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Japanese Government and Utilitarian Behavior

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Abstract

When optimal policies for governments are studied in economics, social welfare functions are often used, but the functions are typically unobservable. This paper estimates the social welfare function of Japan's central government from FY 1955 to 2010. We assume that the central government determines its subsidies to the local governments of prefectures to maximize a social welfare function, which is assumed to be a weighted sum of the utility of a representative resident of each prefecture. The weight on each prefecture is estimated from the amounts of subsidies using the method developed by Iritani and Tamaoka (2005). Using regression analysis, we show that the weight on a prefecture is approximately equal to the prefecture's population. The correlation coefficient between weights and populations is 0.969. This implies that the social welfare function is approximately the (unweighted) sum of the utilities of all individuals in the entire country, that is, *utilitarian with identical weights on all individuals*.

Keywords: utilitarian social welfare, subsidies to local governments, local public finance, vote value

JEL Classification: H50, H77.

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1 Introduction

A government's policy reflects the government's preferences, which are typically unobservable. However, if the government determines its policy by maximizing a social welfare function, we can estimate this function by using the chosen policy as the revealed preference of the government.

We focus on Japanese central government's preferences for local governments. Our purpose is to determine the social welfare function of the central government and to investigate the determinants of the weight the central government attaches to each local government. We assume that the social welfare function is a weighted sum of each prefecture's utility, whose form is given by the natural logarithm of the per-capita prefectural income. Our approach is the same as that of Iritani and Tamaoka (2005), that is, to calculate the weight the central government attaches to each of the 47 prefectures in the country, from the amounts of subsidies paid to the prefectures, which are assumed to be optimally determined by the central government. By using data, Iritani and Tamaoka (2005) show that the central government gives more weight to urban areas. Since urban areas are typically populous areas, we investigate the relation between the weights and the populations of prefectures. We find that their correlation coefficient is approximately 1. This implies that approximately, the relation between weights and populations is linear. We also show that *the weight given to a prefecture by the central government equals approximately its population share in the country*. Figure 1 depicts the proportional relation between populations and weights for nine years between FY 1955 and 2010. The lines in these graphs are regression lines obtained by pooled OLS of these nine years. The regression result is $\alpha_i = 1.04\bar{N}_i - 0.001$, where α_i is the weight on prefecture i, $\bar{N}_i$ is the population share of prefecture i, and $\bar{R}^2 = 0.94$ is the coefficient of determination.[1]

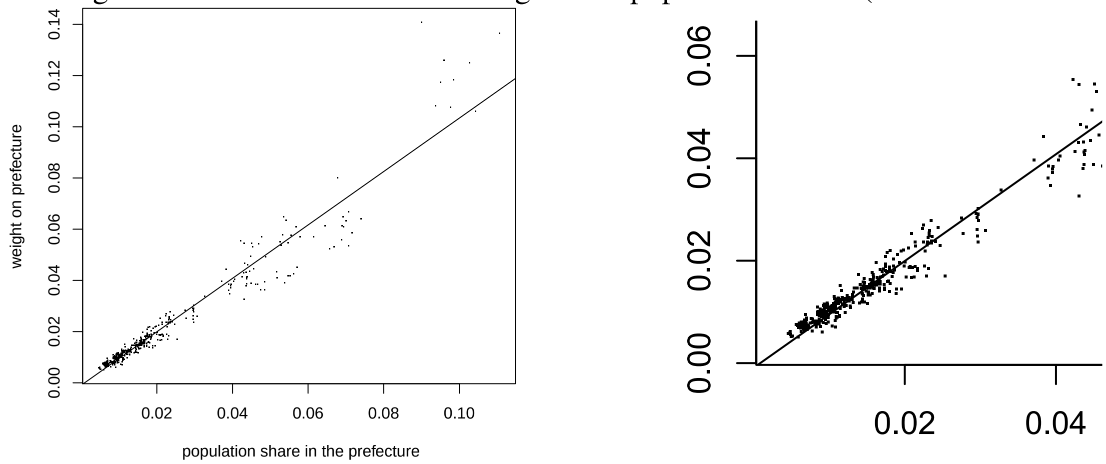
This result implies that the social welfare function is given by $\sum_i (1.04\bar{N}_i - 0.001)u_i = 1.04 \sum_i \bar{N}_i u_i - 0.001 \sum_i u_i$, where u_i is the utility of a resident in prefecture i. Normalizing the weights, the social welfare function is equivalent to $0.999 \sum_i \bar{N}_i u_i + 0.001(-\sum_i u_i)$, which implies that 99.9% of the social welfare function is utilitarian with identical weights.[2]

Japanese local public financial system has been said to equalize fiscal revenues of local governments. According to DeWit and Steinmo (2002), the average of per-capita revenues after redistribution of the five lowest-taxed prefectures (rural areas) is higher than that of the five highest-taxed prefectures (urban

[1] The standard error of the intercept is 0.0006 and that of $\bar{N}_i$ is 0.037. The coefficient of population share is statistically significant at the 1% level.

[2] In section 2, we consider another factor, the size of land.

Figure 1: The relation between weights and population shares (FY 1955–FY 2010)



- The left figure represents the relation between the percentage of the population living in a prefecture and the weight attached by the central government to the prefecture. (1955–2010)
- The right figure provides a detailed view of the lower-left portion of the left figure.
- The lines in these graphs are regression lines.

areas). Hence the system is said to be transferring excessively to rural areas. For example, DeWit and Steinmo (2002) write, "the system clearly 'over-equalizes', as it leaves Japan's rural areas with a much higher index of per-capita revenues than the urban areas, a phenomenon that is not evident in the other countries" (171). Akai, Sato and Yamashita (2003) write about local allocation tax, which is a fiscal transfer used for intergovernmental fiscal adjustments, saying, "the status quo that the amount of transfer of local allocation tax is in excess, and interregional redistribution is gone too far is common sense among critics and supporters of local allocation tax" (22). This characteristic can be explained by the utilitarian social welfare function. If the central government has the utilitarian social welfare function, the central government tries to equalize per-capita consumption. For per-capita consumption to be equalized across prefectures, rural areas, where per-capita income is low, need more fiscal transfers than urban areas. Hence the amounts of per-capita fiscal net revenues after redistribution are higher for rural areas than for urban areas.

We now discuss two issues of our basic model. First, we consider the gap between populations and weights. To do so, we investigate some features of prefectures where the gap between the weight and the population is large. We consider the number of National Diet members in each prefecture.[3] The reason is as follows. Fukui and Tottori prefectures, whose weight-population ratios are respectively the second

[3]The National Diet is Japan's bicameral legislature.

and the third highest of the 47 prefectures, also have many Diet members: the ratios of the number of Diet members to the population in these prefectures are respectively the fourth highest and the highest of all prefectures. On the other hand, Kanagawa and Chiba prefectures, which have the third lowest and the lowest weight-population ratios, respectively, also have low ratios of Diet members to population: Diet member to population ratios in these prefectures are respectively the second lowest and the sixth lowest. Therefore, it is reasonable to expect that the Diet member to population ratio is a determinant of the weight.

Regression analysis for FY 2010 and other years indeed shows that the Diet member to population ratio significantly explains the gap between weights and populations.[4] Interestingly, the estimation implies that, in FY 2010, the weight attached by the central government to an Upper House member is approximately 136680 times that to an ordinal resident.

