INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI
University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313 761-4700 800 521-0600
Optimal fiscal policy for the provision of local public services: Some simulation results for the case of elementary education in Korea

Oh, Youngsoo, Ph.D.
University of Hawaii, 1990
OPTIMAL FISCAL POLICY FOR THE PROVISION
OF LOCAL PUBLIC SERVICES: SOME SIMULATION RESULTS
FOR THE CASE OF ELEMENTARY EDUCATION IN KOREA

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF
THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN ECONOMICS

MAY 1990

By

Young-Soo Oh

Dissertation Committee:

Sumner J. La Croix, Chairman
Minja K. Choe
Edwin T. Fujii
James E.T. Moncur
John A. Dixon
ACKNOWLEDGEMENTS

I wish to express my greatest appreciation to my dissertation chairman, Prof. Sumner J. La Croix, for his invaluable guidance and constructive advice throughout this research. I am also grateful to the dissertation committee members: Prof. Minja K. Choe, Prof. Edwin T. Fujii, Prof. James E.T. Moncur, Dr. John A. Dixon for their comments and suggestions for the improvement of this study.

I am thankful to the Environment and Policy Institute, East-West Center for the financial support. I would also like to thank the professors in the Department of Social Studies, Teachers College, Kyungpook National University, Korea, for their generous support during my studies in the U.S. My special thanks are due to Dr. Hyung-Kyu Kim, who always encourages me to complete my study while I have been out of duties to the Department.

Finally, my deepest gratitude belongs to my wife, Young-Suk, for her great assistance and sacrifice during the whole period of my study, and to my two sons, Seung-Ho and Ju-Hyun for their understanding and encouragement.
This monograph presents policy simulation models for the evaluation of alternative fiscal policies for the provision of local public services where equity is relatively emphasized. For this framework, we propose four equalizing grant-in-aid schemes (the lump-sum general and the lump-sum specific grant-in-aid, the matching grant-in-aid, and the foundation aid plan), and compare them with perfectly decentralized and perfectly centralized fiscal schemes.

Our models are characterized by an endogenous central government acting as a grantor cum tax collector. The central government is also subject to a full-financing constraint (revenue from central taxation = expenditures for equalizing grants), which makes the central tax rate indicate the relative scale of financial cost (or the degree of decentralization) of each fiscal scheme.

We simulate the six fiscal models with various values of five selected system parameters: income and price elasticities of the service concerned, alternative evaluating criteria, share of expenditures for the service, and welfare cost of central taxation. The simulation study primarily searches for any systematic relations between the five parameters and the two key variables: the central tax rate and relative priority rankings of each fiscal scheme. The simulation results provide valuable guidance in selecting a particular fiscal scheme for the provision of a particular public service. In the simulation, Korean elementary education is selected as an example.

The simulation results show that income elasticity is the most important
parameter that affects the relative priority rankings of each fiscal scheme as well as
the financial cost. The lump-sum general grant-in-aid scheme turns out to require
the highest, while the foundation aid plan requires the lowest intervention rate. It
is also found that matching grants are more stimulative than lump-sum general
grants.

Based on the results of policy priority rankings and the endogenous central
tax rates in each fiscal scheme, we select the foundation aid plan as the optimal
policy scheme for the provision of elementary education in Korea.
TABLE OF CONTENTS

ACKNOWLEDGEMENTS .................................................................................................................. iv

ABSTRACT ..................................................................................................................................... v

LIST OF TABLES ............................................................................................................................ ix

LIST OF FIGURES ........................................................................................................................... xi

CHAPTER I INTRODUCTION

1.1 Purpose of Study ......................................................................................................................... 1
1.2 Efficiency vs. Equity in the Provision of Local Public Services .......... 6

CHAPTER II LOCAL FISCAL CHOICE AND INTERGOVERNMENTAL
GRANT-IN-AID: A SURVEY

2.1 Majority Voting and the Median Voter Theorem ................................................................. 10
   2.1.1 Theoretical Background ................................................................................................. 10
   2.1.2 The Median Voter Model for Local Fiscal Choice ....................................................... 13
2.2. Theory of Intergovernmental Grant-in-aid ................................................................. 16
   2.2.1 Effects of Grants-in-aid on Local Spending ............................................................... 16
   2.2.2 Fiscal Imbalances and Equalizing Grants-in-aid ....................................................... 19

CHAPTER III THE MODELS - ALTERNATIVE POLICY SCHEMES FOR THE PROVISION OF LOCAL PUBLIC SERVICES

3.1 Overview ................................................................................................................................. 25
   3.1.1 Assumptions and General Framework of the Model ............................................. 26
   3.1.2 Evaluating Criteria for the Optimality ................................................................. 30
3.2 Perfectly Decentralized Provision ..................................................................................... 32
3.3 Perfectly Centralized Provision ......................................................................................... 34
3.4 The Foundation Aid Plan ..................................................................................................... 36
3.5 The Equalizing Grant-in-aid Plans ..................................................................................... 38
   3.5.1 Equalization with Lump-sum General Grant-in-aid ........................................... 39
   3.5.2 Equalization with Matching Grant-in-aid ........................................................... 43
   3.5.3 Equalization with Lump-sum Specific Grant-in-aid ......................................... 45

CHAPTER IV THE PROVISION OF EDUCATION IN KOREA

4.1 The Financial Structure of Education ................................................................................... 50
4.2 Regional Distribution of Elementary Education Expenditure ....................... 55
CHAPTER V  SIMULATION RESULTS

5.1 The Endogenous Central Tax Rate - Degree of Decentralization .... 59
5.2 Policy Priority Rankings among Alternative Fiscal Schemes .......... 68
  5.2.1 General Trends ................................................................. 69
  5.2.2 Further Considerations in the Determination of Policy Priority
  Rankings ................................................................................... 73
    5.2.2.1 Policy Rankings under Alternative Shares of Elementary
    Education Expenditure ......................................................... 73
    5.2.2.2 Policy Rankings under Alternative Parameters for Tax
    Distortion .............................................................................. 76
5.3 Demand for Local Public Education ............................................ 83
  5.3.1 Empirical Studies on the Estimation of Income and Price
    Elasticity .............................................................................. 83
  5.3.2 Income Elasticity of Education in Korea ............................... 87
5.4 The Optimal Policy for the Provision of Elementary Education in Korea
       .......................................................................................... 90
  5.4.1 The Optimal Policy - The Foundation Aid Plan ....................... 90
  5.4.2 Optimal Values under the Foundation Aid Plan ....................... 97

CHAPTER VI  CONCLUSIONS .................................................................. 99

APPENDICES
Appendix A  The Central Tax Rates under Various Demand Elasticities ..107
Appendix B  Social Welfare Indexes and Policy Rankings of Each Fiscal
  Scheme under Alternative Shares of Education Expenditure
  ......................................................................................... 109
Appendix C  Social Welfare Indexes and Policy Rankings of Each Fiscal
  Scheme under Alternative Degrees of Tax Distortion ............ 114
Appendix D  Optimal Values under Alternative Grant-in-aid Policies ... 120
Appendix E  Estimation of Engel Curve of Educational Expenditure in
  Korea(1987) .............................................................................. 122

BIBLIOGRAPHY ............................................................................. 125
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Share of Public Expenditures on Education</td>
<td>51</td>
</tr>
<tr>
<td>4.2 Distribution of Public Educational Expenditure in Korea</td>
<td>53</td>
</tr>
<tr>
<td>4.3 Functional Classification of Central Government Expenditure in Korea</td>
<td>54</td>
</tr>
<tr>
<td>4.4 Structure of Local Education Budget (Special Account)</td>
<td>55</td>
</tr>
<tr>
<td>4.5 Regional Distribution of Elementary Education Expenditure and Major Local Indicators</td>
<td>56</td>
</tr>
<tr>
<td>5.1 The Central Tax Rate</td>
<td>61</td>
</tr>
<tr>
<td>5.2 The Revised Central Tax Rate</td>
<td>63</td>
</tr>
<tr>
<td>(Constant student-population ratio, N = 0.2)</td>
<td></td>
</tr>
<tr>
<td>5.3 Total Expenditure on Elementary Education</td>
<td>70</td>
</tr>
<tr>
<td>5.4 Policy Priority Rankings under Alternative Welfare Criteria</td>
<td>71</td>
</tr>
<tr>
<td>(B = 0.01, a = 0.95, b = 0.05, ( U_i = BX_i^aG_i^b ))</td>
<td></td>
</tr>
<tr>
<td>5.5 Policy Priority Rankings under Alternative Welfare Criteria</td>
<td>74</td>
</tr>
<tr>
<td>(B = 0.01, a = 0.99, b = 0.01, ( U_i = BX_i^aG_i^b ))</td>
<td></td>
</tr>
<tr>
<td>5.6 Policy Priority Rankings under Alternative Welfare Criteria</td>
<td>75</td>
</tr>
<tr>
<td>(B = 0.01, a = 0.90, b = 0.10, ( U_i = BX_i^aG_i^b ))</td>
<td></td>
</tr>
<tr>
<td>5.7 Policy Priority Rankings under Alternative Parameters of Tax</td>
<td>79</td>
</tr>
<tr>
<td>Distortion (( \lambda = 0.2, U_i = 0.01X_i^{0.95}G_i^{0.05} ))</td>
<td></td>
</tr>
<tr>
<td>5.8 Policy Priority Rankings under Alternative Parameters of Tax</td>
<td>80</td>
</tr>
<tr>
<td>Distortion (( \lambda = 0.3, U_i = 0.01X_i^{0.95}G_i^{0.05} ))</td>
<td></td>
</tr>
<tr>
<td>5.9 Policy Priority Rankings under Alternative Parameters of Tax</td>
<td>81</td>
</tr>
<tr>
<td>Distortion (( \lambda = 0.5, U_i = 0.01X_i^{0.95}G_i^{0.05} ))</td>
<td></td>
</tr>
<tr>
<td>5.10 Estimation of Income and Price Elasticity of Education</td>
<td>86</td>
</tr>
<tr>
<td>5.11 Means of the Major Variables in Family Income and Expenditure Survey Data (1987)</td>
<td>87</td>
</tr>
</tbody>
</table>
5.12 Income Elasticity and Share of Each Expenditure Item (1987) .................. 89

