) etc. conducted researches using panel data of U.S. states. According to Panizza (2002), while most cross-country studies find a positive relationship between income equality and economic growth, most existing studies that use panel data suggest the presence of a negative relationship between income equality and growth. The research in Panizza (2002), however, found some evidence in support of a positive relationship between equality and growth, using a panel data of the 48 states of the continental US for the 1940-1980 period. Atems (2013) also used U.S. county panel data to estimate dynamic spatial Durbin model, and found that the direct effect of a one-point increase in a county's inequality is associated with a 3.3% decrease in its growth, while one-point increase in inequality in a county's neighbors decrease its growth by 4.8%.

Partridge (1997) also used panel data of U.S. states and found out that equality measured with the Gini index has negative and significant effect on growth, and that equality measured with the income share of the third quintile has positive and significant effect on growth. This research used Japanese prefectural panel data in estimation and found the same effects as Partridge (1997). Partridge explain the result the median voter theory, and this can also be applied to Japanese results.

Using a regional panel data within one country has an advantage that the county's stage of growth, other factors such as whether a country is open to capital flows from abroad, and the measurement method of equality are the same. Therefore, in this paper, empirical investigation using prefectural panel data in Japan is conducted, following the recent empirical researches. Since such research using Japanese panel data has not been conducted yet, it is important to find out what kind of effects such data shows.

This paper is organized as follows. Section 2 illustrates data set; Section 3 presents the results of estimation; Section 4 concludes.

2. Data

In this paper, Japanese prefectural panel date is used in estimation. The summary statistics is shown in table 1, and the correlation matrix is shown in table 2.

Data is a panel for 47 prefectures for the 1980 (1979 for Gini coefficients) - 2010, every 5 years for 6 periods. Growth 5 is the five-year average annual growth rate from the base year, growth10 is the ten-year average annual growth rate of each prefecture. LogIncome is the natural log of the average per capita income in prefectures. These data are obtained

Table 1. Summary Statistics

	No.of obs.	Average	S.E.	Minimum	Maximum
growth5	282	0.0117	0.0245	-0.0375	0.0654
growth10	141	0.0145	0.0253	-0.0200	0.0627
LogIncome	329	3.3730	0.110997	3.0790	3.6646
Gini	282	0.2523	0.0850	0.0590	0.3800
Q3	282	0.1769	0.0045	0.1565	0.1892
HighSchool	282	41.1663	5.8431	25.0151	56.8238
College	282	20.1745	8.2518	7.3391	47.6881
Agriculture	282	10.2585	6.0017	0.4000	26.6000
Urban	282	48.5993	18.5704	23.4000	98.0000
Old	282	16.7283	4.6685	6.1636	27.1352
Manufacturing	282	20.8058	6.5005	4.9178	34.6487
FinanInsRealEst	282	3.3291	0.9038	2.0771	7.0241
Government	282	3.7017	0.8064	2.2581	6.7096

