JOURNAL OF ECONOMIC DEVELOPMENT
Volume 12, Number 1, June 1987

An Indirect Approach to Measure Governmental Perceptions of Regional Welfare Inequalities*

Jaewan Hur**

As an attempt to measure the implicit governmental tradeoffs arising in interregional welfare comparisons, an indirect approach is introduced by viewing the observed governmental expenditures as the result of a series of decisions. Given appropriate assumptions, this model takes the form of a multinomial logit model. The empirical results based on this approach using the U.S. data suggest that the U.S. federal government weigh the social and health factors more importantly than the economic and political factors when making interregional welfare comparisons.

I. Introduction

Since the national government may frequently wish to evaluate or monitor the relative levels of regional welfare so as to allocate public funds more equitably[1] among regions, it may be of great interest to investigate the question of how the national government perceives the relative welfare disparities among regions. For example, how does the national government implicitly assign relative weights to economic factors such as income and

* The author is indebted to Professor Tony Smith for his valuable comments. Any remaining errors are solely the author's responsibility.
** Assistant Professor, Department of Regional Development, Chung-Ang University, Seoul, Korea.

[1] Many empirical studies on the pattern of federal expenditures in the U.S.A. have reported that, in general, federal expenditures have been allocated more favorably to regions with lower welfare levels such as the Southern States (e.g., Cameron; Pack 1980; GRC 1977, 1981; and Pack 1982, etc.).

employment in comparison to other socio-environmental factors such as public safety, education, health and environmental quality when making regional welfare comparisons? The investigation of such implicit governmental tradeoffs can contribute to our understanding of the underlying values or weights used by the government regarding the respective welfare implications of various regional indicators. Furthermore, since the use of a single indicator such as income or employment as welfare surrogate has been based on the conventional belief that these indicators are actually the most important policy variable in determining regional welfare (see, for example, Biehl), such investigations can provide a good opportunity to examine the empirical validity of such arguments.

In spite of the necessity of such investigations, to our knowledge there have been no empirical attempts to measure such implicit governmental tradeoffs. The absence of empirical studies on this subject in fact is not due to the lack of researchers' interests in this problem but due to the lack of an appropriate method to measure such tradeoffs.[2]

With this in mind, the central objective of this paper is to attempt to measure such implicit tradeoffs based on an alternative approach. For this purpose, an indirect method is suggested within the framework of a discrete choice model in following section. Section III will be devoted to describing the data used for the empirical application, whereas the empirical results are reported in Section IV. Finally, some concluding remarks are made in Section V.

II. The Theoretical Background of the Method

Let us assume a nation consisting of R ($r = 1, \ldots, R$) political regions and the national government. The government is then assumed to respond to perceived welfare disparities among regions by means of various regional policies. Under this assumption, the domestic policy decisions of the national government should in-

[2] One notable exception is the approach suggested by Smith within the programming framework. However, this method is suffering from its restrictive characteristics (see Hur for more explanations about this problem).

volve, at least implicitly, the monitoring and evaluation of the relative levels of regional welfare disparities.

Let us consider this implicit evaluation process in more detail by focusing on the national government's perceptions of regional welfare differences. In order to model such perceptions, it is assumed that, following a number of recent attempts on defining regional welfare, the government perceives *regional welfare* to be a multidimensional concept which is determined by the levels of some relevant set of *regional indicators* $S^i (i = 1, \ldots, N)$, reflecting the socio-economic and environmental characteristics of each region. Such indicators may include, for example, regional levels of per capita income, employment, education, health, environmental quality, housing, crime rate, transportation condition and so on. For simplicity it is assumed that the national government perceives higher levels of each indicator to correspond to higher levels of regional welfare, other things being equal.[3] Given these regional indicators, let us assume that at any time t the *welfare* of each region r is determined by its *regional indicator profile*

$$(1)\ S_{rt} = (s_{rt}^1, \ldots, s_{rt}^i, \ldots, s_{rt}^N) \quad ; \quad r = 1, \ldots, R$$

where s_{rt}^i denotes the level of regional variable i in region r at time t.