5.13 Policy Rankings of Alternative Fiscal Schemes ($\alpha = -0.5, \beta = 0.5$) .............. 91

5.14 Initial vs. Final Income Distribution under Four Grant-in-aid Policies .......... 93
($\alpha = -0.5, \beta = 0.5, \lambda = 0, A = 2.18531, G_t = A(N^{\delta - 1})^{\alpha \delta \beta}$)

5.15 Final to Initial Income Ratio under Four Grant-in-aid Policies .................. 93

5.16 Optimal Values under the Foundation Aid Plan ........................................ 97
($\alpha = -0.5, \beta = 0.5, \lambda = 0, A = 2.18531, G_t = A(N^{\delta - 1})^{\alpha \delta \beta}$)
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Alternative Evaluation Criteria</td>
<td>32</td>
</tr>
<tr>
<td>3.2 Perfectly Centralized Provision</td>
<td>35</td>
</tr>
<tr>
<td>3.3 The Foundation Aid Plan</td>
<td>38</td>
</tr>
<tr>
<td>3.4 Equalization with Lump-sum General Grant-in-aid</td>
<td>43</td>
</tr>
<tr>
<td>3.5 Equalization with Matching Grant-in-aid</td>
<td>45</td>
</tr>
<tr>
<td>3.6 Central Compensation with Lump-sum Specific Grant</td>
<td>47</td>
</tr>
<tr>
<td>5.1 The Central Tax Rate - 1</td>
<td>64</td>
</tr>
<tr>
<td>5.2 The Central Tax Rate - 2</td>
<td>65</td>
</tr>
<tr>
<td>5.3 Stimulative Effect of Matching Grant</td>
<td>68</td>
</tr>
<tr>
<td>E.1 Engel Curve of Education Expenditure</td>
<td>124</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

1.1 Purpose of Study

Efficiency and equity are central goals to be reconciled in the design of economic institutions and public policies. In public sector economics, there has been increasing attention paid to the task of combining equity and efficiency in studies of optimal taxation, public sector pricing, and evaluation of public expenditure decisions.

One of the main problems in financing and providing a particular local public good or service\(^1\) is how to combine efficiency and equity goals in an ideal fashion to maximize the welfare of a society. The answer may depend upon characteristics of the service concerned (e.g. income and price elasticities) and other related factors such as society's general attitudes towards horizontal inequalities and costs of the policy executed.

In providing a particular local public service, the selection of a particular fiscal institution (or policy scheme) is very important since each fiscal scheme will result in different specifications of equity-efficiency combinations. In general, the more decentralized a fiscal scheme is, the more it is preferred from the efficiency

---

\(^1\) Throughout this paper, local public goods are defined to be publicly provided goods excluding natural environments. As for the relation between local public goods and services, following Bergstrom and Goodman (1973), we use the relation \( G = \frac{Q}{N^\delta} \), where \( G \): local public service, \( Q \): local public good, \( N \): number of users, \( \delta \): congestion parameter (\( \delta = 0 \) for pure public good, \( \delta = 1 \) for pure private good).
point of view, while the more centralized a fiscal scheme is, the more emphasis is
given to the equity goal. However, a decentralized fiscal system is accompanied by
horizontal inequalities between local jurisdictions, while a centralized fiscal system
may lose the gains stemming from decentralized fiscal choice. Therefore, the primary
concern of this paper is how to harmonize these trade-offs with particular fiscal
institutions or policy schemes.

This paper presents a comparative fiscal institution analysis using simulation
techniques. The main purpose of the study is to establish normative guidelines useful
for the selection of particular fiscal schemes for the provision of particular local
public services, especially for those services in which categorical equity is relatively
emphasized. For this, we propose four decentralized fiscal choice models in which
a target level of categorical equity is achieved with alternative grant-in-aid policies.
We also compare them with a perfectly centralized and a perfectly decentralized
fiscal scheme. The four alternative fiscal schemes are equalizing grant-in-aid schemes
intended to equalize horizontal inequalities in the local public service concerned.
They are: (1) foundation aid plan, (2) lump-sum general grant, (3) lump-sum specific
grant, and (4) matching grant-in-aid policy.

We employ simulation techniques to examine all the factors potentially
related to relative preferences of each fiscal scheme. The central parameters to be
simulated are selected so as to reflect the basic considerations in the determination
of a fiscal scheme for a particular local public service. They are: (1) income and

---

2 The principle of categorical equity requires that commodities in particular categories should be
provided equitably regardless of general income inequalities. For more details, refer 1.2.
price elasticity of the service \((\beta, \alpha)\), (2) relative share of expenditure for the service \((b)\), (3) social planner's alternative views on horizontal inequalities \((\sigma)\), and (4) welfare cost of each fiscal scheme \((\lambda)\).

As a case study of our simulation models, we apply the six models to the case of Korean elementary education, which is fully financed and provided by the central government under the current education system. During its recent rapid economic development, Korea adopted a centralized government system for allocating national resources. However, Korea is now at a turning point both politically and economically facing two seemingly conflicting demands from her people. One is for a more decentralized political and fiscal system, the other is for a more equitable distribution of commodities across income classes and regional areas.

Therefore, one of the controversial issues in Korea's forthcoming transition to a decentralized fiscal system\(^3\) is how to harmonize these two demands with appropriate institutional designs and policy schemes. Especially for the provision of local public services, the choice of intergovernmental fiscal policy is critical in determining the relative emphasis between efficiency and equity.

Given this background, elementary education in Korea provides fertile grounds for this policy evaluation exercise, since elementary education itself can be a good example of the type of public service where categorical equity is more or less emphasized relative to other public services. Moreover, it is provided by the central government only under the current provision system, which is expected to be

---

\(^3\) In Korea, local autonomy is about to begin. On Dec. 19, 1989, the National Assembly of Korea finally passed the long disputed acts on local autonomy, which specify the organization of local units. According to the government schedule, local congress shall be organized in early 1990 by residents' direct vote, and local governor will be elected until 1991. (Korea Times, Dec. 20, 1989)
reformed in her forthcoming decentralized fiscal scheme.

The main contribution of this study centers around two points.

First, we present a complete policy evaluation framework operating with simulation techniques. In particular, this framework is distinguished from existing simulation models by its endogenous grantor government. Unlike traditional models for intergovernmental grant-in-aid analysis, the central government in our model is incorporated into the model as a grantor cum tax collector and also subject to a full-financing constraint (revenue from central taxation = expenditure for equalizing grants). From this perspective, our models can be referred to a "general equilibrium model". This new modeling technique enables our simulation models to produce many useful results which could not be obtained in traditional models for intergovernmental grant-in-aid analysis. The most distinctive feature of this structure is that the endogenous central tax rate can reflect the relative scale of the financial cost for each fiscal scheme as well as the different stimulative effects of each grant-in-aid policy.

Second, from the simulation using Korean data, we obtain some valuable results ranging from theoretical propositions on intergovernmental grants-in-aid to practical policy implications for the provision of Korean elementary education. The results are also expandable to other local public services which have similar characteristics. Moreover, since the results are critically dependent upon the values of the system parameters specified, the policy implications can be flexibly adjusted to changes in policy variables, exogenous variables, and parameter values.

More specifically, the main questions intended to be addressed in our
simulation are summarized as follows.

(1) Among the six alternative fiscal schemes, what is the optimal scheme in terms of social welfare for the provision of elementary education in Korea?

(2) What are the main factors affecting the relative priority rankings of each policy scheme? Are there any systematic changes of policy rankings when system parameters change?

(3) How does the central tax rate\(^4\) differ across alternative fiscal policies? What are the main factors affecting this rate?

This paper is composed of the following contents.

In the second section of chapter one, we discuss the concept of efficiency and equity in the economies of local public service more specifically, since they constitute main goals in designing and evaluating the alternative fiscal schemes.

In chapter two, we survey two topics which provide the theoretical background for our fiscal models: (1) an economic model of local fiscal choice, i.e., the median voter model, (2) general theories of intergovernmental grants-in-aid focusing on their equalization function.

In chapter three, we model six alternative fiscal schemes which provide the main frameworks for simulation: the perfectly decentralized fiscal system, the perfectly centralized fiscal system, and four equalizing grant-in-aid schemes.

In chapter four, since our models are constructed and simulated with respect

\(^4\) In our fiscal models, the central tax rate represents the degree of decentralization of each fiscal scheme or the relative scale of financial cost in equalizing the public service targeted.
to elementary education in Korea, we introduce the Korean education system focusing on its financial structure and regional distribution of the expenditures on elementary education.

Chapter five presents simulation results. In this chapter, we focus on two variables: (1) the central tax rate in each fiscal scheme; and (2) the policy priority rankings under various ranges of system parameters. As a prelude to the main simulation study, we estimate the income elasticity of education in Korea using family income and expenditure survey data (1987).

Chapter six summarizes the theoretical findings and policy implications from the study.

1.2 Efficiency vs. Equity in the Provision of Local Public Services

The notion of efficiency in the economics of local public good is rather special in the sense that it requires two different notions: intra- and inter-jurisdictional efficiency. The condition for intra-jurisdictional efficiency is equivalent to the Samuelson rule (\(MRT = \Sigma MRS\)). In other words, a local public good (or service) is efficiently provided within a jurisdiction if the marginal cost of the service is equal to the users' sum of marginal benefits from the service.