Second, we consider inter-prefectural trades, which are not considered in Iritani and Tamaoka. We extend their model to include domestic trades between prefectures. The extended model implies that the weight on a prefecture also depends positively on the prefecture's net export. This implies that if two prefectures have the same population, the prefecture with greater net export is given greater weight from the central government.

1.1 Related Literature

There are many studies that estimate governments' preferences. Standard ways to estimate weights in a social welfare function are the following two methods: one is to invert the optimization problem and explicitly calculate the weights using data. The other is to estimate the parameters of the social welfare function by using optimality conditions and econometric methods.

Henderson (1968) empirically estimates local governments' preferences between public and private expenditures.

In agricultural economics, a political preference function is often used to analyze the influence of pressure groups.[5] For example, Lianos and Rizopoulos (1988) study Greek cotton market and estimates preferences of agricultural policy makers. Salhofer, Hofreither, and Sinabell (2000) estimate political weights on Austrian farmers, consumers, and taxpayers.

[4] Similar results are obtained for FYs 1995, 2000, 2005, and 2010, but not for other years.

[5] See, for example, Bullock (1994).

Much of the literature that estimates social welfare weights considers equality among income groups or regions. Bourguignon and Spadaro (2012), Mattos (2008), and Bargain and Keane (2010) consider social welfare weights implied by the actual income-tax system. These papers consider a weight on each income group. Bourguignon and Spadaro (2012) invert Mirrlees (1971) and Saez's (2002) optimal taxation problems and calculate weights on income groups in France. They show that the weight on a high-income group is negative, concluding that the social welfare function is not Paretian. Mattos (2008) uses the method of Bourguignon and Spadaro (2012) to calculate weights for the US and Brazil. He shows that the Brazilian social welfare function is utilitarian with approximately equal weights on income groups. Bargain and Keane (2010) also use the method of Bourguignon and Spadaro (2012) to study Irish government's preferences. In the literature of indirect tax, for example, Ahmad and Stern (1984) show a way to calculate social welfare weights and calculate the weights on income groups implied by Indian tax system. They show that some of the calculated weights are negative and hence a Pareto improving tax reform is possible. Christiansen and Jansen (1978) study Norwegian tax system. Using the optimality condition and a nonlinear least square method, they estimate the parameters of the social welfare function.

On the other hand, by using data for the distribution of public services among regions, Behrman and Craig (1987) estimate the parameter of government's inequality aversion among regions. Iritani and Tamaoka (2005) consider redistribution of financial resources to each local government and calculate the weights on local governments.

The present paper shows that Japanese social welfare function is utilitarian with identical weights on all residents. As mentioned above, Mattos (2008) shows that Brazil also has a utilitarian social welfare function. However, Mattos considers weights on income groups. The present paper considers weights on local governments. To the best of our knowledge, no paper, except for Iritani and Tamaoka (2005), studies social welfare weights on local governments.

To explain the gap between weights and populations, the present paper also investigates the influence of Diet members on subsidies. In the literature of political economy, Doi and Ashiya (1997) verify whether Diet members in the ruling party influence subsidies. They empirically show that prefectures with more Diet members in the ruling party receive more subsidies. Doi and Ihori (2002) investigate the influence of local interest groups on government's expenditures during Japanese fiscal reconstruction process by analyzing a dynamic game among local interest groups, and show empirically that after 1995, local interest groups influence the central government's expenditure to prefectures.

2 Preferences of Central Government

2.1 Calculation of Weights

In this section, we calculate the weights that the central government gives to prefectures using the method developed by Iritani and Tamaoka (2005), who calculate the weights based on the amounts of subsidies paid by the central government to prefectures.[6]

First, we explain the model of Iritani and Tamaoka (2005). The disposable income of each prefecture is defined as

$$Y_i = (1 - t_i)m_i(S_i + T_i + P_i + I_i),$$

where t_i is the national tax rate in prefecture i, and m_i is the multiplier for the expenditure within the prefecture. Thus, one unit of expenditure in prefecture i generates m_i units of income in the prefecture. Hence, $m_i(S_i + T_i + P_i + I_i)$ is the pre-tax income of prefecture i, where the sum $S_i + T_i + P_i + I_i$ denotes the expenditure in the prefecture. The term S_i represents revenue sources transferred to the local government by the central government, T_i represents prefecture i's local tax revenues, P_i represents the other public expenditures,[7] and I_i represents private sector investments in the prefecture.[8] The welfare of prefecture i is given by $u_i(Y_i/N_i) = \ln(Y_i/N_i)$, where Y_i/N_i is the per-capita income of prefecture i.

The social welfare function of the central government is a weighted sum of prefectural welfare, and its maximization problem is given by

$$\max_{S_1,\dots,S_n} \sum_i \alpha_i \ln\left(\frac{Y_i}{N_i}\right), \text{ s.t. } \sum_i S_i \leq s \sum_i t_i m_i(S_i + T_i + P_i + I_i), \tag{1}$$

where α_i is the weight on prefecture i, and s $(0 < s < 1)$ is a fixed percentage of the expenditure of the central government spent for local governments. Solving this maximization problem yields[9]

$$\alpha_i = \frac{(1 - st_i m_i)E_i}{\sum_j (1 - st_j m_j)E_j}, \tag{2}$$

where $E_i = S_i + T_i + P_i + I_i$.

[6] In Iritani and Tamaoka, weights are called *welfare positions*.

[7] For example, P_i includes public spending by the central government for the prefecture excluding the fiscal transfer to the prefecture, and the local government's spending financed with local bonds.

[8] For details on the data, refer to Appendix C.

[9] For the derivation, see Appendix A.

Equation (2) implies that $t_i m_i$ is negatively related to α_i. That is, prefectures with larger values of $t_i m_i$ are given less weights from the central government. To see why, recall that the budget constraint is $\sum_k S_k \leq s \sum_k t_k m_k E_k$. Since E_k includes S_k, rewriting the constraint yields

$$\sum_k (1 - s t_k m_k) S_k \leq s \sum_k t_k m_k (T_k + P_k + I_k).$$

Thus the effective price of S_k is $1 - s t_k m_k$. The price is less than unity since one unit of subsidy given to prefecture k generates $t_k m_k$ units of tax revenues and a fraction s of them becomes available for subsidies. Now, consider two prefectures i and j such that $t_i m_i > t_j m_j$. Then since the price (or marginal cost) of subsidies to i is lower than that to j, it must be that, at the optimal choice of subsidies, the marginal benefit of subsidies to i is also lower than that to j. With the logarithmic social welfare function, the marginal benefit of subsidies to i is given by α_i / E_i. Thus if $E_i = E_j$, we have $\alpha_i < \alpha_j$, which explains the negative relation between α_i and $t_i m_i$.

We calculate the values of α_i using equation (2) and the data of subsidies.[10] The result is shown in Table 1. Iritani and Tamaoka (2005) note that prefectures that are given high values of α_i are major metropolitan areas, such as Tokyo, Kanagawa, and Osaka. Indeed, as shown in Table 1, whose bottom rows compare the average α_i between major metropolitan areas and the other areas, the average α_i is higher for major metropolitan areas (i.e., prefectures with * in the table). This is also clear from a test of the difference between means (Welch's t-test) reported in the last row.

To see why the central government gives more weights on major metropolitan areas, the next section examines the determinants of the weights.