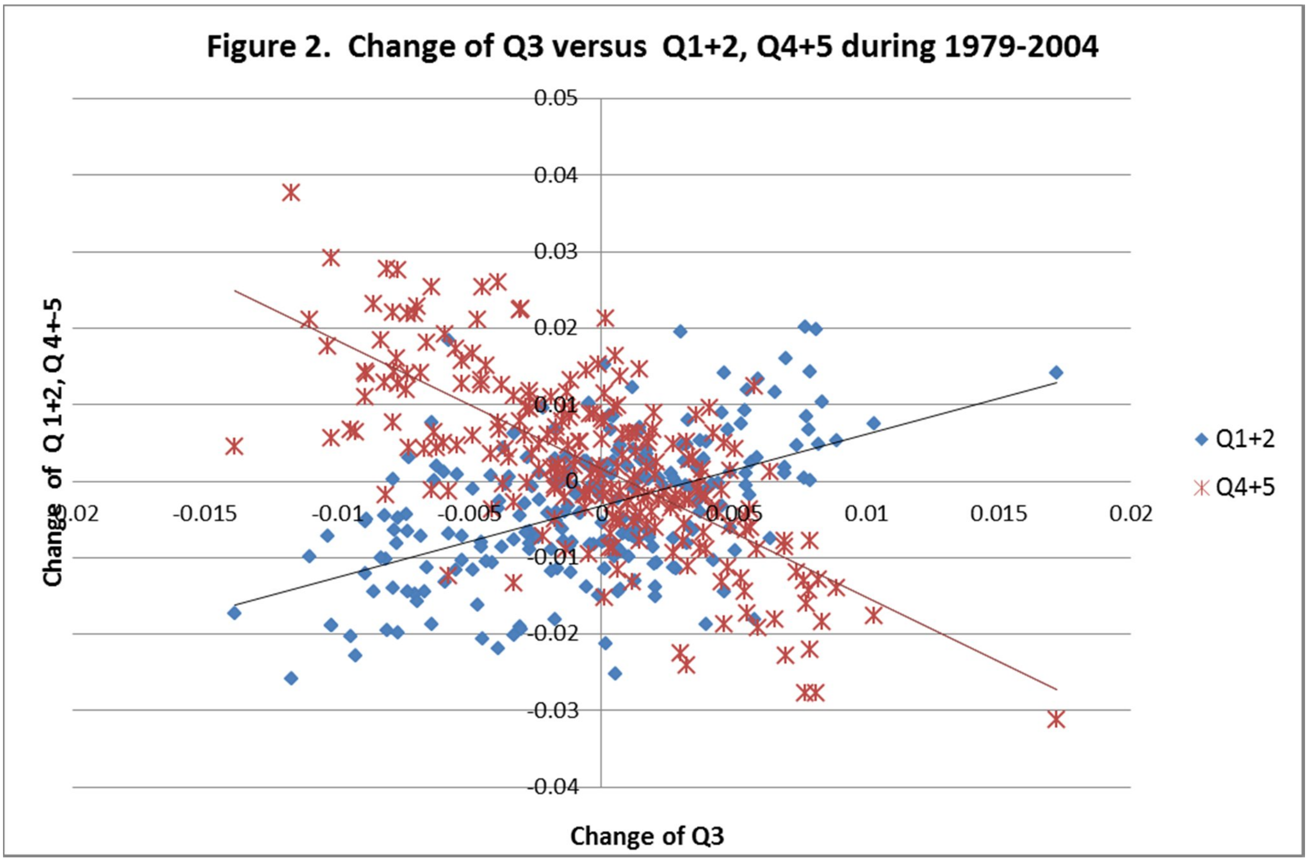
Table 2 . Correlation Matrix

	growth5	growth10	LogIncome	Gini	Q3	HiSchool	College	Agriculture	Urban	Old	Manufacturing	FinanInsRealEst	Government
growth5	1.000												
growth10	0.948	1.000											
LogIncome	-0.759	-0.879	1.000										
Gini	-0.601	-0.944	0.707	1.000									
Q3	0.332	0.258	-0.254	-0.378	1.000								
HighSchool	-0.384	-0.742	0.379	0.337	0.089	1.000							
College	-0.738	-0.728	0.780	0.512	-0.401	0.224	1.000						
Agriculture	0.476	0.510	-0.741	-0.366	0.326	-0.157	-0.760	1.000					
Urban	-0.148	-0.153	0.382	0.103	-0.346	-0.094	0.537	-0.697	1.000				
Old	-0.382	-0.732	0.251	0.636	-0.142	0.172	0.234	0.053	-0.348	1.000			
Manufacturing	0.217	0.116	0.197	-0.174	0.303	0.064	-0.098	-0.310	-0.018	-0.288	1.000		
FinanInsRealEst	-0.138	-0.224	0.424	0.159	-0.286	-0.044	0.554	-0.645	0.835	-0.350	-0.015	1.000	
Governmenment	0.030	0.060	-0.403	0.017	-0.119	0.022	-0.178	0.373	-0.157	0.119	-0.785	-0.138	1.000

or calculated from "the Annual Report on Prefectural Accounts" released by the Cabinet Office.

Gini is the Gini index and Q3 is the income share of the third quintile in 47 prefectures, and both data are obtained or calculated from "the National Survey of Family Income and Expenditure." Table 2 shows that the correlation between the Gini index and Q3 is -0.378. The Gini index is the established measure of income distribution, and the negative correlation with the Gini index shows that Q3 is the measure of income equality.

Also, the figure 2 shows the change of the income share of the third quintile (Q3) at the horizontal axis, and the change of the income share of the first and second quintiles (Q1 and Q2) and that of the richer fourth and fifth quintiles (Q4 and Q5) at the vertical axis. This figure shows that when the income share of the middle class increases, income share of the poorer quintiles tend to increase and the income share of the richer quintiles tend to decrease. Therefore, we can interpret that the overall income equality tends to increase when Q3 increases.