However, although the conditions for intra-jurisdictional efficiency are satisfied, if individuals' inter-jurisdictional mobility are considered, there may be further room to improve on efficiency from the overall point of view. In other words, we can enhance inter-jurisdictional efficiency by prompting individuals to segregate...
themselves into homogeneous groups. The equilibrium where each homogeneous group has an optimal number of member is called as the 'Tiebout equilibrium', which is proved to be in the 'core'.

In this paper, we exclude the possibility of Tiboutian migration in modeling the six fiscal schemes. Therefore, the discussion of efficiency is confined throughout this paper to intra-jurisdictional efficiency. i.e., each local jurisdiction can maximize its welfare by choosing its own scale of local public services under given local tastes and endowments.

However, another important problem for society concerns is how to deal with the underlying (horizontal) inequalities resulting from a decentralized fiscal choice; the equity goal is introduced to consider this issue. In the economics of local public goods and services, a rather new distributive concern - "categorical equity" (Feldstein, 1975) or "specific egalitarianism" (Tobin, 1970) - has been prominent through public debates and litigations on local school financing in the 1970's in the U.S.

In Serrano vs. Priest (1971), the landmark case in this area, the California Supreme Court judged that local expenditures for public education should not be based solely on the taxable wealth available to each local jurisdictions. This

---


6 L.A.29820, Superior Court no.93854, 5 Cal. 3d 584 (1971). The Serrano vs. Priest case produced three distinct rulings: the 1971 California Supreme Court decision (Serrano I), the 1974 trial-court decision (Supreme Court of Cal., County of L.A., No.938254) and the 1976 California Supreme Court decision (Serrano II, 18 Cal. 3d 728). Each ruling stated in same fashion that California’s system for financing public education must be wealth-neutral. The Serrano I was considered a major victory for reformers, but the movement was slowed by the 1973 Rodriguez vs. San Antonio decision of the U.S. Supreme Court in which the justices rejected a Serrano-like argument. However, the trial-court decision (1974) held the California finance system in violation of the state constitution based on the principles cited in the original Serrano decision. In the 1976 Serrano II case, the California Supreme Court upheld the 1974 trial-court ruling.
landmark decision was followed by several similar cases in other states such as Texas 
(Rodriguez vs. San Antonio, 1971⁷), New Jersey (Robinson vs. Cahill, 1972⁸), 
Connecticut (Horton vs. Meskill, 1974⁹).

The principle of categorical equity singles out particular categories of 
commodities which are deemed to be 'fundamental interests' such as education and 
medical care, and asserts that the provision of those services should not differ 
substantially as a result of differences in ability to pay for them. Therefore, a 
distribution rule different from market forces should be applied to those 
commodities as they are closely related to the fundamental inequalities of human 
capital endowments and to the opportunities to accumulate human capital. The 
underlying philosophy of categorical equity is,

"... The social conscience is more offended by severe inequality 
in nutrition and basic shelter, or in access to medical care or to 
legal assistance, than by inequality in automobiles, books, 
clothes, furniture, boats. ..... There are some commodities 
where strict equality of distribution is deemed a crucially 
important objective, ..... indeed some are rights or privileges 
rather than goods and services in the usual sense." (Tobin, 
1970, pp.266-267)

In our study, the notion of intra-jurisdictional efficiency and the categorical 
equity constitute the two main pillars for modeling and simulation of the six fiscal 
schemes. In each fiscal scheme (except for perfectly decentralized fiscal scheme), 
the local choice of the service is targeted to be equalized to a stipulated level by

⁸ 118, N.J. Superior Court No.223, 1972
⁹ 31 Connecticut Superior Court No.377, 322A, 2d 113. 1974
alternative fiscal policies. Each policy is supposed to result in different combination of efficiency and equity, different policy cost, different local utility levels, and ultimately different social welfare states. All these aspects of each policy will be compared within the framework of our evaluative models.
CHAPTER II
LOCAL FISCAL CHOICE AND INTERGOVERNMENTAL GRANT-IN-AID:
A SURVEY

This chapter reviews two theories related to our study: the median voter model as a basic framework and intergovernmental grants-in-aid as main policy instruments. In the first section, we review an economic model for collective local fiscal choice, i.e., the median voter model, from its theoretical foundation to typical forms for empirical studies. In the second section, major predictions in traditional grant-in-aid theories are summarized and compared with empirical findings. We also review other studies related to our simulation study.

2.1 Majority Voting and the Median Voter Theorem

2.1.1 Theoretical Background

One of the main developments in economic theory during the past four decades is the analysis of non-market decision making processes -- public choice theory. The central question in public choice theory is whether there exists an ideal non-market decision making scheme which can satisfy a set of desirous and minimally required normative criteria, i.e., Pareto-efficiency and non-dictatorial choice.

Wicksell (1896) thought that if net benefits are created by a cooperative
allocation, a means of redistributing those gains through taxation could be found which ensures that all citizens preferred the new allocation to the non-cooperative status quo. The new cooperative allocation would be approved unanimously. Lindahl (1919) proposed an adjustment process which describes how a government might achieve in practice such a level of public expenditure. In his equilibrium, the preferred expenditure level of each individual is equal to their tax share and unanimity prevails. Johansen (1963) formalized the Lindahl process in a simple general equilibrium model.

The Wicksell-Lindahl scheme (so called "voluntary exchange theory") is based on the explicit assumption of cooperative behavior. However, if the assumption is discarded, a coercive auctioneer is needed who forces participants to reveal their true benefits and costs from public activity. Without a coercive auctioneer, the Wicksell-Lindahl process will be nothing but an another example of the Prisoner's Dilemma game in the house of government.

Therefore, our next interest is to find a coercive collective choice mechanism which can be substituted for market institutions. The fundamental question in coercive collective choice mechanisms is: Are there any democratic collective choice mechanisms which can allocate the social resources as efficiently as markets can do? The answer is 'no'. Arrow (1963) in his famous 'Impossibility Theorem' extracts five axioms that are required in any collective choice mechanism and proves the inconsistency of the five axioms. The conclusion of this theorem is quite pessimistic.

1 They are Pareto optimality (P), Non-dictatorship (ND), Unrestricted domain (U), Rationality (R) - complete rank and transivity-, Independence of irrelevant alternatives (I). Later works by Gibbard (1973) and Satterthwaite (1975) have extended Arrow's analysis to a more general behavioral structure and they reach the same negative conclusion.
The five axioms cannot be satisfied simultaneously in any collective choice mechanisms.

The majority rule process is recognized as the only collective decision making mechanism which is both democratic and allocatively efficient, but the mechanism may not have an stable equilibrium because of the "majority voting paradox". The possibility of cyclical voting can be avoided if all the voters are assumed to have single-peaked preference profiles. An agenda set in a single dimensional space (e.g., determination of a project size) is one of the typical examples of controlled agendas.

The median voter theorem is that the equilibrium generated by the majority rule process is the one most preferred by the median voter when preferences are single-peaked. This theorem originates from Hotelling's duopoly theory (1929) of spatial competition; it was developed by Bowen (1943), Downs (1957), and Black (1958), and has been applied in a wide range of economic contexts such as pollution control, income redistribution, minimum wage legislation, union behavior, and especially demand estimation of local public services.

To estimate the demand for public goods in a democratic society, we have to specify the process of collective choice or at least make assumptions about the political process that aggregates the profiles of preference in the society. The central advantage of the median voter model is that it allows us to analyze collective choice via the preference of a single decisive individual, i.e., the median voter.

\footnote{Under single-peaked preferences of voters, majority voting equilibrium will always exist. In other words, the paradox of majority voting arises if some of the preferences are not single-peaked. Where there are three voters (A,B,C) and three alternatives (X,Y,Z), the paradox of majority voting arises if A prefers X>Y>Z, B prefers Z>X>Y, and C prefers Y>Z>X. In this case, voter B has double peaks at Z and X.}
2.1.2 The Median Voter Model for Local Fiscal Choice

In this section, we present a typical median voter model for the analysis of local fiscal behavior. This framework provides a fundamental foundation for our six fiscal models in chapter 3.

The preference of a decisive individual, i.e., the median voter, is defined over after-tax private income $X$ and public service $G$, $U(X, G)$. Public services are assumed to flow from a public good ($Q$) and the number of people ($N$) in the locality, $G = G(Q, N)$. The cost schedule of providing $G$ follows from the specification of the service technology. Facilities ($Q$) are assumed to be produced by a constant returns to scale technology, $Q = A L^a K^{1-a}$. If we assume constant prices of labor and capital as in a competitive markets for labor ($L$) and capital ($K$), the unit cost of the public good ($c$) is also constant.

Now if we consider the grant-in-aid from a higher level of government, residents pay only a part of net expenditures after deducting the lump-sum aid ($Z$) and matching aid ($m$ is the matching rate). The total payment $T = (1-m)cQ - Z$ will be shared by all residents within the community. If local taxes are proportional, each resident’s share of total cost is equal to his share of tax base ($b$) out of total tax base in the locality ($BN$), where $B$ is the aggregate tax base per resident in the locality. A typical local resident pays a tax ($t$) equal to

---

3 The grants in traditional median voter models are assumed to be given exogenously. However, our models in chapter 3 are designed to have endogenous grants.
\[ t = \frac{b}{BN}[(1-m)cQ - Z] \]  
\[ (1) \]

And his personal income constraint is \( X + t = I \), where \( I \) is personal income. The budget constraint is

\[ X + \frac{b}{BN}(1-m)cQ = \frac{bZ}{BN} + I \]  
\[ (2) \]

This relation can be rearranged with regard to the local public service from the familiar relation \( G = \frac{Q}{N^\delta} \), where \( \delta \) is the coefficient of congestion. Then equation (2) is:

\[ X + \frac{b}{BN^{1-\delta}}(1-m)cG = \frac{bZ}{BN} + I \]  
\[ (2)' \]

Now the problem is:

\[
\begin{align*}
\text{Max. } U_{med} &= U(X, G) \\
\text{Sub.to } X + P_gG &= I + \frac{bZ}{BN} \\
\text{where, } P_g &= \frac{b}{BN^{1-\delta}}(1-m)c
\end{align*}
\]

In most empirical studies, the demand function is assumed to have a log-log functional form.\(^4\) The log-log demand function is chosen mainly for simplicity of estimation since the elasticities are the main parameters to be estimated; the specification is globally consistent with the Cobb-Douglas demand function.