2.2 Determinants of Weights

To investigate the determinants of the weights, we perform regression analysis using two possible factors: the population and the size of land for each prefecture. The estimation equation is as follows:

$$\alpha_i = \beta_0 + \beta_N \bar{N}_i + \beta_{area} area_i + \varepsilon_i, \tag{3}$$

[10] We calculate the weights for every fifth year and for the latest available year, FY 2010. Before 1985, we calculate weights for 1985, 1975, 1965, and 1955, because tax data are available only for these years.

Table 1: Calculated values of weights α_i

Prefecture	FY 1955	FY 1965	FY 1975	FY 1985	FY 1990	FY 1995	FY 2000	FY 2005	FY 2010
Aichi*	0.0554	0.0493	0.0538	0.0578	0.0634	0.0547	0.0576	0.0609	0.0571
Akita	0.0117	0.0124	0.0118	0.0104	0.0095	0.0109	0.0107	0.0104	0.0100
Aomori	0.0152	0.0125	0.0130	0.0127	0.0111	0.0128	0.0142	0.0126	0.0126
Chiba*	0.0230	0.0283	0.0396	0.0414	0.0388	0.0385	0.0384	0.0363	0.0364
Ehime	0.0154	0.0119	0.0134	0.0121	0.0112	0.0117	0.0116	0.0120	0.0120
Fukui	0.0109	0.0087	0.0095	0.0084	0.0082	0.0076	0.0075	0.0078	0.0080
Fukuoka*	0.0466	0.0397	0.0443	0.0385	0.0362	0.0347	0.0380	0.0372	0.0384
Fukushima	0.0278	0.0169	0.0179	0.0184	0.0169	0.0179	0.0183	0.0167	0.0168
Gifu	0.0159	0.0146	0.0147	0.0156	0.0154	0.0159	0.0164	0.0165	0.0152
Gumma	0.0156	0.0159	0.0136	0.0154	0.0146	0.0146	0.0147	0.0151	0.0151
Hiroshima*	0.0238	0.0254	0.0247	0.0235	0.0246	0.0230	0.0219	0.0270	0.0263
Hokkaido*	0.0648	0.0550	0.0570	0.0544	0.0446	0.0531	0.0494	0.0461	0.0430
Hyogo*	0.0404	0.0415	0.0435	0.0380	0.0412	0.0544	0.0388	0.0407	0.0431
Ibaraki	0.0184	0.0167	0.0253	0.0237	0.0237	0.0239	0.0235	0.0259	0.0249
Ishikawa	0.0071	0.0102	0.0095	0.0100	0.0092	0.0098	0.0106	0.0098	0.0095
Iwate	0.0154	0.0136	0.0132	0.0115	0.0107	0.0124	0.0127	0.0109	0.0105
Kagawa	0.0100	0.0079	0.0097	0.0095	0.0077	0.0079	0.0081	0.0080	0.0079
Kagoshima	0.0170	0.0136	0.0147	0.0149	0.0132	0.0146	0.0154	0.0147	0.0147
Kanagawa*	0.0338	0.0545	0.0452	0.0571	0.0613	0.0524	0.0532	0.0560	0.0536
Kochi	0.0081	0.0071	0.0070	0.0069	0.0067	0.0072	0.0075	0.0069	0.0070
Kumamoto	0.0168	0.0139	0.0154	0.0147	0.0141	0.0149	0.0151	0.0144	0.0147
Kyoto*	0.0185	0.0229	0.0181	0.0189	0.0186	0.0187	0.0186	0.0188	0.0187
Mie	0.0155	0.0133	0.0147	0.0135	0.0151	0.0158	0.0151	0.0166	0.0158
Miyagi*	0.0196	0.0161	0.0194	0.0188	0.0179	0.0189	0.0182	0.0177	0.0170
Miyazaki	0.0111	0.0098	0.0100	0.0094	0.0088	0.0093	0.0097	0.0092	0.0097
Nagano	0.0190	0.0190	0.0182	0.0216	0.0181	0.0209	0.0188	0.0172	0.0169
Nagasaki	0.0145	0.0140	0.0118	0.0119	0.0128	0.0124	0.0122	0.0125	0.0122
Nara	0.0086	0.0078	0.0078	0.0083	0.0090	0.0091	0.0093	0.0099	0.0091
Niigata	0.0253	0.0265	0.0237	0.0225	0.0198	0.0221	0.0219	0.0212	0.0203
Oita	0.0119	0.0099	0.0130	0.0105	0.0108	0.0110	0.0114	0.0113	0.0116
Okayama	0.0145	0.0160	0.0197	0.0173	0.0151	0.0156	0.0150	0.0147	0.0138
Okinawa	-	-	0.0103	0.0117	0.0089	0.0101	0.0107	0.0106	0.0113
Osaka*	0.0434	0.0800	0.0641	0.0586	0.0669	0.0634	0.0609	0.0613	0.0649
Saga	0.0088	0.0071	0.0078	0.0072	0.0065	0.0074	0.0072	0.0069	0.0074
Saitama*	0.0170	0.0259	0.0326	0.0395	0.0410	0.0390	0.0417	0.0418	0.0425
Shiga	0.0085	0.0093	0.0094	0.0111	0.0106	0.0112	0.0116	0.0119	0.0120
Shimane	0.0072	0.0080	0.0069	0.0077	0.0062	0.0074	0.0078	0.0073	0.0076
Shizuoka*	0.0236	0.0249	0.0261	0.0284	0.0302	0.0278	0.0290	0.0292	0.0292
Tochigi	0.0143	0.0149	0.0136	0.0163	0.0157	0.0156	0.0152	0.0162	0.0158
Tokushima	0.0102	0.0070	0.0075	0.0067	0.0064	0.0068	0.0069	0.0075	0.0075
Tokyo*	0.1408	0.1366	0.1061	0.1076	0.1259	0.1082	0.1174	0.1183	0.1249
Tottori	0.0065	0.0051	0.0053	0.0053	0.0052	0.0056	0.0061	0.0058	0.0058
Toyama	0.0151	0.0111	0.0111	0.0113	0.0099	0.0103	0.0105	0.0096	0.0101
Wakayama	0.0117	0.0105	0.0093	0.0082	0.0077	0.0081	0.0082	0.0082	0.0086
Yamagata	0.0133	0.0109	0.0125	0.0112	0.0102	0.0110	0.0114	0.0100	0.0099
Yamaguchi	0.0220	0.0177	0.0173	0.0139	0.0126	0.0128	0.0126	0.0128	0.0124
Yamanashi	0.0061	0.0062	0.0071	0.0078	0.0080	0.0085	0.0088	0.0078	0.0078
Av of * added	0.0424	0.0462	0.0442	0.0448	0.0470	0.0451	0.0449	0.0455	0.0458
Av of others	0.0136	0.0121	0.0125	0.0123	0.0115	0.0122	0.0123	0.0120	0.0119
Welch's t-test	3.103	3.773	4.819	4.911	4.464	4.904	4.503	4.594	4.391

- The * represents prefectures that contain a major metropolitan area or central city as defined by Statistics Bureau of Japan (2005).
- Av of * added is the average of the weights for prefectures with *.
- Welch's t-test is a test of the difference between the means of prefectures with * and those without *.
- With the two-sided test, the differences are statistically significant at the 1% level for all FYs.