Although such a profile can describe the welfare aspects of each region reasonably comprehensively, it is clear that the multidimensional nature of this set creates difficult problems in making interregional comparisons of welfare.[4] Thus it is essential to focus on the nature of the tradeoffs implicit in any governmental comparisons of regional welfare levels.

To avoid such tradeoffs problem, we shall assume that such tradeoffs can be approximated, at least locally, by some implicit

[3] For example, unemployment rates u might be expressed as a regional indicator $S_i = -u$.

[4] For example, in comparing the regional profiles $S_{rt} = (s_{rt}^1, \ldots, s_{rt}^N)$ and $S_{ut} = (s_{ut}^1, \ldots, s_{ut}^N)$ for two regions r and u at time t, if $S_{rt} \geqslant S_{ut}$ (i.e., if $s_{rt}^i \geqslant s_{ut}^i$ were to hold for all $i = 1, \ldots, N$) then it would be reasonable to say that the national government perceives the welfare level of region r to be at least as high as that in region u. However, if neither $S_{rt} \geqslant S_{ut}$ nor $S_{rt} \leqslant S_{ut}$ were true, then any overall comparison of regional welfare levels must necessarily involve implicit tradeoffs among the levels of regional indicators.

exponential weighing scheme.[5] More specifically, it is assumed that at any time t, the interregional welfare comparisons made by the national government can be represented by a *regional welfare function* as in the equation (2):

$$(2)\quad W_t(S_{rt}) = \exp(\alpha_t' S_{rt})\,;\quad r = 1, \ldots, R$$

where the *welfare-weight vector* $\alpha_t = (\alpha^1_t, \ldots, \alpha^N_t)$ consists of positive weights α^i_t reflecting the government's implicit valuation of the relative welfare implications of each regional indicator s^i at time t. In terms of this representation, we then hypothesize that the national government regards the overall welfare level in region r to be at least as high as that in region u whenever $W_t(S_{rt}) \geqslant W_t(S_{ut})$. The implicit weights α^i_t in W_t are of course seldom made explicit, and in general can only be revealed indirectly in terms of observed governmental decision behavior.

In responding to perceived regional welfare disparities, the national government is in turn assumed to have available a policy variable by which it can stimulate relative regional growth, and more generally, can alter the relative levels of the regional indicators $s^1, \ldots, s^N$. For analytical simplicity, let us assume that such policy variable can be characterized in terms of a *government expenditure variable* g_{rt}. This expenditure variable can be a sum of various government expenditure categories aiming at regional development such as federally funded public works projects, community development programs, and direct revenue transfers to regional governments.

To develop a statistical approach, let us reinterpret this expenditure variable g_{rt} from a viewpoint of discrete choice. More specifically, we regard each unit expenditure of g_{rt} as a decision made by the national government. Then we view the observed government expenditures g_{rt} as the result of a series of such decisions. Furthermore we assume that the decision behavior of the national government on expenditure allocation is inherently probabilistic due to its political nature.

Let denote P_{rt} as the probability of government choosing region r at time t in allocating a unit expenditure among regions. Obviously we require that

5 For a similar approach to regional welfare inequalities, see Bartels and Nijkamp.

$$(3)\quad 0 \leqslant P_r \leqslant 1\ ;\ r=1,\ \ldots,\ R$$

where the equality signs hold in the limiting case of a deterministic choice, and that

$$(4)\quad \sum_{r=1}^{R} P_r = 1$$

The usual theorems of probability theory are also assumed to hold. Furthermore, we assume the relative odds of choosing one region over another is unaffected by the presence or absence of any additional regions in the set of regions (i.e., *independence from irrelevant alternatives).*

In this context, the hypothesis that the central government allocate relatively more expenditures to regions with relatively lower welfare levels may be asserted that regions with lower welfare levels have higher probabilities of receiving a unit expenditure from the national government than regions with higher welfare levels. In other words there can be assumed to be a direct negative correlation between probability of expenditure allocation and regional welfare level. Hence it seems reasonable to postulate that a ratio of probabilities can be expressed as a inverted ratio of welfare levels.