The functional specification is:

\[ \log G = \beta_0 + \beta_1 \log P_g + \beta_3 \log I + \beta_4 \log S + \mu \]

\( S \): Vector of control variables

From the relation of \( G = \frac{Q}{N^\delta} \) and \( P_g = \frac{P_q}{N^\delta} \),

\[ \log Q - \delta \log N = \beta_0 + \beta_1(\log P_q + \delta \log N) + \beta_3 \log I + \beta_4 \log S + \mu \]

\[ \log Q = \beta_0 + \beta_1 \log P_q + \beta_2 \log N + \beta_3 \log I + \beta_4 \log S + \mu \]

where \( \beta_2 = \delta(1 + \beta_1) \), and \( \beta_1, \beta_2, \beta_3 \) represents the elasticity with respect to each variable.

This median voter methodology has been used by a large number of authors to estimate demand functions for public services and most empirical studies have shown correct signs in the estimation of income and price elasticities with significant coefficients.\(^5\)

In this model, if \((b/B) = 1\), the two components of full fiscal income (private income and lump-sum grants-in-aid) are expected to have identical effects on the local demand for public services; this is the case of the traditional grant-in-aid theory. If \((b/B) > 1\), the exogenous grant-in-aid will have more stimulative effects than an increase in residential income, and vice versa. The empirical evidence shows that lump-sum grants generally have greater effects on the local expenditure for public services than private income, which is the so called "flypaper effect".\(^6\)

Summing up, the median voter model is basically a demand-side model and "competitive" in its spirit, for it assumes that any government that spends far from the median demand level will soon be driven by the opposition that proposes an expenditure closer to the median demand level.

---

\(^5\) The results of general demand estimation for various public services are well surveyed in Inman (1979) and Rubinfeld (1987). The estimation of income and price elasticity of local public education is summarized in 5.4.2.

\(^6\) The term 'flypaper effect' was labeled by Gramlich and Galper (1973), and originally coined by Okun. According to empirical studies, the flypaper effect is estimated between $0.20 and $0.98 per dollar of lump-sum grant-in-aid. The results of empirical studies are aptly summarized in Gramlich (1977) and Inman (1979).
2.2 The Theory of Intergovernmental Grant-in-aid

2.2.1 Effects of Grants-in-aid on Local Spending

The traditional theory of grants-in-aid is typically couched in an utility maximization approach to local fiscal choice behavior. The preference that is defined over a particular public service and the residual income (or composite private good) is assumed to be represented by a community indifference curve⁷ or by an indifference curve of the median voter in the community.

In general, a grant has three different effects: a price effect reflecting changes in cost, an income effect reflecting the additional available funds, and indirect effects on other grant programs and complementary private expenditures. In particular, the analyses of income and price effects are well established within the traditional framework of indifference curve analysis.

The theoretical predictions of the traditional model can be summarized as follows.

1) Lump-sum specific grants have more or equally stimulative effects on the stipulated local public spending than lump-sum general grants do. Wilde (1968) called the former situation the "deflective effect".

Theoretically, the larger the amount of a lump-sum specific grant or the larger

---

⁷ The existence of community indifference curves requires very strict assumptions such as a fixed and known distribution of income (Samuelson, 1954).
the relative portion of expenditure on public services, the more the 'deflective effect' is likely to occur, and vice versa. However, according to one empirical study (Follain, 1979), the deflective effect was seldom operating. In a study of ten central-city governments in the U.S., Follain concludes that lump-sum specific grants do not stimulate local expenditure more than lump-sum general grants do.

2) Matching grants tend to stimulate the grantees' spending more than equal lump-sum grants do. Therefore, matching grants are generally preferred by the grantor government as a policy to achieve the target level of public service more efficiently.

3) A dollar increase in a lump-sum grant has the same effects on the grantee's spending as a dollar increase in residential income by direct transfers from a grantor government. "Revenue sharing is just a veil for the tax cut." (Gramlich, 1977 p.225).

These theoretical predictions come from traditional community indifference curve analysis, which is a pure economic model for the analysis of local fiscal choice. However, in result 3), the two effects may not be equal if we consider the distributive effect of different sources of funds or conflicts between decision units.

In his review of empirical evidence for various types of grants-in-aid in the United States, Gramlich (1977) concludes that the levels and structures of grants are important determinants of the grantee's expenditure. According to his survey, the following results are verified by empirical studies.
(A) The local spending stimulated by open matching grants\(^8\) is generally less than the amount of the grants transferred, i.e., the price elasticities of local public services are less than unity (in absolute value).

(B) Lump-sum general grants stimulate grantee’s expenditure less than open matching grants do.

(C) In the long-run, lump-sum grants tend to stimulate grantee’s spending much more than the same amount of tax cuts from a higher level of government.

Result (C), known as the 'flypaper effect', directly contradicts the predictions of traditional grant-in-aid theory. The empirical results confirm the different stimulative effects of lump-sum and matching grants, while invalidating the traditional prediction that lump-sum grants have identical effects as direct transfers to income.

Since the flypaper effect was recognized by Gramlich and Galper (1973), a large literature has appeared to explain this phenomenon. The literature has attributed the flypaper effect to various reasons: monopolistic bureaucrats or political institutions\(^9\), fiscal illusion of consumers\(^10\), and income effects from tax substitution\(^11\).

Those new models offer better explanations for the flypaper effect, but they are also incomplete in that they cannot predict the different stimulative effects

---

\(^8\) Matching grants are divided into closed and open matching grants. The former has an upper limit on the total amount of the grant while the latter does not.

\(^9\) Niskanen (1968), Romer and Rosenthal (1979)


\(^11\) Fisher (1979)
between matching and lump-sum grants within their theoretical frameworks. The traditional theory as well as the new models for the flypaper effect has not given a complete explanation for those two main stylized facts in local fiscal choice within a single framework.

The alternative fiscal models in chapter 3 are based on the framework of traditional median voter model, since the main concern of this paper lies in the relative equalizing performances of each grant-in-aid policy rather than in the explanation of the flypaper effect.

2.2.2 Fiscal Imbalances and Equalizing Grants-in-aid

Intergovernmental grants-in-aid have been developed as one of the main policies for fiscal problems in the federal government system: spillover of benefits and costs of local public services, fiscal disparities and imbalances among different or the same levels of government. Therefore, the type of grant-in-aid policy adopted is closely related to the perceived deficiencies of fiscal federalism.

In general, the purposes of grants fall into four categories: (1) Grants to correct spillover effects of local public services, (2) Grants to enforce the grantor's preferences for local government actions, (3) Grants to correct fiscal imbalance between different tiers of governments, and (4) Grants to neutralize fiscal inequalities among the same level of government.

---

12 Many alternative policies have been suggested for the adjustment of intergovernmental fiscal problems: tax base sharing, tax sharing, tax transfer, local tax deductions, and local tax credits, etc.
Under an ideal federal system, it must be decided which level of government will perform specific functions, and the revenue sources for these expenditure functions also must be allocated in a corresponding manner. However, a mismatch or divergence may exist between the revenue source and functional expenditure obligations among the governments of a federation, which is referred to as "vertical fiscal imbalance". This problem results when the central government's tax base is more income elastic than that of local government, and local expenditures are more income elastic than their revenue sources. Tax sharing or revenue sharing is usually adopted as a policy to adjust this vertical imbalance problem.

The horizontal fiscal imbalances mainly come from the difference between fiscal needs and fiscal capacities among governments of the same level. Because of residents' mobility across local jurisdictions, horizontal imbalances raise more complicated problems than vertical imbalances. For example, in the absence of any equalizing policies, if households at the same income level are differently treated in differently endowed jurisdictions, i.e., if they have different fiscal residuum\(^{13}\), then a migration tends to occur. Under the assumption of free mobility, migration will lead to a capitalization of horizontal fiscal imbalances into the land price of each jurisdiction. If the capitalization occurs perfectly, the horizontal imbalance can be fully compensated by the differences in land prices and no additional migration would occur in equilibrium. If this adjustment process works perfectly, equity as well

\(^{13}\) Fiscal residuum is defined as the differences between the value of benefits received and taxes paid. (Buchanan, 1950)
as allocative efficiency can be simultaneously attained within a pure decentralized fiscal system.

However, in a decentralized fiscal system with imperfect capitalization and costly migration, the distributive goal of society calls for equalizing policies for these horizontal fiscal imbalances. The equalizing grants-in-aid policies would contribute not only to reducing the horizontal inequalities but also to eliminating the incentives for Tiboutian migration. From this perspective, equalizing grant-in-aid policies can be justified from an efficiency as well as equity perspective, since Tiboutian migration produces no social benefits by itself.

As mentioned already, the main concern of this paper concentrates on the horizontal inequalities in a particular local public service (elementary education) without Tieboutian migration. Instead, we consider alternative equalizing grant-in-aid schemes which can eliminate the incentives for Tieboutian migration.

Several studies have dealt with the issue of categorical equity in a particular local public service (education) and analyzed alternative equalizing policies to neutralize the underlying categorical inequalities.