Table 2: OLS result of weights α_i

	intercept	$\bar{N}_i$	$area_i$	$\bar{R}^2$
FY 1955	-0.005^{***} (0.001)	1.262^{***} (0.049)	-0.055^{**} (0.023)	0.911
FY 1965	-0.004^{***} (0.001)	1.211^{***} (0.043)	-0.027^{**} (0.010)	0.982
FY 1975	0.000 (0.001)	0.944^{***} (0.047)	0.055^{***} (0.009)	0.973
FY 1985	−0.000 (0.001)	0.976^{***} (0.068)	0.041^{***} (0.012)	0.972
FY 1990	−0.002 (0.001)	1.098^{***} (0.107)	−0.017 (0.017)	0.951
FY 1995	−0.000 (0.001)	0.971^{***} (0.086)	0.047^{***} (0.015)	0.949
FY 2000	−0.000 (0.001)	0.981^{***} (0.111)	0.028 (0.018)	0.940
FY 2005	0.000 (0.001)	0.981^{***} (0.100)	0.015 (0.016)	0.946
FY 2010	0.000 (0.001)	0.979^{***} (0.110)	0.005 (0.016)	0.939

The estimation uses OLS, where the White robust standard error is in parentheses and $\bar{R}^2$ is the corrected coefficient of determination. Because of a data constraint, the sample size is 47 for FYs 1975–2010 and 46 in FYs 1955 and 1965. With the two-sided test, individual coefficients with *, **, and *** are statistically significant, respectively, at the 10%, 5%, and 1% levels.

where $\bar{N}_i$ is the fraction of the population in prefecture i and $area_i$ is the land size of the prefecture.[11] The result is shown in Table 2. Observing this result, we find that the population, and not other factors, is significant for all years. Table 3 shows the weight and the population share for each prefecture. The table also indicates that the weight on a prefecture is explained considerably by the population.[12] For FY 1955 to 2010, the correlation coefficient between populations and weights is 0.969. The result suggests that *the weight that the central government attaches to a prefecture approximately equals the fraction of the population in the prefecture.*

To see the implications of this result, rewrite equation (3) as $\alpha_i = h\bar{N}_i + d_i$, where h denotes the regression coefficient of $\bar{N}_i$ and d_i denotes the sum of the remaining terms. Substituting this into the social welfare function in (1) yields

$$\sum_i (h\bar{N}_i + d_i) \ln\left(\frac{Y_i}{N_i}\right) = h \sum_i \bar{N}_i \ln\left(\frac{Y_i}{N_i}\right) + \sum_i d_i \ln\left(\frac{Y_i}{N_i}\right). \tag{4}$$

This says that the social welfare function is a weighted sum of a utilitarian function with identical weights on individuals and a weighted sum of prefectural utilities. According to Table 2, $h = 0.979$ in FY 2010.

[11]For details on the data, refer to Appendix C.

[12]Table 3 shows the data for FY 2010. We omit the data in other years because they are similar to those in FY 2010.

Table 3: A comparison of weights and population shares (FY 2010)

Prefecture	Weight	Population			
Aichi	0.0571	0.0579	Miyazaki	0.0097	0.0089
Akita	0.0100	0.0085	Nagano	0.0169	0.0168
Aomori	0.0126	0.0107	Nagasaki	0.0122	0.0111
Chiba	0.0364	0.0485	Nara	0.0091	0.0109
Ehime	0.0120	0.0112	Niigata	0.0203	0.0185
Fukui	0.0080	0.0063	Oita	0.0116	0.0093
Fukuoka	0.0384	0.0396	Okayama	0.0138	0.0152
Fukushima	0.0168	0.0158	Okinawa	0.0113	0.0109
Gifu	0.0152	0.0162	Osaka	0.0649	0.0692
Gumma	0.0151	0.0157	Saga	0.0074	0.0066
Hiroshima	0.0263	0.0223	Saitama	0.0425	0.0562
Hokkaido	0.0430	0.0430	Shiga	0.0120	0.0110
Hyogo	0.0431	0.0436	Shimane	0.0076	0.0056
Ibaraki	0.0249	0.0232	Shizuoka	0.0292	0.0294
Ishikawa	0.0095	0.0091	Tochigi	0.0158	0.0157
Iwate	0.0105	0.0104	Tokushima	0.0075	0.0061
Kagawa	0.0079	0.0078	Tokyo	0.1249	0.1028
Kagoshima	0.0147	0.0133	Tottori	0.0058	0.0046
Kanagawa	0.0536	0.0707	Toyama	0.0101	0.0085
Kochi	0.0070	0.0060	Wakayama	0.0086	0.0078
Kumamoto	0.0147	0.0142	Yamagata	0.0099	0.0091
Kyoto	0.0187	0.0206	Yamaguchi	0.0124	0.0113
Mie	0.0158	0.0145	Yamanashi	0.0078	0.0067
Miyagi	0.0170	0.0183			

Since the sum of the weights is normalized to one, $1 = \sum_i (h\bar{N}_i + d_i) = h + \sum_i d_i$, which implies $\sum_i d_i \approx 0.02$. Hence, approximately 98% of the social welfare function is utilitarian with identical weights on all individuals.[13]

3 Welfare Weights on Diet Members

In section 2, we confirm that $\alpha_i \approx \bar{N}_i$. If the central government has a utilitarian social welfare function with identical weights on all individuals, the ratio $\alpha_i/\bar{N}_i$ is identical for all i. The ratio $\alpha_i/\bar{N}_i$ can be interpreted as the weight on the entire population of prefecture i since the social welfare function is $\sum_i \alpha_i u_i = \sum_i (\alpha_i/\bar{N}_i)(\bar{N}_i u_i)$, where u_i is the utility of a resident in prefecture i. As Table 4 shows, $\alpha_i/\bar{N}_i$ is not identical across the prefectures. That is, there is a gap between weights and population shares. To explain the gap, this section considers the number of members in the Diet (Japanese national assembly)

[13]In this section, we ignore the non-negativity condition of subsidies. The non-negativity condition is important since in FY 2010, for example, the local allocation tax for Tokyo, which is included in S_{Tokyo}, was 0. This suggests that the subsidy for Tokyo might have been a corner solution in that year. However, the local allocation tax is only one of many kinds of subsidies. In fact, Tokyo did receive a positive amount of subsidies in that year. Since the central government can adjust the total amount of subsidies to Tokyo, we cannot say that the subsidy for Tokyo was a corner solution.

Table 4: The ratio of weight to population share (FY 2010)

Prefecture	$\alpha_i/\bar{N}_i$				
Aichi	0.986	Kagawa	1.021	Osaka	0.937
Akita	1.180	Kagoshima	1.103	Saga	1.119
Aomori	1.174	Kanagawa	0.758	Saitama	0.757
Chiba	0.750	Kochi	1.171	Shiga	1.087
Ehime	1.076	Kumamoto	1.033	Shimane	1.351
Fukui	1.273	Kyoto	0.908	Shizuoka	0.994
Fukuoka	0.970	Mie	1.093	Tochigi	1.006
Fukushima	1.059	Miyagi	0.925	Tokushima	1.223
Gifu	0.938	Miyazaki	1.097	Tokyo	1.216
Gumma	0.965	Nagano	1.003	Tottori	1.267
Hiroshima	1.177	Nagasaki	1.092	Toyama	1.184
Hokkaido	1.001	Nara	0.835	Wakayama	1.102
Hyogo	0.988	Niigata	1.097	Yamagata	1.086
Ibaraki	1.075	Oita	1.239	Yamaguchi	1.093
Ishikawa	1.044	Okayama	0.911	Yamanashi	1.160
Iwate	1.014	Okinawa	1.043		

from each prefecture.