Following Panizza (2002), Partridge (1997) and Perotti (1996), other variables are the average skills of the labor force (HighSchool is the percentage of the population over 15 years old that have graduated from high school, but not a college, and College is the percentage that graduated from two- or four-year college or graduate school) and they are from "the employment status survey." The degree of urbanization (Urban measures the fraction of the population that lives in urban areas), age structure (Old measures the percentage of the population above 65 years of age), and industrial structure (Agriculture, Manufacturing, FinanInsRealEst, Government measure the percentage of the population employed in agriculture; construction; manufacturing; finance, insurance, and real estate; and government) are also used. Agriculture, Urban are data from "Statistical Indicator of Social Life –Prefectural Indicator—" by the Statistics Bureau, Ministry of Internal Affairs and Communications. Old, Construction, Manufacturing, FinanInsRealEst, Government are from "the Population Census."

3. Estimations

In this section, the results of OLS and fixed effects estimations are shown. First, the basic simple regression of the following equation is conducted:

$$Growth_i = \beta y_i + \gamma DISTRI_i + \theta X_i + \varepsilon_i \qquad (1)$$

where $Growth_i$ is the prefecture i's annual growth rate of income per capita, y_i is prefecture i's natural log of income per capita, $DISTRI_{t,i}$ is a variable capturing income distribution (measured using the income share of the third quintile or the Gini index) and X_i is the prefecture i's matrix of controls. The matrix X_i includes stock of human capital (HighSchool and College), the degree of urbanization (Urban), age structure (Old) and the initial industrial mix of the prefecture (Agriculture, Manufacturing FinanInsRealEst, Government).

First, I estimated equation (1) with pooled OLS and the result is shown in table 3. They suggest that income share of the 3rd quintile has positive or negative significant effects on growth, depending on the length of growth episodes. As for the Gini indexes, they have positive effects on five-year

Table 3. Pooled OLS Estimation: Five and ten-year growth episodes

	Length of Growth Episodes					
	5 years			10 years		
LogIncome	-0.160	-0.181	-0.189	-0.182	-0.082	-0.060
	(-13.28)***	(-10.67)***	(-10.78)***	(-18.06)***	(-4.93)***	(-3.64)***
Q3	0.160		0.319	-0.121		-0.576
	(0.92)		(1.70)*	(-0.76)		(-4.12)***
Gini		0.032	0.044		-0.115	-0.142
		(1.74)*	(2.26)**		(-7.00)***	(-8.43)***
HighSchool	-0.0003	-0.0003	-0.0003	0.0001	-0.0002	-0.0001
	(-1.99)**	(-1.89)*	(-2.14)**	(0.67)	(-0.85)	(-0.70)
College	-0.0011	-0.0010	-0.0009	0.0000	-0.0004	-0.0005
	(-5.85)***	(-4.95)***	(-4.73)***	(-0.21)	(-2.80)**	(-3.45)***
Urban	0.0004	0.0003	0.0003	0.0001	0.0000	0.0000
	(4.36)***	(4.14)***	(4.14)***	(0.64)	(0.20)	(-0.27)
Old	0.0014	0.0011	0.0010	-0.0010	-0.0002	-0.0001
	(6.79)***	(3.90)***	(3.39)***	(-2.42)**	(-0.51)	(-0.39)
Agriculture	0.0012	0.0012	0.0011	0.0003	0.0001	0.0002
	(3.83)***	(3.94)***	(3.41)***	(0.98)	(0.44)	(0.90)
Manufacturing	0.0024	0.0025	0.0023	0.0010	0.0006	0.0006
	(8.88)***	(9.35)***	(8.58)***	(3.51)***	(2.40)**	(2.73)***
FinanInsRealEst	0.013	0.012	0.012	0.004	0.004	0.004
	(8.79)***	(8.29)***	(7.98)***	(2.96)***	(3.35)***	(3.58)***
Government	0.0041	0.0032	0.0027	-0.0021	0.0003	0.0009
	(2.34)**	(1.79)*	(1.45)	(-1.25)	(0.22)	(0.64)
Constant	0.400	0.499	0.476	0.626	0.306	0.337
	(7.58)***	(8.20)***	(7.66)***	(13.37)***	(5.73)***	(6.62)***
Adj. R2	0.844	0.845	0.846	0.926	0.946	0.952
N.obs.	282	282	282	141	141	141

Notes: t statistics in parentheses

* Denotes a parameter which is significant at 10%, ** at 5%, and *** at 1%.

growth rate and negative effects on ten-year growth rate. Therefore, in the OLS estimations, the effects of the income distribution on economic growth are mixed and not very clear.