$$(5)\quad \frac{P_{rt}}{P_{ut}} = \frac{W_t(S_{ut})}{W_t(S_{rt})} \qquad ;\qquad r,\ u\ =\ 1,\ \ldots,R$$

where P_{rt} and P_{ut} denote the probabilities of a unit expenditure's being allocated to region r and u at time t, respectively. Based on the above assumptions for the probability, P_{rt} can be expressed as follows[6]:

$$(6)\quad P_{rt} = \frac{W_t(S_{rt})^{-1}}{\sum_{u=1}^{R} W_t(S_{ut})^{-1}} \qquad ;\qquad r=1,\ \ldots,\ R$$

Due to equation (2), we finally get a logit model:

6 For more technical discussions of these assumptions, see any standard textbook on the discrete choice model such as Ben-Akiva and Lerman.

$$(7)\quad P_{rt} = \frac{\exp(-\alpha_t' S_{rt})}{\sum_{u=1}^{R} \exp(-\alpha_t' S_{ut})} \quad ; \qquad r = 1, \ldots, R$$

Given the logit model in (7), the relative welfare weight vector α can be estimated by the maximum likelihood procedure since the regional allocation pattern of federal expenditures can be observed. Then, with the set of total expenditure variables $Q_t = (g_{1t}, \ldots, g_{rt})$, the likelihood function and the log-likelihood function can be defined as equation (8) and (9), respectively.

$$(8)\quad L(\alpha_t \mid Q_t) = \prod_{r=1}^{R} \left[\frac{\exp(-\alpha_t' S_{rt})}{\exp(-\alpha_t' S_{ut})} \right]^{g_{rt}}$$

$$(9)\quad \log L(\alpha_t \mid Q_t) = -\sum_{r=1}^{R} g_{rt} \log \left(\sum_{u=1}^{R} \exp(\alpha_t' (S_{rt} - S_{ut})) \right)$$

The first and second derivatives of the log-likelihood function can be obtained

$$(10)\quad \frac{\partial \log L(\alpha_t \mid Q_t)}{\partial \alpha_t} = \sum_{r=1}^{R} (g_{rt} - P_{rt})\, S_{rt}$$

$$(11)\quad \frac{\partial^2 \log L(\alpha_t \mid Q_t)}{\partial \alpha_t\, \partial \alpha_t'} = \sum_{r=1}^{R} (S_{rt} - S)\, P_{rt}\, (S_{rt} - S)'$$

where $P_{rt} = 1 / \sum_{u=1}^{R} \exp(\alpha_t' (S_{rt} - S_{ut}))$ and $S = \sum_{u=1}^{R} S_{ut}\, P_{ut}$.

Provided that the data S_{rt} are not multicolinear, they will normally satisfy the full-rank condition which guarantees that the Hessian matrix in (11) is negative definite. Then the log-likelihood function (9) is strictly concave and any vector α_t satisfying $\partial \log L(\alpha_t \mid Q_t) / \partial \alpha_t = 0$ is a unique maximizer for the likelihood function.

III. The Data

Two types of data are required; data for regional policy

variable g as well as regional state variables S. However there has been no common consensus on the best indicator of regional welfare, or appropriate expenditure data to imply regional policy.

To represent the vector of regional state variables (S_{rt}), let assume that the variable S_{rt} is consists of six broadly-defined components

$$(12) \quad S_{rt} = (ECON_{rt}, EDU_{rt}, ENV_{rt}, HEL_{rt}, POL_{rt}, SOC_{rt})$$

where $ECON_{rt}$ = economic components of region r at time t;
EDU_{rt} = educational components of region r at time t;
ENV_{rt} = environmental components of region r at time t;
HEL_{rt} = health components of region r at time t;
POL_{rt} = political components of region r at time t; and
SOC_{rt} = social components of region r at time t.

Then we constructed six aggregate indices corresponding to the above six components, widely known as quality of life (QOL) indices.[7] These QOL indices are based on 75 regional indicators which have been selected for the 48 continental states[8] for 1982.