Fukui and Tottori prefectures, which have high per-capita weights, have high ratios of Diet members to population. By contrast, Kanagawa and Chiba prefectures, which have low per-capita weights, have low ratios of Diet members to population. This suggests a hypothesis that the weight is influenced by the number of Diet members divided by population.

The number of Diet members in prefecture i divided by the prefecture's population is the value of an individual vote from the prefecture. Let v_{ui} be the value of an individual vote for the Upper House (i.e., the House of Councilors, Sangiin), and $v_{\ell i}$ is the value of an individual vote for the Lower House (i.e., the House of Representatives, Shugiin). Therefore, $v_{ji} = n_{ji}/N_i$, where N_i is the population of prefecture i, and n_{ji} is the number of Diet members in prefecture i belonging to House j ($j = u, \ell$).

To verify the hypothesis that the vote value influences the weight, we estimate the following equation:

$$\frac{\alpha_i}{\bar{N}_i} = \gamma_0 + \gamma_{upper} v_{ui} + \gamma_{lower} v_{\ell i}.$$

The result of regression is shown in Table 5. As it shows, γ_{upper} is significant in FY 2010. The estimated

Table 5: Estimation result of the effect of Diet member/population ratio (1955–2010)

	intercept	upper	lower	$\bar{R}^2$
FY 1955	0.913*** (0.173)	51522 (37135)	1717 (34970)	0.012
FY 1965	1.320*** (0.072)	36720 (37854)	−80511*** (20757)	0.271
FY 1975	0.838*** (0.082)	−4752 (56551)	37823 (27229)	0.063
FY 1985	0.863*** (0.075)	57091 (38796)	13370 (21531)	0.130
FY 1990	0.936*** (0.078)	6448 (44036)	7964 (21096)	−0.031
FY 1995	0.773*** (0.085)	31199 (32294)	44106** (21563)	0.231
FY 2000	0.668*** (0.082)	34062 (36779)	121700*** (38534)	0.324
FY 2005	0.822*** (0.091)	80745** (31866)	36126 (39198)	0.254
FY 2010	0.750*** (0.099)	102510*** (37593)	54778 (46865)	0.384

The result is estimated using OLS and the robust standard error. $\bar{R}^2$ is the corrected coefficient of determination. The sample size is 47 for 1975–2010 and 46 for 1955 and 1965.

equation can be rewritten as

$$\alpha_i = 0.750\frac{N_i}{N} + 102510\frac{n_{ui}}{N} + 54778\frac{n_{\ell i}}{N}, \quad \text{(FY 2010)}$$

where $N = \sum_{i=1}^{n} N_i$. This equation implies that the weight on an individual resident differs between the general public and Diet members.[14] The weight on an ordinary resident is 0.750, while the weight on a member of the Upper House is 102510 and that on a member of the Lower House is 54778. Thus the weight on a member of the Upper House is more than 136680 times larger than that on an ordinal resident. This suggests that the central government gives more weights to Diet members than to the general public. In addition, the estimation also implies that the weights on Lower House members are smaller than those on Upper House members. This suggests that the members of the Upper House have larger influences on inter-prefectural redistribution.

The OLS results for other years are also shown in Table 5. They suggest that the value of a vote has been a significant variable in recent years. Before 1995, the value of a vote did not influence the gap between weights and populations. Hence, we conclude that Diet members influenced the weights in recent years but not before 1995.

The table also shows another regularity. For 2010, 2000, 1985, 1965 and 1955, when γ_{upper} is higher

[14] This analysis is based on a suggestion by Prof. Eiichi Miyagawa.

than γ_{lower}, the Upper House election took place sooner than that of the Lower House, and vice versa. As an index of how close the next election is, we use the number of months before the next election divided by the term of office.[15] We hypothesize that the Diet members whose next election is closer have more influences on redistribution. To verify this, let *near* be the number of Diet members whose next election is closer, and let *far* be the number of other Diet members. That is, if the election for the Lower House is sooner than that for the Upper House, $near_i$ is the number of Lower House members from prefecture i and vice versa.[16] Using regression analysis, we obtain the following result:

$$\frac{\alpha_i}{\bar{N}_i} = \sum_j \mu_j Yd_j + \underset{(0.031)}{0.987^{***}} + \underset{(24882)}{122020^{***}} \frac{near_i}{N_i} - \underset{(10209)}{8108} \frac{far_i}{N_i} \quad (\bar{R}^2 = 0.140), \tag{5}$$

where Yd_j, $j = 1955, 1965, 1975, 1985, 1990, 1995, 2000, 2005$ are year dummies.[17,18] This result implies that the Diet members facing an election have more influences than other Diet members.

4 Discussions

4.1 Utility Function

The preceding analyses depend on the assumption that the utility function is logarithmic. As a robustness check, we here consider a utility function $(Y_i/N_i)^\eta$, which includes the logarithmic function $\ln(Y_i/N_i)$ as a special case. Then, the equation for the weights, equation (2), changes to

$$\alpha_i = (1 - st_i m_i) \frac{E_i}{(Y_i/N_i)^\eta} \left(\sum_{j=1}^{n} (1 - st_j m_j) \frac{E_j}{(Y_j/N_j)^\eta} \right)^{-1}. \tag{6}$$

The result of estimation with this equation is shown in Table 6 for $\eta = 0.1, 0.2, \ldots, 1$. If η is close to 0, the result is similar to that in the logarithmic case.

[15] The number of months and the terms of office are ex post.

[16] The number of seats in the Diet for each prefecture varies every election year by approximately 1.45 seats per election for the Upper House and by 11.64 seats for the Lower House.

[17] The estimated values of μ_j are not reported to save space.

[18] The result is estimated using OLS and the robust standard error. $\bar{R}^2$ is the corrected coefficient of determination. The sample size is 421.

Table 6: The result of the estimation of $\alpha_i = \beta_0 + \beta_N \bar{N}_i$. (FY 2010)

	β_N	β_0	$\bar{R}^2$
original	0.980^{***} (0.108)	0.000 (0.002)	0.940
$\eta = 0.1$	0.966^{***} (0.099)	0.001 (0.002)	0.946
0.2	0.952^{***} (0.091)	0.001 (0.001)	0.952
0.3	0.939^{***} (0.083)	0.001 (0.001)	0.956
0.4	0.925^{***} (0.075)	0.002 (0.001)	0.961
0.5	0.912^{***} (0.068)	0.002^{*} (0.001)	0.964
0.6	0.899^{***} (0.061)	0.002^{**} (0.001)	0.967
0.7	0.886^{***} (0.054)	0.002^{***} (0.001)	0.970
0.8	0.873^{***} (0.048)	0.003^{***} (0.001)	0.971
0.9	0.861^{***} (0.043)	0.003^{***} (0.001)	0.972
1.0	0.848^{***} (0.038)	0.003^{***} (0.001)	0.972

The sample size is 47, the standard error is written in parentheses, and $\bar{R}^2$ is the corrected coefficient of determinant.