In addition, in the following fixed effects estimations, F-tests which test the null hypothesis that all prefecture-specific fixed effects α_i are zero were conducted. As the table 4 and table 5 show, The test results always reject the null hypothesis, so there exist unobservable prefecture-specific fixed effects and therefore the fixed effects estimations are preferred over pooled OLS estimations.

Therefore, this paper shows the results of estimating the following fixed effects model:

$$Growth_{(t,t+n),i} = \beta y_{t,i} + \gamma DISTRI_{t,i} + \theta X_{t,i} + \alpha_i + \eta_t + \varepsilon_{t,i} \qquad (2)$$

In this equation, $Growth_{(t,t+n)}$ is the average annual growth rate of prefectural income from year t to t+n, α_i denotes the prefecture i's unobservable prefecture-specific effect, η_t denotes a period-specific intercept, and $\varepsilon_{t,i}$ is the remainder stochastic disturbance term. The estimation results are shown in table4 and 5.

In order to decide which of the random effects and fixed effects estimation should be adopted, the Hausman test results are shown in the bottom of these two tables. When Hausman test is effective, it always reject the null that explanatory variables $X_{t,i}$ and the prefecture-specific effect α_i is not correlated. This means that random effects estimates are not consistent and fixed effects estimations should be adopted rather than random effects estimations. Therefore, the estimation results of fixed effects are shown.

In the fixed effects estimation with five-year growth episodes in table 4, the income share of the third quintile (Q3) have positive and significant effects on growth most of the time, and the Gini index also has positive and statistically significant effects on growth in most estimations.

In the table 5, the fixed effects estimation with ten-year growth episodes are reported. In this table, the income share of the third quintile (Q3) has negative but insignificant effects, and the Gini index have positive and mostly statistically significant effects on the economic growth.

These fixed effects estimation results of table 4 and 5 may be biased by

Table 4. Fixed effects estimations: Five-year growth episodes.

	No controls			Controls			Controls and period dummies		
LogIncome	-0.234	-0.388	-0.383	-0.183	-0.284	-0.313	-0.381	-0.383	-0.384
	(-26.02)***	(-30.00)***	(-32.42)***	(-10.30)***	(-12.35)***	(-13.45)***	(-12.73)***	(-12.83)***	(-12.81)***
Q3	0.829		1.297	0.250		0.675	0.280		0.098
	(3.21)***		(6.93)***	(1.47)		(4.17)***	(1.92)*		(0.50)
Gini		0.196	0.212		0.167	0.206		-0.110	-0.089
		(12.79)***	(14.99)***		(6.37)***	(7.63)***		(-2.33)**	(-1.40)
HighSchool				0.000	0.000	0.000	0.000	0.000	0.000
				(0.34)	(0.48)	(-0.14)	(-0.26)	(0.00)	(-0.04)
College				-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
				(-2.77)***	(-2.15)**	(-1.83)*	(-1.00)	(-0.89)	(-0.91)
Urban				0.000	0.000	0.000	0.000	0.000	0.000
				(0.18)	(-0.82)	(-0.54)	(-0.96)	(-0.91)	(-0.89)
Old				0.002	0.000	0.000	-0.002	-0.002	-0.002
				(12.34)***	(-0.02)	(-1.18)	(-2.08)**	(-1.98)**	(-2.00)**
Agriculture				0.002	0.001	0.000	0.001	0.001	0.001
				(4.52)***	(1.74)*	(0.76)	(0.96)	(1.22)	(1.18)
Manufacturing				0.003	0.002	0.002	0.002	0.002	0.002
				(4.69)***	(3.38)	(2.94)***	(2.88)***	(2.81)***	(2.83)***
FinanInsRealEst				0.013	-0.001	-0.001	0.001	0.002	0.002
				(2.88)***	(-0.11)	(-0.22)	(0.18)	(0.37)	(0.37)
Government				-0.002	-0.001	0.001	0.005	0.005	0.005
				(-0.53)	(-0.28)	(0.34)	(1.15)	(1.14)	(1.17)
Constant	0.662	1.276	1.026	0.450	0.917	0.892	1.189	1.241	1.224
	(10.41)***	(31.67)***	(19.92)***	(6.13)***	(10.15)***	(10.20)***	(11.16)***	(11.92)***	(11.20)***
Overall R2	0.5951	0.4709	0.4936	0.7192	0.5554	0.5881	0.5213	0.5278	0.5282
F rest that all α_i = 0	4.67***	11.29***	13.90***	5.21***	6.82***	7.56***	3.28***	3.86***	3.85***
Hausman Test	-214.97	-32105.16	-2165.86	-103.31	-217.32	-147.32	183.59***	187.71***	185.77***
N.obs.	282	282	282	282	282	282	282	282	282