Motivated by a series of judicial decisions on school financing, Feldstein (1975) suggests a wealth neutralizing matching grant-in-aid scheme as a policy to achieve wealth neutrality without sacrificing local choices in the provision of local public education. He argues that the traditional "district power equalizing (DPE)
grant scheme\textsuperscript{15} would only be wealth neutralizing in the special case that absolute wealth and price elasticities are equal. He derives a wealth-neutralizing matching rate formula and applies it to school expenditure in Massachusetts school districts.

Inman and Wolf (1976) propose a computer simulation program named SOFA (Simulation of Fiscal Assistance) by which the effect of various grant-in-aid policies can be analyzed. They apply this model to the case of New York metropolitan school financing reform and compare the current exogenous grants-in-aid system with a more pro-poor school financing system (fiscal base equalizing aid).

Based on the SOFA model, Inman (1978) compares six alternative education reform proposals for the New York metropolitan area: foundation aid program, two district power equalization plans, property tax credits, expanded \textit{Title I} assistance under the Elementary and Secondary Education Act, and the centralized financing/spending control scheme. He evaluates the alternative proposals under alternative evaluating rules: Utilitarian rule, Rawlsian rule, and the Atkinson equity criterion.

Friedman (1984) presents four alternative policy schemes for the simulation of school financing: wealth neutralizing matching grant, DPE matching grant, full state financing, and pre-reform financing (decentralized provision system). He employs three welfare criteria for evaluation: a pro-equity (Rawlsian), a pro-efficiency (Utilitarian), and the Nash criterion.

Kye-Sik Lee (1987) develops Friedman's model and simulates it with the local income and population data from Korea. In his simulation three variables are chosen

\textsuperscript{15} The DPE grant scheme in school financing, which is proposed by Coons et al. (1970), purposes the equalization of target fiscal base per pupil by the grant which equals the difference between the revenue raised from local jurisdiction's own fiscal bases and the revenue that should have been raised if the fiscal base were equal to the target.
as the main parameters to be varied: income and price elasticities, and the share of the public service expenditure. His simulation results can be summarized as follows (Lee, p.169).

First, if income and price elasticities are equal, the two matching grant schemes (wealth neutralizing matching grant, DPE matching grant) and the centralized provision system result in identical outcomes. Second, as the share of public service expenditure from personal income increases, the grants to each jurisdiction increase proportionately. However, matching rates remain invariant. Third, as the demand for the service becomes more income elastic, per capita expenditure on the public service increases rapidly.

However, these results do not display any systematic relation between the policy selected and the parameters considered, which is mainly due to the model's limitation. In other words, the models are limited not only in the scope of the fiscal schemes considered (limited to matching grant-in-aid policy only) but also in the parameters considered. In particular, since the central government is modeled as a completely exogenous grantor, grants are perceived to be given costlessly to local residents. Furthermore, since no particular local public service is specified as the target commodity that needs categorical equity, the price variable is not defined specifically for that service; therefore, no specific policy is recommended.

In this literature, most studies regarded equalizing grants as exogenous policy instruments. Therefore, the financial cost of each policy scheme is not explicitly considered and alternative fiscal policies could not be compared appropriately.

Our models in this paper are more extensive than those in previous studies.
not only in the scope of the policies considered but also in their use of modeling techniques. More specifically, we consider four different equalizing grant-in-aid schemes in addition to the perfectly decentralized and perfectly centralized provision scheme. In modeling these schemes, we incorporate the central government into the framework as an equalizing grantor cum tax collector. By this modeling technique, we can obtain theoretical characteristics of each policy as well as their equalizing performances and relative preferences.
CHAPTER III
THE MODELS - ALTERNATIVE POLICY SCHEMES
FOR THE PROVISION OF LOCAL PUBLIC SERVICES

3.1 Overview

In this chapter, we present alternative fiscal policy schemes for the provision of a particular local public service in which equity considerations are particularly emphasized. We select elementary education as a typical example of this service and intergovernmental grant-in-aid policies as the main policy instrument.

The basic framework for the models is constrained maximization, which is consistent with the traditional median voter model (which is reviewed in 2.2) for local fiscal behavior. However, our models are distinguished from the traditional median voter models in the following aspects:

First, the models are constructed in a general equilibrium framework; the central government is incorporated within the model as an endogenous grantor cum tax collector. Tentatively it is assumed that the main concern of the central government to equalize (or reduce) the horizontal inequalities of the service through various grant-in-aid policies. The incorporation of the central government within the framework enables us to compare the financial cost (or the degree of decentralization) of each policy scheme.

Second, equalizing grant-in-aid policies are constrained to the full-financing condition of the central government, i.e., the sum of equalizing grants sent to each
local jurisdiction should be equal to the sum of the central income tax collected from each local jurisdiction. By this constraint, the scale of central government's budget is endogenously determined with other variables and system parameters in each fiscal scheme. The central tax rate indicates the relative scale of this budget requirements.

3.1.1 Assumptions and General Framework of the Model

The models are based on the following assumptions:

A.1. The selected public service (elementary education) is provided only by the public sector. No private substitutes are assumed to exist.

A.2. There are 'k' local jurisdictions and one central government. In each local jurisdiction, population (N), income (I), and the number of pupils in elementary school (N^6) are assumed to be different. However, the price (\(\alpha\)) and income elasticity (\(\beta\)) of the demand for elementary education are assumed to be identical (constant) across local jurisdictions.

A.3. The preference of each local jurisdiction is represented by the median voter. The utility function is defined over per capita expenditure on private consumption (X) and per pupil elementary education expenditure (G) in the community, i.e., \(U = U(X, G)\).

A.4. The median voter has an average income level in his jurisdiction and

---

1 In general, \(\delta\) denotes the degree of congestion in the following relation between local public goods (Q) and services (G), \(G = Q/\delta N^6\). If we interpret (A.2) by this relation, the term \(N^6\) implicitly assumes that the benefit of education emits only to the students attending.
shares \((1/N)\)th of local education expenditures after paying central taxation.

**A.5.** The role of the central government is to equalize or reduce the horizontal inequalities in local spending for elementary education.

**A.6.** Neither Tieboutian migrations nor spillover effects of education are considered.

Throughout this paper, we analyze the demand for education by an input unit, the expenditures on education. Of course, the output (or quality) of a service should be distinguished from the expenditures on it, especially those in personally dedicated services such as education and health care. In the case of education, output may depend on other characteristics such as student's personal ability, desire, and family background. However, although such arguments are true, our reason for expenditure analysis is simple; the production relationships in public schooling are extremely complex and data are not fully available for additional qualitative factors. For this reason, we use school spending as a proxy for output by treating dollars spent on pupils as if they were the direct object of household concern.

The variables in our models are specified as follows:

\[
\begin{align*}
X &= \text{Private consumption expenditure} \\
G &= \text{Elementary education expenditure per pupil} \\
N &= \text{Residential population} \\
N^\delta &= \text{Number of elementary school pupils, } 0 < \delta < 1 \\
N^\delta G &= \text{Total expenditure for elementary education} \\
N^{\delta-1} &= \frac{N^\delta}{N} = \text{Ratio of elementary school pupil to population}
\end{align*}
\]
$N^{6-1}G \ (= N^6G/N) = \text{Elementary education expenditure per capita}$
$I = \text{Personal income before central taxation}$
$t = \text{Central income tax rate}$

These variables also can be classified as follows:

**Exogenous variables**: $N$, $I$, and $\delta$ (therefore, $N^6$ and $N^{6-1}$)

**Endogenous variables**: $G$, $X$, $t$, and grants transferred to each jurisdiction

**Policy variables**: Choice of fiscal scheme, target level of education expenditures per pupil

The main parameters selected for simulation come from the social planner's (or the central government's) considerations in providing this service: income and price elasticities ($\beta$, $\alpha$), share of education expenditure ($b$), inequality-aversion parameter for alternative welfare criteria ($\sigma$), and welfare costs of tax distortion ($\lambda$). Details on each of these parameters are explained in chapter 5.

Under these assumptions, the fundamental framework of the six models can be formalized as the following maximization problem in each local jurisdiction.

\[
\begin{align*}
\text{Max.} & \quad U = U (X, G) \\
\text{Sub. to} & \quad X + N^{6-1}G = I
\end{align*}
\]

The local utility level (more specifically, utility of the median voter in a

---

2 Later in this chapter (3.2), we assume this target level to be a national average of local expenditures on education under the perfectly decentralized provision system.
locality) is assumed to be determined by private consumption expenditures (X) and elementary education expenditure per pupil (G) in each jurisdiction.

In the budget constraint, total personal income (I) divides into private consumption expenditures (X) and per capita elementary education expenditure (N^cS.G). In this equation, N^cS-1 can be interpreted as a relative price of G to X, since, other things being equal, per pupil educational expenditure (G) in a particular local jurisdiction tends to be lower (higher) as the relative proportion of students increases (decreases). In other words, residents’ per capita burden of educational expenditure within a jurisdiction will be heavier as a higher portion of the population requires education expenditures.

In the typical median voter model, the price of a particular local public service represents the median voter’s share from total costs borne by each locality. The most common form of price variable in previous estimations was the median voter’s share of the property tax base (=b/NB), where b is median voter’s tax base, B is aggregate tax base per resident, and N is local population. In our model, however, since the median voter is assumed to have an average income in the locality, he naturally shares (1/N)th of total costs, N^cS.G. In our price variable, b is assumed to be equal to B and the possibility of the flypaper effect is excluded.

In our models, the value of G comes from the presumed Cobb-Douglas demand function: G = AP^aI^b, where P=N^cS-1. Once G is derived under given price and income elasticities (α, β), X can be derived from the budget constraint. Finally, each jurisdiction’s utility level is determined by the values of G and X under given exogenous variables and parameters.
Now, the next problem is how to specify a particular welfare criterion to evaluate different distributive states. In the next section, we discuss alternative evaluating criteria.