On the other hand, the data G_{rt} are supposed to represent by definition the expenditure categories which can be regarded as regional polices aimed at stimulating regional growth. In fact, however, it is difficult to decide what expenditure programs should be termed as regional policy expenditures since it has been argued that the United States does not currently have a set of strong, explicit regional policies. However even if the government professes to operate no regional policies at all, there is no doubt that many government policies introduced to achieve nonspatial objectives discriminate in favor of some places and against others. In fact, even when spatial policies are at work their effects may be swamped by the geographical repercussions of these nonspatial policies.

With this observation in mind, we have used three different type of expenditure categories as the data for g_{rt}; i) the expenditures explicitly aimed at stimulating regional development[9]

[7] Liu (1976) provides excellent explanations for the concept of quality life indices.

[8] Hawaii, Alaska, and District of Columbia are not included because of their special place in the federal budget.

[9] This includes five specific expenditure programs: *Regional Development Programs*

(e.g., explicit regional policy expenditures), ii) all federal aid to states and local governments[10] (e.g., explicit regional policy expenditures plus narrowly-defined implicit regional policy expenditures) and iii) flow of federal funds[11] (e.g., explicit regional policy expenditures plus broadly-defined implicit regional policy expenditures). In actual calculation, all these expenditures are expressed in per capita value.

IV. Empirical Results

Table 1 reports the estimated relative welfare weights, based on the maximum likelihood procedure, for six QOL indices.[12] First observe that the likelihood ratio tests (see the last row) for the case of both *Federal Aid to States* and *Flow of Federal Funds* indicate that the parameters are jointly different from zero at the 0.01 level of significance, whereas that for the case of *Explicit Regional Policy Expenditures* is not jointly different from zero. The estimated parameters are not all statistically significant. For example, in the case of *Federal Aid to States,* four estimates are statistically significant among six parameters at 5% significance level. Contrary to the theoretical expectation, some negative estimates are resulted. However none of these negative parameters turn out to be statistically significant. In particular, note that the estimated results in the case of *Federal Aid to States* (see the fourth column) are relatively very satisfactory when compared to those of the other cases in terms of sign and statistical significance. Hence we can impose economic meaning to the significantly positive estimates in this case. In other words, those positive values can be regarded as the national government's im-

(Regional Action Planning Commissions), *Community Development* (Department of Housing and Urban Development), *Rural Development* (Farmers Home Administration), *Public Works Program* (Economic Development Administration) and *Appalachian Regional Development Programs* (Funds appropriated by the President).

10 This contains *Federal Aid to States* which includes the portion (of total federal expenditures) that relates to Federal grants-in-aid to state and local Governments (refer to "Federal Aid to States: Fiscal Year 1982" for detailed discussions).

11 The flow of federal funds includes all negative (e.g., tax revenue) and positive government expenditures. Refer to "Statistical Abstract of the United States" for more detailed explanations.

12 Refer to Ben-Akiva and Lerman for detailed discussions about the computational procedure of the logit model.

Table 1

RESULTS OF THE LOGIT APPROACH

Variable number	Variable name	Coefficient Estimates E.R.P.E.	F.A.S.	F.O.F.
1	Economic Index	2.152*	0.968*	1.466*
		(2.172)	(1.582)	(3.065)
2	Educational Index	-0.169	0.104	0.228
		(-0.163)	(0.170)	(0.608)
3	Environmental Index	1.569*	-0.275	-0.207
		(2.342)	(-0.865)	(-0.962)
4	Health Index	1.745*	1.190*	-0.103
		(1.555)	(2.394)	(-0.211)
5	Political Index	-0.284	0.184*	0.003
		(-0.322)	(1.387)	(0.009)
6	Social Index	1.206	1.961*	1.780
		(0.282)	(1.459)	(1.111)
Likelihood Ratio Statistic		47.134	82.338	69.607

Figures in parenthesis are the asymptotic t-values
*Coefficient significantly different from zero at 5% level
Economic Index: based on 18 regional indicators.
Education Index: based on 8 regional indicators.
Environment Index: based on 9 regional indicators.
Health Index: based on 11 regional indicators.
Political Index: based on 12 regional indicators.
Social Index: based on 17 regional indicators.