4.2 Daytime Population

The preceding sections use the nighttime population of each prefecture. This is justified if the social welfare of a prefecture is given by the utilities of the *residents* of the prefecture. However it is possible that the government considers the utilities of the *workers* in the prefecture as the welfare of the prefecture. Let us then consider the daytime population of each prefecture. The OLS result with daytime populations is as follows:

$$\alpha_i = \underset{(0.001)}{0.001} + \underset{(0.046)}{0.943^{***}} \bar{N}_i^D + \underset{(0.008)}{0.010} area_i, \quad \bar{R}^2 = 0.985, \text{ (FY 2010)}$$

where $\bar{N}_i^D$ denotes the fraction of daytime population in prefecture i. The result says that the weights are approximately equal to the daytime population shares. In this case, 94% of the social welfare is the utilitarian function with identical weights on all individuals.

4.3 Expenditures and Weights

From Equation (2), we see that the weight α_i is heavily dependent on the amount of expenditure $E_i = S_i + T_i + P_i + I_i$. Indeed, the coefficient of variation of $1 - st_i m_i$ is 0.030, and

$$\alpha_i = \underset{(0.001)}{0.002^{***}} + \underset{(0.034)}{0.902^{***}} \bar{E}_i, \quad \bar{R}^2 = 0.9935, \quad \text{(FY 2010)} \tag{7}$$

where $\bar{E}_i = E_i / \sum_j E_j$. That is, the weight on a prefecture α_i is also proportional to the expenditure E_i on the prefecture. This implies that E_i is also proportional to the population N_i of the prefecture.[19] This suggests another hypothesis, which is that the central government is actually equalizing per-capita expenditures E_i/N_i between the prefectures, since this also implies proportionality between weights and populations.

Under the hypothesis, the central government's problem is given by

$$\min_{S_1,\ldots,S_n \geq 0} \sum_{i=1}^{n} \left(\frac{E_i}{N_i} - \frac{\sum_{j=1}^{n} (E_j/N_j)}{n} \right)^2 \text{ s.t. } \sum_i S_i \leq s \sum_i t_i X_i. \tag{8}$$

If the solution is interior, $E_i/N_i = k$ for all i, where k is constant. Then, the weight α_i is given by

$$\alpha_i = \frac{(1 - st_i m_i)E_i}{\sum_j (1 - st_j m_j)E_j} = \frac{(1 - st_i m_i)N_i}{\sum_j (1 - st_j m_j)N_j}.$$

This implies that the social welfare function is utilitarian with a weight $1 - st_i m_i$ on each resident of prefecture i. The value $1 - st_i m_i$ is high in prefectures with low national tax because $t_i m_i = K_i/E_i$, where K_i is the amount of national tax in prefecture i.[20] Hence, this hypothesis implies that the central government prefers prefectures with smaller national taxes.

The first-order condition of problem (8) yields

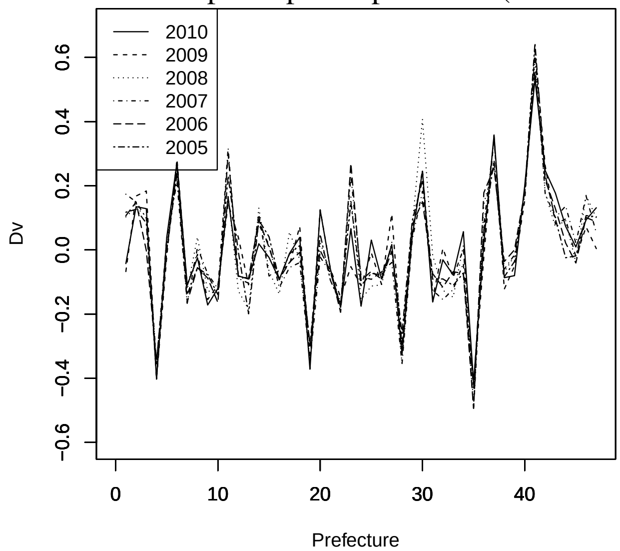
$$2\left(Dv_i - \frac{1}{n}\sum_j Dv_j\right) \geq \lambda(st_i m_i - 1)N_i, \text{ equality with } S_i > 0, \text{ for all } i, \tag{9}$$

where $Dv_i = E_i/N_i - \sum_j (E_j/N_j)/n$. In the data, $S_i > 0$ and $1 > st_i m_i$ for all i. Thus the left-hand side of inequality (9) must have the same sign for all i. Since the second term of the left-hand-side of (9) is the

[19]Indeed, the relation between per-capita expenditure and population is $\bar{E}_i = \underset{(0.002)}{-0.001} + \underset{(0.157)}{1.063^{***}} \bar{N}_i, \quad (\bar{R}^2 = 0.9063)$.

[20]This is because $t_i = K_i/(m_i E_i)$.

Figure 2: The deviation of per-capita expenditure (FY 2005–FY 2010)



- This figure shows the Dv_i for FYs 2005–2010.
- Prefectures are in alphabetical order.

average of Dv_i, each Dv_i equals the average. That is, $Dv_i = 0$ for all $i = 1, 2, \ldots, n$. In the data, $Dv_i \neq 0$ for all i. We then verify whether the errors are accidental. If the errors are auto-correlated, we cannot say that the errors are accidental. To verify this, we consider the coefficient of correlation between Dv_i of some years. If the coefficient of correlation is high, the distributions of errors are similar in those years.

Figure 2 shows Dv_i for each year. It shows that the distributions of Dv_i in these years are similar. The coefficient of correlation between Dv_i of FY 2010 and that of FY 2009 is 0.964.[21] This implies that the Dv_i are auto-correlated. Thus the hypothesis that the central government equalizes per-capita expenditures is not supported by the data.

5 Extension: Inter-Prefectural Trades

This section extends the model of Iritani and Tamaoka (2005) to include trades between prefectures. To do so, we define the prefectural income X_i by $X_i = C_i + E_i + Ex_i - Im_i$, where C_i is the total consumption by residents in prefecture i, Ex_i is the amount of export from prefecture i, and Im_i is the amount of import into prefecture i. We assume that the consumption, export, and import are endogenously determined by

[21] Between other pairs of years, the coefficient of correlation of Dv_i is as follows: 0.905 between FYs 2009 and 2008; 0.952 between FYs 2008 and 2007; 0.972 between FYs 2007 and 2006; and 0.968 between FYs 2006 and 2005.

prefectural income. Let C_{ji} be the amount of prefecture i's consumption of prefecture j's products. Then, we can write $C_i = \sum_j C_{ji}$, $Ex_i = \sum_{j\neq i} C_{ij}$, and $Im_i = \sum_{j\neq i} C_{ji}$. Thus $X_i = (C_i + Ex_i - Im_i) + E_i = \sum_j C_{ij} + E_i$. We also assume that $C_{ji} = \sigma_{ji} X_i$, where σ_{ji} is prefecture i's (constant) marginal propensity to consume the products of prefecture j. Substituting it into $X_i = \sum_j C_{ij} + E_i$ yields

$$X_i = \sum_j \sigma_{ij} X_j + E_i \quad \text{for all } i. \tag{10}$$

Rewriting this in matrix form yields $X = (X_1, \ldots, X_n)^T = (\mathbf{1} - \Sigma)^{-1}(E_1, \ldots, E_n)^T = (\mathbf{1} - \Sigma)^{-1}E$, where $\mathbf{1}$ is an identity matrix and $\Sigma = (\sigma_{ij})$.[22]