3.1.2 Evaluating Criteria for the Optimality

It is impossible to judge between two alternative economic states without using an ethical welfare function. According to the two pioneering works of Dalton (1920) and Atkinson (1970), any underlying measure of inequalities (e.g., variance, standard deviation, coefficient of variation, Gini coefficient) is implicitly embodied with certain kinds of value judgement about social welfare. For example, the widely used Gini coefficient tend to attach more weight to transfers affecting middle income classes\(^3\) and the standard deviation to transfers at the lower end of the income distribution.

However, since some of the value judgement may not have wide support, it seems more reasonable to approach the issue of inequality evaluation directly by using the social welfare function that we should like to employ rather than evaluating indirectly through conventional statistical measures. Although there is no agreement about the form of social welfare function, this method allows us to exclude the undesirable value judgement in evaluating the underlying inequalities.

In this paper, as a specific welfare criterion to evaluate underlying inequalities

\(^3\) The implicit welfare function behind the Gini coefficient weights individual income only by the ranking of income not by their size.
of local utility indexes, we adopt a social welfare function suggested by Atkinson (1970), i.e., the inequality-aversion welfare function. The function is characterized by a parameter for inequality-aversion, by which we can express how seriously a social planner (or the central government) recognizes horizontal inequalities.

\[ W = \left\{ \frac{1}{\sigma} \sum_{i=1}^{k} U_i^\sigma \right\}^{1/\sigma}, \quad 0 \leq \sigma \]

\[ U_i = U(X_i, G_i), \quad i = 1, 2, \ldots, k \]

\[ \sigma = \text{inequality-aversion parameter} \]

In this function, we can specify alternative degrees of equity consideration by the values of \( \sigma \). More specifically, as \( \sigma \) decreases, the social planner will attach more weight to transfers at the lower end of the distribution and less weight to transfer at the top. One extreme case is \( \sigma \to \infty \), giving the function \( \min\{U_i\} \) which only takes account of transfers to the very lowest utility group; this is the 'Rawlsian' criterion. At the other extreme, we have \( \sigma = 1 \) giving the linear welfare function which ranks distributions solely according to total utility level, which is the 'Utilitarian' criterion.

This welfare function is illustrated in Figure 3.1 for the case of two jurisdictions. In Figure 3.1, the three solid lines represent alternative social welfare functions, which are determined by the values of the inequality-aversion parameter, \( \sigma \). A distributive state \( D (U_1, U_2) \) is equally treated with the state \( A, C, \) and \( B \) under

---

4 The increasing/constant/decreasing inequality-aversion means that we are increasingly/constantly/decreasingly concerned about inequality as the general income level rises. More strictly, inequality-aversion is increasing/constant/decreasing according as \( \partial Y_{eq}/\partial \theta \) is less than/equal to/greater than 1. '\( \theta \)' is absolute additions to income and \( Y_{eq} \) is the level of income which, if equally distributed, would give the same level of social welfare as the present distribution. The value of \( Y_{eq} \) will be closer to the average of the present distribution under a more equal distribution.
the Rawlsian ($\sigma=-\infty$), Benthamite ($\sigma=1$), and a welfare function between them where $0<\sigma<\infty$. In general, as the social planner recognizes the underlying inequalities among jurisdictions more seriously, i.e., as $\sigma$ decreases, the equally-distributed-equivalent utility level ($U_{eq}$) will be less and closer to $A$.

![Figure 3.1 Alternative Evaluation Criteria](image)

In this paper, we evaluate alternative fiscal schemes under three alternative welfare criteria: Utilitarian ($\sigma=1$), Nash ($\sigma=-1$), and Rawlsian criteria ($\sigma\rightarrow-\infty$).

3.2 Perfectly Decentralized Provision

In this fiscal system, each local jurisdiction finances and provides elementary education based on its own fiscal base without receiving any grants and paying any taxation to the central government. Therefore, the provision of education in each jurisdiction is determined by the two local specific variables, i.e., the price of elementary education ($N^{\delta,1}$) and the local income ($I$).
This model is especially important in this paper because it provides not only a basic framework but also a target level of equity for the other five models. This model can be formulated as follows.\(^5\)

\[
\begin{align*}
\text{Max.} & \quad U_i = U(X_i^D, G_i^D) \\
\text{Sub. to} & \quad X_i^D + N^{\delta-1}G_i^D = I_i \\
& \quad i = 1, 2, \ldots, k
\end{align*}
\]

From this maximization problem, the demand equation is assumed to be in log-linear form with constant price and income elasticities:

\[
G_i^D = A(N^{\delta-1})^{\alpha I_i^\beta}
\quad (1-1)
\]

Since income \((I)\) and population \((N)\) are exogenously given in each jurisdiction, if we specify the value of \(\alpha, \beta,\) and \(A,\) we can obtain the particular values of \(G\) and \(X\) from the equation (1-1) and (1-2).

\[
X_i^D = I_i - N^{\delta-1}G_i^D
\quad (1-2)
\]

This mechanism can be summarized as follows:

< Model 1 - Perfectly Decentralized Provision >

\[
\begin{align*}
U_i & = U(X_i^D, G_i^D) \\
G_i^D & = A(N^{\delta-1})^{\alpha I_i^\beta} \quad (1-1) \\
X_i^D & = I_i - N^{\delta-1}G_i^D \quad (1-2) \\
& \quad i = 1, 2, \ldots, k
\end{align*}
\]

\(^5\) Superscript \(D\) denotes the perfectly decentralized fiscal scheme.
3.3 Perfectly Centralized Provision

In this fiscal scheme, education is assumed to be financed and provided by the central government. More specifically, the central government raises revenue from central income taxation in local jurisdictions and redistributes it by providing education in an uniform fashion.

Let's assume that $G$ is the target level of education expenditure (per pupil) intended by the central government. The policy variable $G$ is very important since it determines the actual degree of equalization under each equalizing grant-in-aid scheme. Throughout this paper, we will assume $G$ to be the national average of education expenditure which would have been provided under the perfectly decentralized provision system.

$$G = \Sigma G_p / k = \Sigma [A(N^{-1})^\alpha k] / k$$  \hspace{1cm} (2-1)

Since each local jurisdiction receives an equal amount of education expenditure per pupil ($G$) while paying the imposed central tax rate ($t^c$), the private consumption expenditure ($X$) is determined as follows:

$$X^c_i = I_i (1 - t^c)$$  \hspace{1cm} (2-2)

$t^c$: Central income tax rate under the perfectly centralized provision system

By the full-financing condition, the central tax rate ($t^c$) is calculated from the central government's budget constraint.

---

6 The superscript C denotes the perfectly centralized fiscal system.
In equation (2-3), LHS represents total revenue from central taxation and RHS is total education expenditure by the central government.

This mechanism is depicted in Figure 3.2 and summarized as Model 2.

\[(t^e)(\sum_{i}^k N_i) = \frac{\overline{G}}{\sum_{i}^k N_i} I_i ( = \Sigma G^P N_i) \quad (2-3)\]

* Each local jurisdiction is supposed to have \((X^C, \overline{G})\). They receive \(\overline{G}I_i\) of education expenditure from the central government after paying central taxation \((t^eI)\).
3.4 The Foundation Aid Plan

In the foundation aid plan, the central government proposes to guarantee a minimal level (foundation level) of education by transferring lump-sum specific grants to local jurisdictions where education expenditure (per pupil) is below the foundation level. However, wealthy jurisdictions are allowed to make additional local expenditures on education. In general, the effective degree of equalization depends on the pre-determined foundation level; the higher the foundation level, the stronger the effective degree of equalization. For example, if the foundation level is set to the provision in the wealthiest jurisdiction, all but the wealthiest jurisdiction would receive at least some amount of lump-sum aid for the provision of education. However, if the foundation level is set to the provision level in the poorest jurisdiction, no jurisdiction will receive foundation aid and this system will be the same as the perfectly decentralized provision system.

The foundation level is assumed to be the average of decentralized provision, \( G \). Then the problem of a local jurisdiction \( i \) is:

\[
\begin{align*}
\text{Max.} & \quad U_i = U(X_i, G_i) \\
\text{Sub. to} & \quad X_i + N^{X_i}G_i = I_i(1-t) \\
& \quad i = 1, 2, \ldots, k
\end{align*}
\]

Under this scheme, the amount of lump-sum grant is \((G - G_i)^7\), where \(G_i\) is

\[7\text{ If } G_i > G, \text{ grants are zero.}\]
the local education expenditure after paying central taxation. Therefore, the education expenditure per pupil in jurisdiction i (\(G^F_i\)) is:

\[
G^F_i = G, \text{ if } G_i > G \\
= G, \text{ if } G_i < G
\]

where, \(G_i = A(N^j)x[I_i(1-t^F)]^j\) (3-2)

In equation (3-2), \(t^F\) should also satisfy the central government's full-financing condition in equation (3-3).

\[
(t^F)(\sum_l N_l) = \frac{R}{\sum_l (G - G_l)N^j_l} (3-3)
\]

\(R\) : number of jurisdictions where \(G_i < G\).

Therefore, \(G_i\) and \(t^F\) are simultaneously determined in equation (3-2) and (3-3). After \(G_i\) and \(t^F\) are derived, the private consumption expenditures (\(X^F\)) can be derived from the local budget constraint:

\[
X^F_i = I_i(1-t^F) - G_i(N^j_l) (3-4)
\]

The mechanism is summarized in Model 3 and depicted in Figure 3.3.