E.R.P.E.: Explicit Regional Policy Expenditures
F.A.S.: Federal Aid to States
F.O.F.: Flow of Federal Funds

plicit valuations of the relative welfare implications of the corresponding regional index (e.g., QOL indies). Among the four significant variables, the social index has the highest weight (1.961) followed by, in order, the health index (1.19), econmic index (0.968) and political index (0.184). In our context, this implies that the federal government weighs social factors (such as the condition of housing, transportation and public safety) most importantly in evaluating and comparing the relative welfare level among regions while it pays relatively less attention to the political

component of regional welfare (such as the professionalism of state and local government).

Note also that a relatively lower weight is given to the economic index. Since most of the existing studies on regional inequalities have primary focused on economic factors such as income or unemployment, based on the belief that such indicators are the most important policy variables, our result is very interesting in the sense that the conventional assertions may lack, at least in this methodological framework, empirical evidence. In fact, in developed countries, it may be reasonable to imagine that the marginal effect of such economic factors on welfare is decreasing while that of health or the living environment is increasing.

V. Conclusion

As an attempt to measure the implicit governmental tradeoffs arising in interregional welfare comparisons, an indirect approach is introduced within the framework of a discrete choice model. Given appropriate assumptions, this model takes the form of a multinomial logit mode. The empirical results based on this model suggest that the U.S. federal government weighs the social and health factors more importantly than the economic and political factors when making interregional welfare comparisons.

It must be born in mind, however, that the alternative logit approach still has several shortcomings. For example, note that for the sake of simplicity we have neglected the interregional feedback effect of government expenditures. It is clear that such omission is not desirable in a system as open as a region of a nation. More importantly, recall that the multinomial logit model introduced in Section II is in essence indirect approach. In other words, we have not specified the underlying causal mechanism among the associated variables. While such an indirect approach can make the problems in question very simple, it is conceptually preferable to develop a direct approach such that we may understand how the change of one variable affects other variables.

In this respect, it is hoped that this study will stimulate more thoughts regarding further extensions of the method in the directions suggested above.

Appendix

Components of 6 Quality of Life Indices

I. Components of the Economic Index

1) Individual Economic Well-being

A. Income
   1. personal income per capita
   2. median income of 4-person families

B. Wealth
   1. savings per capita
   2. percent of owner-occupied housing units
   3. asset per capita

2) Community Economic Health

A. Income Distribution
   1. percent of persons below poverty level
   2. ratio of the highest percentile to the lowest

B. Employment Condition
   1. unemployment rate
   2. labor force participation rate
   3. female participation rate
   4. wage rate
   5. percent of insured unemployed

C. Degree of Economic Concentration
   1. concentration rate

D. Productivity
   1. value added in manufacturing
   2. value added in retail
   3. value added in wholesale
   4. value added in services

E. Capital Availability
   1. total bank deposits per capita

II. Components of the Education Index

1) Individual Condition

1. median school years completed by persons 25 years old and over
2. percent of persons 25 years and over, who completed 3 years of high school or more
3. percent of population ages 3 to 34 enrolled in schools

2) Community Condition

1. pupil-teacher ratio in public schools
2. educational expenditure per pupil
3. average teacher's salary in public schools
4. percent of population enrolled in higher education
5. ratio of per capita education expenditure to per capita income

III. Components of the Environmental Index

1) Air pollution

1. tons of particulate emissions per year per acre
2. tons of sulfur oxide emissions per year per acre
3. tons of carbon monoxide emissions per year per acre
4. tons of nitrogen oxide emissions per year per acre
5. tons of volatile compounds emissions per year per acre

2) Noise

1. population density
2. registered motor vehicles per 1,000 population
3. registered cycles per 1,000 population

3) Water

1. clean water consumption per day

IV. Components of Health Index

1) Individual Conditions

1. infant mortality rate
2. death rate
3. personal health care expenditure

2) Community Conditions

1. dentists per 1,000 population
2. physicians per 1,000 population
3. hospital beds per 1,000 population
4. hospital occupancy rates
5. daily room charge
6. nursing beds per 1,000 population
7. state and local government health expenditure
8. mental patients per 1,000 population