Then, the maximization problem is given by

$$\max_{S_1,\ldots,S_n} \sum_i \alpha_i \ln\left(\frac{Y_i}{N_i}\right), \text{ s.t. } \sum_i S_i \leq s \sum_i t_i X_i. \tag{11}$$

Solving this yields[23]

$$\alpha_i = \lambda\left(1 - \sum_{j=1}^{n} \sigma_{ji} - st_i\right) X_i, \tag{12}$$

where λ is the Lagrange multiplier. To see the intuition of the equation, recall that X_i is determined by the system of equations (10), where $E_i = S_i + T_i + P_i + I_i$. Thus, by choosing $\{S_i\}_{i=1}^n$, the central government indirectly chooses $\{X_i\}_{i=1}^n$. Summing up the equations (10) for all i yields $\sum_i \{1 - \sum_j \sigma_{ji}\} X_i = \sum_i E_i = \sum_i (S_i + T_i + P_i + I_i)$. Substituting the budget constraint $\sum_i S_i \leq s \sum_i t_i X_i$ yields

$$\sum_i \left\{1 - \sum_j \sigma_{ji} - st_i\right\} X_i \leq \sum_i T_i + P_i + I_i.$$

Thus the effective price of X_i is $1 - \sum_j \sigma_{ji} - st_i$. On the other hand, the marginal benefit of X_i is α_i / X_i under the logarithmic social welfare function, which explains the first-order condition (12).

The OLS estimation result is shown in Table 7. It shows that the weights are explained by population shares. However, the coefficients of determination are relatively small after FY 2000. We thus examine other determinants of the weights. Since $\sum_j \sigma_{ji} = C_i / X_i$ and $X_i - C_i = E_i + Ex_i - Im_i$, (12) is equivalent

[22] Superscript T denotes the transposition of a matrix or vector.
[23] See Appendix B for the derivation.

Table 7: The OLS result of weight (12)

	intercept	$\bar{N}_i$	$area_i$	$\bar{R}^2$
FY 1990	-0.003^{***} (0.001)	1.262^{***} (0.079)	-0.116^{***} (0.013)	0.973
FY 1995	-0.003^{**} (0.001)	1.200^{***} (0.095)	-0.082^{***} (0.015)	0.966
FY 2000	-0.004 (0.002)	1.246^{***} (0.184)	-0.081^{***} (0.029)	0.905
FY 2005	-0.006^{*} (0.003)	1.353^{***} (0.270)	-0.082^{*} (0.041)	0.836
FY 2010	-0.004 (0.002)	1.238^{***} (0.195)	-0.067^{**} (0.029)	0.889

to[24]

$$\alpha_i = \lambda\{(1 - st_i m_i)E_i + (Ex_i - Im_i)\}, \tag{13}$$

where $m_i = X_i/E_i$. For example, in FY 2010, $\lambda \sum_j (1 - st_j m_j)E_j \approx 0.815$ and $\lambda \sum_j |Ex_j - Im_j| \approx 0.296$. Therefore,

$$\alpha_i \approx 0.815 \frac{(1 - st_i m_i)E_i}{\sum_j (1 - st_j m_j)E_j} + 0.296\, nex_i,$$

where $nex_i = (Ex_i - Im_i)/\sum_j |Ex_j - Im_j|$. The term $(1 - st_i m_i)E_i/\sum_j (1 - st_j m_j)E_j$ is equal to the weight α_i without inter-prefectural trades given in (2), which is, by the previous results, approximately equal to the population share. Thus (13) implies that, with inter-prefectural trades, the weight on a prefecture is determined by its population share and net export.

In the ordinal Keynesian model, $X_i = C_i + E_i + Ex_i - Im_i = C_i + Tax_i + Saving_i$. Thus, $Ex_i - Im_i = Tax_i - G_i + Saving_i - I_i$, where Tax_i is tax revenues from prefecture i and G_i is governmental expenditures on prefecture i. This suggests that the central government gives heavy weight to prefectures with large values of $Tax_i - G_i$, i.e., prefectures with a large fiscal surplus. Indeed, a regression yields

$$\alpha_i = \underset{(0.003)}{-0.001^{***}} + \underset{(0.071)}{0.931^{***}}\bar{N}_i - \underset{(0.013)}{0.014}area_i + \underset{(0.033)}{0.243^{***}}balance_i, \quad \bar{R}^2 = 0.969, \quad \text{(FY 2010)}$$

where $balance_i$ is the fiscal surplus of prefecture i, that is, tax revenue minus expenditure for the local government of prefecture i. Table 8 shows the regression results for the other years. It shows that the

[24]In the data, X_i is not equal to $C_i + E_i + Ex_i - Im_i$ since X_i includes income earned in other prefectures, which is not included in $C_i + E_i + Ex_i - Im_i$.

Table 8: The OLS result of weight (12)

	intercept	$\bar{N}_i$	$area_i$	$balance_i$	$\bar{R}^2$
FY 1990	-0.002^{***} (0.001)	1.318^{***} (0.081)	-0.104^{***} (0.010)	-0.100 (0.070)	0.977
FY 1995	-0.002^{**} (0.001)	1.236^{***} (0.113)	-0.061^{***} (0.017)	-0.071 (0.079)	0.968
FY 2000	-0.001 (0.001)	1.028^{***} (0.040)	-0.020 (0.013)	-0.120^{**} (0.057)	0.942
FY 2005	-0.003^{***} (0.001)	1.038^{***} (0.095)	-0.034^{**} (0.017)	0.152^{***} (0.015)	0.969
FY 2010	-0.003 (0.001)	0.931^{***} (0.071)	-0.014 (0.013)	0.243^{***} (0.033)	0.969

coefficient of fiscal surplus is positive and significant in FYs 2005 and 2010.

Table 8 also shows that the coefficient of fiscal surplus is positive and significant only after 2005. To consider its reason, it is worth mentioning that Japan enacted many laws for decentralization around 2000. In particular, from FY 2004 to 2006, the so-called Trinity Reform[25] reduced subsidies from the central government to local governments considerably. At the same time, a large amount of tax resources were transferred from the center to local governments. That is, the central government reduced national tax and increased local governments' authority over local tax. This reform is unfavorable to prefectures with a small fiscal surplus since they can no longer depend on fiscal transfer from the center. On the other hand, it may be beneficial to prefectures with a large fiscal surplus since it increases the amount of resources that they can use at their discretion. If this reform is considered as a change of weights on local governments, it explains our regression result that, after 2005, the central government gives greater weight to prefectures with a larger fiscal surplus.

6 Concluding Remarks

This paper shows that the weight that the central government attaches to a prefecture approximately equals the fraction of the population in the prefecture. This implies that Japanese central government uses a utilitarian social welfare function with approximately equal weights on all residents. Japanese local financial systems are said to achieve regional equity (e.g., Mochida (2001) and Iqbal (2001)). Our result gives a support on this view.

Although the weight on a prefecture approximately equals its population share, there is a gap between

[25] Council on Economic and Fiscal Policy (2003), Ministry of Internal Affairs and Communications (http://www.soumu.go.jp/main_sosiki/jichi_zeisei/czaisei/czaisei_seido/zeigenijou.html , in Japanese).

weights and population shares. This gap is significantly explained by the value of an individual vote, particularly after 1995. Before 1995, $\bar{R}^2$ in Table 5 is relatively low. It is worth mentioning that, in 1994, the Japanese election system was revised. This may suggest that the election system after 1994 gives Diet members more incentives to influence interregional redistribution. Doi and Ihori (2002) also show that the amounts of subsidies are influenced by local interest groups after 1995. Our result is consistent with theirs.