Notes: t statistics in parentheses

* Denotes a parameter which is significant at 10%, ** at 5%, and *** at 1%.

Table 5. Fixed effects estimations: Ten-year growth episodes.

	No controls			Controls			Controls and period dummies		
LogIncome	-0.219	-0.296	-0.307	-0.199	-0.246	-0.246	-0.260	-0.261	-0.260
	(-46.73)***	(-13.69)***	(-13.39)***	(-13.80)***	(-12.41)***	(-11.05)***	(-10.69)***	(-10.70)***	(-10.58)***
Q3	-0.050		0.265	-0.197		-0.001	-0.122		-0.143
	(-0.26)		(1.37)	(-1.40)		(-0.01)	(-0.88)		(-0.74)
Gini		0.088	0.103	0.000	0.062	0.062		0.021	-0.009
		(3.64)***	(3.90)***	(0.08)	(3.07)***	(2.69)***		(0.50)	(-0.16)
HighSchool				0.000	0.000	0.000	0.000	0.000	0.000
				(-1.04)	(0.41)	(0.41)	(0.79)	(0.82)	(0.80)
College				0.000	0.000	0.000	0.000	0.000	0.000
				(-0.39)	(-1.11)	(-1.09)	(-0.08)	(-0.02)	(-0.06)
Urban				0.000	0.000	0.000	0.000	0.000	0.000
				(0.36)	(-0.51)	(-0.51)	(-0.46)	(-0.40)	(-0.46)
Old				0.000	0.000	0.000	0.000	0.000	0.000
				(0.36)	(-0.14)	(-0.14)	(0.03)	(0.10)	(0.02)
Agriculture				0.000	0.000	0.000	0.000	0.000	0.000
				(0.49)	(0.13)	(0.13)	(0.25)	(0.21)	(0.28)
Manufacturing				0.001	0.001	0.001	0.001	0.001	0.001
				(1.93)*	(1.65)	(1.64)	(1.31)	(1.28)	(1.31)
FinanInsRealEst				0.002	-0.001	-0.001	-0.001	-0.001	-0.001
				(0.56)	(-0.26)	(-0.26)	(-0.22)	(-0.20)	(-0.18)
Government				0.002	0.002	0.002	0.003	0.003	0.003
				(0.45)	(0.61)	(0.59)	(0.68)	(0.74)	(0.69)
Constant	0.761	0.991	0.977	0.688	0.815	0.815	0.872	0.852	0.876
	(17.99)***	(14.72)***	(14.39)***	(11.60)***	(11.06)***	(10.98)***	(10.24)***	(10.23)***	(9.75)***
Overall R2	0.772	0.662	0.646	0.815	0.701	0.701	0.699	0.700	0.700
F rest that all α_i = 0	11.16***	4.09***	3.82***	6.52***	4.79***	3.97***	3.30***	3.28***	3.25***
Hausman Test	-44.86	163.57***	157.56***	-5.94	467.37***	1396.81***	179.34***	118.18***	173.72***
N.obs.	141	141	141	141	141	141	141	141	141

Notes: t statistics in parentheses

* Denotes a parameter which is significant at 10%, ** at 5%, and *** at 1%.

the fact that equation (2) contains a lag of the dependent variable (Panizza 2002; Caselli *et al.* 1996; Judson and Owen 1999). In order to address this point, I re-estimated the equation (2) with the robust GMM estimators developed by Arellano and Bond (1991). The estimation results are shown in table 6.