< Model 3 - The Foundation Aid Plan >
\[ X^F_i = I_i(1-t^F) - G_i(N^{i-1}) \]  
\[ i = 1, 2, \ldots, R, \ldots, k \]

**Figure 3.3 The Foundation Aid Plan**

*The wealthy jurisdiction \( r \) is allowed to have \((X^F_r, G_r)\) after paying central taxation. But the poor jurisdiction \( p \) will have \((X^F_p, G_p)\) since it receives a lump-sum grant \((G-G_p)\) from the central government.

### 3.5 The Equalizing Grant-in-Aid Plans

In this section, we propose three different equalizing grant-in-aid schemes: lump-sum general grant, matching grant, and lump-sum specific grant. These equalizing grant-in-aid schemes require that if a local jurisdiction raises educational funds in excess of the target level set by the central government, the excess should be transferred to the central government, which is referred to as the ‘recapture’
clause. In other words, additional local expenditures on education are not allowed under these equalization grant-in-aid schemes.

Since different grants-in-aid have different stimulative effects on local spending, the financial costs required in each equalizing grant-in-aid plan are also expected to be different. In our models, the endogenous central tax rate is supposed to indicate this effect by the full-financing constraint imposed on each equalizing policy. The target level is still set to the average of the decentralized provision level, $G$.

### 3.5.1 Equalization with Lump-Sum General Grant-in-Aid

Under this plan, each local jurisdiction is supposed to pay income taxes to the central government and receive a lump-sum subsidy ($Z$) in return. The central government distributes grants for each jurisdiction to equate the target level of education expenditure (per pupil) with their final income ($= \text{initial income} - \text{central tax} + \text{lump-sum grants received}$). The problem in local jurisdiction $i$ can be formalized as follows:

\[
\begin{align*}
\text{Max.} & \quad U_i = U(X_i, G_i) \\
\text{Sub. to} & \quad X_i + N_i^{-1}g_i = I_i(1-t) + Z_i/N_i \\
Z_i & : \text{total lump-sum grant to jurisdiction } i \\
i & = 1, 2, \ldots, k
\end{align*}
\]
As in the previous models, the demand function of education expenditure from this optimization problem is assumed to have the following log-linear form:

\[ G_t = A (N^{c-1})^\nu [I_t (1-t^GL) + Z_t/N_t]^\theta \]

Now, the first step is to determine the central tax rate \((t^GL)\) and the amount of lump-sum grant to each jurisdiction \((Z_t)\). In the previous foundation aid model, we derived the central tax rate from the central government's full-financing budget condition. However, in this scheme, the tax rate derived from the central government's full-financing condition is insufficient to satisfy the equal provision of \(G_t\) across jurisdictions. In other words, with the tax rate from central government's full-financing condition, some wealthy jurisdictions still can have \(G_t\) higher than the target level of education \((G)\) after paying the central tax.

By this reasoning, we derive the central tax rate in a manner such that we can achieve the equalization of \(G_t\) rather than satisfy the central government's full-financing condition. After achieving the equalization goal, we then consider the full-financing condition by returning the central government's budget surplus, if any.

In deciding the central tax rate by this process, we need a specified criterion since the intervention by central government could be unnecessarily excessive without this criterion. In an extreme case, for example, it is possible that the central government collects all local income by central taxation and redistributes it in the form of both education expenditure and private consumption.

To minimize the administrative effort in each equalizing grant-in-aid policy, we initially derive the central tax rate from the wealthiest jurisdiction so that the wealthiest jurisdiction needs no grant to achieve the target level of expenditure.
under the underlying central tax rate. By this mechanism, all jurisdictions except the wealthiest jurisdiction at least receive some amount of equalizing lump-sum grants-in-aid.\(^8\)

If \(G_w\) is the education expenditure (per pupil) in the wealthiest jurisdiction \(w\), the central tax rate \(t^{GL}\) can be derived by the following equation:

\[
G_w = G = A(N^{\delta-1})\beta[I_w(1-t^{GL})]^{\beta}
\]

where, 
\[
G = \Sigma G^p / k
\]

Once \(t^{GL}\) is determined as \(t^{GL^*}\), the amount of the lump-sum grant transferred to each local jurisdiction \((Z_i)\) can be derived from the following equation:

\[
G_i = G = A(N^{\delta-1})\beta[I_i(1-t^{GL^*}) + Z_i/N_i]^{\beta}
\]

\(i = 1, 2, \ldots, k\)

Next, the private consumption expenditure \((X^{GL})\) is obtained from the local budget constraint:

\[
X_{GL_i} = I_i(1 - t^{GL^*}) + Z_i^*/N_i - N^{\delta-1}G_p, \quad (G = G)
\]

However, this private consumption expenditure is not the equilibrium value and is subject to change according to the central government’s full-financing budget condition. If there are any budget surpluses \((S)\) under the tax rate \(t^{GL^*}\), they should return to each local jurisdiction in proportion to their contribution to central taxation, i.e., each jurisdiction’s income level. The surplus in central government’s budget can be derived as;

\(^8\) If the tax rate is determined in the middle income jurisdiction, the central tax rate would be lower. In this case, only the jurisdictions below middle income will receive some amount of equalizing grants. However, under this tax rate, since the jurisdictions above middle income still can have additional education expenditure over the target level, we have to collect additional tax in such jurisdictions. But that is not an economical way.

\(^9\) The superscript GL denotes the lump-sum general grant-in-aid program.
The final value of $X$ including the surplus return is:

$$X_{GL} = (1 - t_{GL}) + Z/N \cdot N^i_i G + (S)I_i /\Sigma N_i I_i$$ (4-4)
This mechanism is graphically depicted in Figure 3.4.

![Figure 3.4 Equalization with Lump-sum General Grant-in-aid](image)

3.5.2. Equalization with Matching Grant-in-aid

The basic mechanism of this scheme is the same as the previous system except that the central government now uses matching grants-in-aid instead of lump-sum grants. The problem in jurisdiction \( i \) is:

\[
\begin{align*}
\text{Max} & \quad U_i = U(X_i, G_i) \\
\text{Sub. to} & \quad X_i + (1-m_i)N^{\delta - 1}G_i = I_i(1-t) \\
& \quad m = \text{matching rate}
\end{align*}
\]

Again, the demand equation for education expenditures is assumed to be:

\[
G_i = A[(1-m_i)N^{\delta - 1}]^\beta [I_i(1-t)]^\theta
\]
As in the previous case, we initially derive the central tax rate \((t^M)\)\(^{10}\) from the wealthiest jurisdiction.

\[
G_w = G = A[N^{d-1}][w(1-t^M)]^g
\]  
\[(5-1)\]

Once \(t^M\) is determined, the matching rate for each jurisdiction \((m_i)\) can be derived by the following equation:

\[
G_i = G = A[(1-m_i)N^{d-1}][i_i(1-t^M)]^g
\]  
\[(5-2)\]

\(i = 1, 2, \ldots, k\)

Finally, \(X^M\) can be derived with the values of \(t^M\) and \(m_i\) in each jurisdiction.

\[
X^M_i = I_i(1-t^M) - (1-m_i)N^{d-1}G
\]  
\[(5-3)\]

By the same analogy as in the lump-sum grant scheme, \(X^M_i\) should be adjusted by \(S\).

\[
S = \frac{k}{\Sigma(N_i I_i) t^M} - \frac{k}{\Sigma(m_i N^g i_i G_i)}
\]  
\[(5-4)\]

where, \(G_i = A[(1-m_i)N^{d-1}][i_i(1-t^M)]^g\)

The final value of \(X^M\) incorporating the surplus return is

\[
X^M_i = I_i(1-t^M) - (1-m_i)N^{d-1}G + I_i S / \Sigma N_i I_i
\]  
\[(5-5)\]

This mechanism is summarized and graphically displayed as follows.

< Model 5 - Matching Grant-in-aid Policy >

\[
U_i = U(X^M_i, G^M_i)
\]

\[
G^M_i = G = \Sigma G^p / k
\]

\[
X^M_i = I_i(1-t^M) - (1-m_i)N^{d-1}G + I_i S / \Sigma N_i I_i
\]  
\[(5-5)\]

\(^{10}\) The superscript \(M\) denotes the matching grant-in-aid program.
\[ t^M = 1 - \left( \frac{1}{I_w} \right) \left[ \frac{\bar{G}}{A(N^{k-1})^{\alpha}} \right]^{1/\beta} \]  \hspace{1cm} (5-1) \\
\[ m_i = 1 - (N^{1-\delta}) \left[ \frac{\bar{G}}{A[I_i(1-t^M)]^{\beta}} \right]^{1/\alpha} \]  \hspace{1cm} (5-2) \\
\[ S = \sum_{i=1}^{k} (N_i I_i) t^{GL} - \sum_{i=1}^{k} (m_i N_i^\delta G_i) \]  \hspace{1cm} (5-4) \\
\[ i = 1, 2, \ldots, w, \ldots, k \] 

Note: The final tax rate would be \( t^M = S/\Sigma N_i I_i \).

---

Figure 3.5 Equalization with Matching Grant

* The matching rate is determined so that each jurisdiction can choose the target level of education expenditure, \( G \). \( (X^M, \bar{G}) \) is the final combination of fiscal choice after receiving the surplus return \( (I_i S/\Sigma N_i I_i) \). In the wealthiest jurisdiction, since the matching rate \( m_w \) is zero, the budget line does not change.