The above results are obtained in our basic model without inter-prefectural trades. In the extended model that includes inter-prefectural trades, the weight on a prefecture has an additional term that is proportional to the prefecture's net export. A prefecture with a large amount of net export is typically a productive area (like Tokyo and Osaka). Our result may suggest that the central government gives more weight to more productive prefectures.

A prefecture with large net export typically also has a large fiscal surplus. The regression result shows that the amounts of fiscal surplus have a positive and significant correlation with weights in 2005 and 2010, but not before 2000. A possible reason for the change between 2000 and 2005 is a decentralization reform implemented around this period called Trinity Reform. From 2004 to 2006, this reform transferred tax resources from the central government to local governments but also reduced subsidies from the central government to local governments. This reform is favorable to prefectures with a large fiscal surplus and unfavorable to those with a small surplus or a deficit. This reform explains our regression result that, after 2005, the central government gives more weight to prefectures with a larger fiscal surplus.

Appendix A Derivation of Equation (2)

In this section, we derive Equation (2) from the maximization problem (1). This paper assumes that the timing of the central government's decision is as follows.

Stage 1. Local governments determine T_i, t_i^L, where T_i, t_i^L are respectively local tax revenue and local tax rate to maximize residents' utility.

Stage 2. The central government determines the amounts of subsidies S_i.

Stage 3. Residents consume.

In stage 3, residents' consumption C_i is given by $C_i = (1 - t_i^N - t_i^L)\tilde{c}_i X_i$, where t_i^N is the national tax rate, $\tilde{c}_i$ is the marginal propensity to consume, and X_i is the prefectural income.

In stage 2, the central government solves

$$\max_{\{S_i\}_{i=1}^{47}} \sum_{i=1}^{47} \alpha_i \ln(Y_i/N_i), \quad \text{s.t.} \sum_{i=1}^{47} S_i = s \sum_{i=1}^{47} t_i^N X_i,$$

where $Y_i = (1 - t_i^N)X_i$. Since T_i, t_i^L are already determined in stage 1, we can consider these variables as given. This problem is the same as the problem (1). By the first-order condition,

$$\alpha_i \frac{dY_i/dS_i}{Y_i} = \lambda(1 - st_i^N(dX_i/dS_i)), \quad \text{for all } i = 1, 2, \dots, 47,$$

where λ is the Lagrange multiplier. In the ordinal Keynesian model, the prefectural income is defined as $X_i = C_i + G_i + I_i$, where $G_i = S_i + T_i + P_i$. Therefore, since $X_i = (1 - t_i^N - t_i^L)\tilde{c}_i X_i + G_i + I_i$, we can write $X_i = m_i E_i$, where $m_i = 1/[1 - (1 - t_i^N - t_i^L)\tilde{c}_i]$. Therefore, we can rearrange the first-order condition as

$$\alpha_i = \lambda(1 - st_i^N m_i)E_i, \quad \text{for all } i = 1, 2, \dots, 47.$$

Normalizing α_i to satisfy $\sum_{j=1}^{47} \alpha_j = 1$ provides Equation (2).

Appendix B Derivation of Equation (12)

This section derives equation (12) by solving problem (11). By the first-order condition,

$$\sum_j \alpha_j \frac{\rho_{ji}}{X_j} = \lambda \left(1 - s \sum_j t_j^N \rho_{ji} \right),$$

where $(\rho_{ij}) = (\mathbf{1} - \Sigma)^{-1}$. With matrix expression,

$$\begin{pmatrix} \rho_{11} & \cdots & \rho_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & \rho_{nn} \end{pmatrix}^T \begin{pmatrix} \alpha_1/X_1 \\ \vdots \\ \alpha_n/X_n \end{pmatrix} = \lambda \begin{pmatrix} 1 \\ \vdots \\ 1 \end{pmatrix} - \lambda s \begin{pmatrix} \rho_{11} & \cdots & \rho_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{n1} & \cdots & \rho_{nn} \end{pmatrix}^T \begin{pmatrix} t_1^N \\ \vdots \\ t_n^N \end{pmatrix}$$

$$\begin{pmatrix} \alpha_1/X_1 \\ \vdots \\ \alpha_n/X_n \end{pmatrix} = \lambda \begin{pmatrix} 1 - \sum_{j=1}^n \sigma_{j1} \\ \vdots \\ 1 - \sum_{j=1}^n \sigma_{jn} \end{pmatrix} - \lambda s \begin{pmatrix} t_1^N \\ \vdots \\ t_n^N \end{pmatrix}.$$

That is,

$$\begin{aligned} \alpha_i &= \lambda \left(1 - \sum_{j=1}^n \sigma_{ji} - st_i^N \right) X_i = \lambda \left(1 - C_i/X_i - st_i^N \right) X_i = \lambda \left(X_i - C_i - st_i^N X_i \right) \\ &= \lambda \left(E_i + Ex_i - Im_i - st_i^N X_i \right) = \lambda \left\{ (1 - st_i^N m_i) E_i + (Ex_i - Im_i) \right\}. \end{aligned}$$

The first and last equations are respectively equation (12) and (13).

Appendix C Variable Descriptions

Variable	Meaning	Definition	Source
X_i	Prefectural income		Annual Report on Prefectural Accounts. Gross prefectural product (nominal, output), Time series table arranged for main figures.
m_i	Multiplier	X_i/E_i	Annual Report on Prefectural Accounts.
E_i	Expenditure	The amount of expenditure (i.e., the sum of private investment, public investment, and public expenditure in prefecture i.)	Annual Report on Prefectural Accounts.
t_i	National tax rate	The ratio of the total amount of collected national tax to prefectural income in prefecture i. Local consumption tax is excluded.	National Tax Agency Annual Statistics Report, Part 4, Ch.16. National Tax Collection.
S_i	Subsidies	The sum of local allocation tax, national treasury disbursements and local transfer taxes in prefecture i.	Annual Report on Local Public Finance Statistics Tables 2-4-1& 2-4-7.
T_i	Local tax revenue	The sum of local tax revenue, rental fee of public facilities, property revenue, donation, and various revenues in prefecture i.	Annual Report on Local Public Finance Statistics Tables 2-4-1 & 2-4-7.
P_i	The other public expenditure	$P_i = E_i - S_i - T_i - I_i$.	
I_i	Investment	The sum of private capital investment and private housing investment in prefecture i.	Annual Report on Prefectural Accounts.
s	The ratio of expenditures to local governments to total expenditures		Annual Report on Prefectural Accounts, Table 1-2-1.
$\bar{N}_i$	The (nighttime) population share	The population of prefecture i divided by the total population.	Historical Statistics of Japan, Ch. 2, Population Census.
$\bar{N}_i^D$	The daytime population share	The daytime population of prefecture i divided by the total population.	Historical Statistics of Japan, Ch. 2, Population Census.
$area_i$	The size of the area	The square of the area of prefecture i divided by the total area of Japan.	Historical Statistics of Japan, Ch. 1.
$balance_i$	The fiscal surplus of prefecture i	The amount of real fiscal balance of prefecture i divided by the total sum of the absolute value of real fiscal balance of all prefectures.	Annual Report on Local Public Finance Statistics Table 2-1-1.

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