V. Components of the Political Index

1)Individual Participation

1. presidential election voting rate

2) State Local Government

A. Professionalism

1. total municipal employment per 1,000 population
2. police and fire protection employment per 1,000 population
3. public welfare employment per 1,000 population

B. Performance

1. revenue per capita
2. percent of federal government aid in total revenue
3. debt outstanding per capita
4. tax base (approximate market value of locally assessed ordinary realty per capita)

C. Welfare Assistance

1. per capita welfare expenditure
2. monthly benefits of retired workers
3. monthly benefits of disabled workers
4. monthly benefits of widows and widowers

VI. Components of the Social Index

1) Individual Concerns

A. Family Life

1. divorce rate
2. marriage rate

B. Information
   1. newspaper circulations per 100 popualtion

C. Others
   1. suicide rate
   2. labor union rate

2) Community Living Condition

A. Public Safety and Law enforcement
   1. crime rates
   2. number of policemen per 1,000 population
   3. population-lawyer ratio

B. Housing Condition
   1. housing units with 1.01 or more persons per room
   2. housing units lacking complete plumbing
   3. monthly owner cost of specified housing
   4. median values of specified housing

C. Leisure and Recreation
   1. park areas per 1,000 population
   2. average working hours per week in manufacturing industry

D. Transportation Condition
   1. highway mileage per car
   2. public transportation utilization rate
   3. state highway maintenance cost per highway mileage

References

Bartels and P. Nijkamp, "An Empirical Welfare Approach to Regional Income Distributions," *Socio-Economic Planning Sciences,* 10, 1976, 117-128.

Ben-Akiva, M. and S.R. Lerman, *Discrete Choice Analysis: Theory and Application to Travel Demand,* The MIT Press, London, 1985.

Biehl, D., "Determinants of Regional Disparities and the Role of Public Finances," *Public Finance,* 35, 1, 1980.

Cameron, G.G., *Regional Economic Development: The Federal Role,* AMS Press, New York, 1970.

Environmental Protection Agency (EPA), *National Emission Report,* U.S. Government Printing Office, Washington, D.C., 1984.

Government Research Corporation (GRC), "A year later, the Frostbelts Strikes Back," *National Journal,* July 1977, 1028-1037.

_____, *Neutral Federal Policies are reducing Frost-Sunbelt Spending Imbalances,* GRC, Feb. 1981, 233-235.

Hur, J.W., "An Empirical Study of Regional Welfare Inequalities and National Expenditure Priorities," *The Review of Regional Studies* (Forthcoming), 1987.

Liu, B.C., "Quality of Life: Concept, Measure and Results," *The American Journal of Economics and Sociology,* 34, 1, 1975.

_____, *Quality of Life Indicators in U.S. Metropolitan Areas: A Statistical Analysis,* Praeger Publishers, 1976.

McFadden, O., "Conditional Logit Analysis of Qualitative Choice Behavior," *Frontiers in Econometrics,* Zarembka, P., ed., Academic Press, New York, 1974, 105-142.

National Center for Education Statistics, *Digest of Education Statistics,* U.S. Department of Education, 1980-1981.

Pack, J.R., *Regional Growth: Historic Perspective,* Advisory Commission on Intergovernmental Relations, U.S. Government Printing Office, Washington, D.C., June 1980.

_____, "The States Scramble for Federal Funds: Who wins, Who loses?" *Journal of Policy Analysis and Management,* 1, 2, 1982, 175-195.

Smith, T.E., "A Representational Framework for the Joint Analysis of Regional Welfare Inequalities and National Expenditure Priorities," *Journal of Regional Science,* 21, 2, 1981, 187-202.

U.S. Bureau of the Census (USBC), *Census of Population,* USBC, 1980.

_____, *County and City Data Book,* U.S. Government Printing Office, Washington, D.C., 1983.

_____, *Statistical Analysis of United States,* U.S. Department of Commerce, U.S. Government Printing Office, Washington, D.C., 1984/1985.