In table 6, changes of Q3 sometimes have positive and significant effects on growth, and changes in the Gini indices have negative and significant effect on changes in growth once. The positive effects of changes of Q3 are the same as those in fixed effects estimations. However, the negative effect of changes in the Gini is the opposite from the fixed effects estimations although the coefficient is statistically significant only in the estimation without Q3 and with period dummies.

Therefore, if the income of the third quintile is used as the equality measure, (changes in) income equality enhances the (changes in) economic growth. However, when (changes in) the Gini indices are used, (changes in) the income equality decreases (changes in) economic growth most of the time. Thus, the results are the same as those in Partridge (1997).

Partridge (1997) used the U.S. state panel data and explained the Q3 results with a positive relationship between the median voter's relative well-being and economic growth as suggested by the Persson and Tabellini (1994) and Alesina and Rodrik (1994). In addition, Partridge (1997) explained the result of the Gini index also with the median voter theory after modest modification. That is, by assuming that the likelihood of growth-enhancing policies increases as higher-income groups gain political power relative to lower-income groups. That is what the positive Gini-economic growth relationship may reflect.

The results from Japanese data can also be explained with this modified median voter theory. Although Japanese prefectural governments are more centralized than U.S. state governments, Doi (1999) empirically showed that the median voter theory also applies to Japanese prefectural governments.

As for other independent variables, if the initial income level is higher, growth rate is lower, which means that prefectural per capita incomes tend to converge. The human capital measured by the shares of high school graduates and college graduates have negative effects on growth, which are opposite signs from the expected. In addition, larger share of employment

Table 6. GMM Estimations

(Dependent variables: growth rate in 5 years)

	No period dummies			Period dummies		
LogIncome	-0.515	-0.552	-0.584	-0.740	-0.739	-0.741
	(.038)***	(.041)***	(.048)***	(.050)***	(.047)***	(.048)***
Q3	0.208		0.396	0.297		0.158
	(.151)		(.2284)*	(.1592)*		(.2227)
Gini		-0.013	0.067		-0.094	-0.057
		(.0388)	(.0606)		(.0471)**	(.06631)
HighSchool	0.000	0.000	-0.001	-0.001	-0.001	-0.001
	(.0003)	(.0003)	(.0002)*	(.0006)**	(.0006)*	(.0005)*
College	0.000	0.001	0.001	-0.001	-0.001	-0.001
	(.0004)	(.0004)	(.0004)	(.0006)	(.0006)	(.0006)
Urban	0.000	0.000	0.000	0.000	0.000	0.000
	(.0006)	(.0005)	(.0005)	(.0005)	(0.0005)	(.0005)
Old	-0.005	-0.004	-0.003	-0.003	-0.003	-0.003
	(.001)***	(.001)***	(.001)**	(.001)**	(.001)**	(.001)**
Agriculture	-0.001	0.000	-0.001	0.001	0.001	0.001
	(.0013)	(.0014)	(.0013)	(.0011)	(.0011)	(.0011)
Manufacturing	0.000	0.001	0.001	0.002	0.002	0.002
	(.0010)	(.0009)	(.0009)	(.0009)**	(.0009)**	(.0009)*
FinanInsRealEst	0.002	0.002	0.002	0.007	0.006	0.006
	(.0060)	(.0059)	(.0058)	(.0053)	(.0051)	(.0054)
Government	0.002	0.004	0.006	0.007	0.007	0.007
	(.0073)	(.0068)	(.0067)	(.0058)	(.0059)	(.005)
Constant	1.730	1.856	1.776	2.476	2.560	2.550
	(.173)***	(.165)***	(.178)***	(.227)***	(.221)***	(.241)***
N. obs.	188	188	188	188	188	188

Notes: Robust standard errors in parentheses

* Denotes a parameter which is significant at 10%, ** at 5%, and *** at 1%.

in agriculture, manufacturing, finance, insurance and real estate and government sometimes raise the growth rate, and larger share of old people increases or decreases the growth rate.

4. Conclusion

In this paper, prefectural panel data of Japan is used for the first time to investigate how income equality affects economic growth. As a result of estimations and tests using data from 1979 to 2010, the fixed effect estimation and GMM estimation results are chosen. In the fixed effect estimations, income equality affects five-year growth positively and statistically significantly, if equality is measured with the income share of the third quintile. However, income equality affects growth negatively and statistically significantly if equality is measured with the Gini index. In the GMM estimations with the Q3, equality enhances growth again. These estimation results are the very similar to those with Partridge (1997), and can be explained with the modified median voter theory.

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