3.5.3 Equalization with Central Compensation by Lump-Sum Specific Grants-in-Aid

Unlike the two previous equalizing grant programs, the central government in this scheme equalizes the local education expenditure by direct compensation with
a lump-sum specific grant. Now, the problem in jurisdiction i is:

Max. \( U_i = U(X_i, G_i) \)

Sub. to \( X_i + N_i^g G_i = I_i(1-t) \)

\( i = 1, 2, \ldots, k \)

Again, the demand for education expenditure is assumed to be:

\( G_i = A[N_i^{g-1}]^a[I_i(1-t)]^b \)

As in the previous equalizing schemes, we derive the central tax rate \( (t^{SL}) \) from the wealthiest jurisdiction \( w \).\(^{11}\)

\[ G_w = G = A[N_i^{g-1}]^a[I_w(1-t^{SL})]^b \quad (6-1) \]

Under this tax rate, the target level of education expenditure is attained in the wealthiest jurisdiction. Based on funds from central taxation, the central government subsidizes local education expenditure with a lump-sum specific grant \( (G - G_i) \). Since the grant is given for a specified expenditure, the grant is much smaller than in the lump-sum general grant-in-aid policy. In other words, the amount of surplus return is excepted to increase. The total surplus \( (S) \) is:

\[ S = \sum_{i=1}^{k} (N_i I_i t^{SL}) - \sum_{i=1}^{k} (G - G_i) N_i \quad (6-2) \]

The equilibrium value of \( X^{SL}_i \) including the surplus return is:

\[ X^{SL}_i = I_i(1-t^{SL}) - (N_i^{g-1})G_i + I_i S/\Sigma N_i I_i \quad (6-3) \]

This mechanism is graphically depicted in Figure 3.6.

\(^{11}\) The superscript SL denotes the lump-sum specific grant policy.
This mechanism is graphically depicted in Figure 3.6.

* The tax rate is determined at the level where the wealthiest jurisdiction can choose A. After receiving the surplus, the final choice in the wealthiest jurisdiction is \( (X_{sw}^{SL}, \overline{G}) \). Other jurisdictions will choose \( (X_{i}^{SL}, G_i) \), after paying central taxation. However, the final choice after surplus return is \( (X_{wi}(1-t_SL), \overline{G}) \).

\[ U_i = U(X_{SL}^{P}, G_i^{SL}) \]
\[ G_i^{SL} = \overline{G} = \Sigma G_j / k \]
\[ X_i^{SL} = I_i(1-t_SL) - (N_i^{SL}) G_i + I_i S / \Sigma N_i i \]

\[ t_{SL} = 1 - \left( \frac{1}{I_w} \right) \left[ \frac{\overline{G}}{A(N_i^{SL})^{\alpha}} \right]^{1/\beta} \]

\[ G_i = A(N_i^{SL})^{\alpha} [I_i(1-t_SL)]^{\beta} \]
\[ S = \sum_i (N_i I_i) t^{SL}_i - [\sum_i (G - G_i) N^\delta_i] \]
\[ i = 1, 2, \ldots, w, \ldots, k \]

Note: The final tax rate is \( t^{SL}_i - S / \Sigma N_i I_i \).

Summing up, the basic mechanism of these six models can be summarized as follows. Once the values of exogenous variables (I,G,\( \alpha, \sigma, k \)), target variables set by the policy maker (G), and system parameters (\( \alpha, \beta, \ldots \)) are given, endogenous variables (t, X) are determined simultaneously. By the value of G and X, the indexes of the local utility function and social welfare functions are determined for each fiscal scheme.

Especially in the three equalizing grant-in-aid schemes, although the central tax rates \( (t^{GL}_i, t^M_i, t^{SL}_i) \) appear to be the same in an initial stage, the final tax rates which are adjusted by the surplus return (S) turn out to be different reflecting different stimulative effects of each grant-in-aid policy. This framework is distinguished from the previous models in the following aspects.

First, the central government is included as an endogenous grantor having its own way of financing (central income tax) for the grants to be transferred. In this sense, our models can be classified as "general equilibrium models". In the traditional models for grant-in-aid analysis, additional grants are perceived to be given costlessly to local residents since they are assumed to be exogenous. In our models, although local fiscal residuum differs across fiscal policies, grants are basically given at the direct expense of residents' income.

Second, the central government - the grantor cum tax collector - is also
subject to full-financing budget condition. The main benefit of this framework is that the financial cost of each grant-in-aid policy can be easily compared via the endogenous central tax rate.

Third, the models are constructed regarding a specific service (education) with intergovernmental grant-in-aid policy instruments. We set a new price variable (= student-population ratio, $N^{6-1}$) in our models.

In next chapter, we introduce the current provision system of elementary education in Korea, with which we simulate the six models presented in this chapter.
CHAPTER IV
THE PROVISION OF EDUCATION IN KOREA

Education in Korea is especially important not only as one of the most critical factors to determine one's social and economic status but also in its scale of investment. In this chapter, first, we introduce Korea's current system of financing and providing education, focusing on public educational expenditures. Next, we examine the regional distribution of elementary education expenditures, which will be used as the main data for the simulation of our six fiscal schemes.

4.1 The Financial Structure of Education

By and large, educational expenditure is divided into two categories: public and private educational expenditure. Public educational expenditures are defined as the ones expended by public budgeting processes. Hence, the amount of expenditure is unaffected by private abilities to pay. By contrast, private educational expenditures are composed of personal spending for education-related purposes such as textbooks, instructional materials and supplies, extra-curricular activities, lodging, and transportation, etc. These expenditures vary according to the consumer's ability to pay for them.

In Korea, the total scale of educational expenditure (both public and private) was estimated at 9,355 billion won in 1985, which corresponds to 13.1% of GNP. The
proportions of public and private expenditure are 49.8% and 50.2%, respectively.¹

In this section, we concentrate on the public educational expenditure not because the private educational expenditure is unimportant, but because no (aggregate) data for private educational expenditure are formally available.

Table 4.1 shows the share of public educational expenditure in GNP and in total government expenditure for twenty selected countries.

Table 4.1
Share of Public Expenditure on Education (1985)

(A): Percent of Gross National Product (GNP)
(B): Percent of Total Government Expenditure

<table>
<thead>
<tr>
<th>Country</th>
<th>(A)</th>
<th>(B)</th>
<th>Country</th>
<th>(A)</th>
<th>(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>6.2</td>
<td>15.7</td>
<td>Korea</td>
<td>6.5</td>
<td>28.2</td>
</tr>
<tr>
<td>Canada</td>
<td>7.0</td>
<td>12.7</td>
<td>Japan</td>
<td>5.1</td>
<td>17.9</td>
</tr>
<tr>
<td>U.K.(84)</td>
<td>5.2</td>
<td>11.3</td>
<td>China (83)</td>
<td>2.7</td>
<td>8.2</td>
</tr>
<tr>
<td>France(83)</td>
<td>6.0</td>
<td>18.5</td>
<td>Hong Kong(84)</td>
<td>2.8</td>
<td>18.7</td>
</tr>
<tr>
<td>Italy</td>
<td>4.0</td>
<td>9.1</td>
<td>Singapore(82)</td>
<td>4.3</td>
<td>9.6</td>
</tr>
<tr>
<td>W.German</td>
<td>4.6</td>
<td>9.2</td>
<td>Thailand(84)</td>
<td>3.9</td>
<td>21.1</td>
</tr>
<tr>
<td>Switzerland</td>
<td>4.8</td>
<td>18.6</td>
<td>Philippine(84)</td>
<td>1.3</td>
<td>7.0</td>
</tr>
<tr>
<td>U.S.S.R.(84)</td>
<td>6.8</td>
<td>10.2</td>
<td>India</td>
<td>3.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Australia</td>
<td>5.6</td>
<td>12.8</td>
<td>Brazil</td>
<td>3.3</td>
<td>17.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Chile</td>
<td>4.5</td>
<td>15.3</td>
</tr>
</tbody>
</table>

Source: *Statistical Yearbook*, UNESCO, 1988

In Table 4.1, Korea is ranked in the country group which spends a relatively large portion of GNP on public education, reflecting the traditional emphasis on education. If private educational expenditures were considered in these figures, Korea's share of educational expenditure would increase relatively more than those of many other countries. The figures in Table 4.1 show that developed countries tend to invest a larger portion of GNP in education than developing countries do.

¹ The share of private educational expenditure is not formally available and this figure is based on estimation by Kong (1985).
In Korea, the main sources for public educational expenditure consist of three different budgetary accounts: (1) Central government (the Ministry of Education) education budget (General account) - (34.7%), (2) Budget of the Provincial Boards of Education and Local School Districts in each locality (Special account) - (36.9%), (3) Private school budgets and other funds - (28.4%).

These three budgetary accounts are closely related to each other since the central government plays a critical role in deciding the structure and size of the two other budgets by means of subsidies and other administrative controls. In particular, the grants from the central government's budget compose the main revenue source in the local education budget (special account). The net amount of public educational expenditure from these three sources (excluding overlapping calculations and the costs of educational administration) was 4,659 billion in 1985, which corresponded to 6.5% of GNP.

Total public educational expenditures are composed of expenditures for public & national schools (61.4%) and for private schools (38.6% in 1985). By school level, the share of the expenditures for primary schools (K-6) takes the largest portion (34.5%) and the share of intermediate schools, high schools, and college/university is 17.9%, 18.4%, and 29.2% respectively.

Table 4.2 shows the distribution of public educational expenditure by public vs. private school and by school levels in 1985.

---

2 In Korea, the private school budget is organized by school. However, the actual scale of the budget is controlled by the central government since private schools are not allowed to set their own tuition, which is their major source of revenue. At the high school level (including university), tuition contributes over two thirds of total revenue.
Table 4.2
Distribution of Public Educational Expenditure in Korea (1985)
(million won)

<table>
<thead>
<tr>
<th>School level</th>
<th>Amount (%)</th>
<th>Public&amp;National school(%)</th>
<th>Private school(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten</td>
<td>59,978 (1.3)</td>
<td>15,233 (25.4)</td>
<td>44,745 (74.6)</td>
</tr>
<tr>
<td>Elementary school (1-6)</td>
<td>1,546,717 (33.2)</td>
<td>1,524,047 (98.5)</td>
<td>22,670 (1.5)</td>
</tr>
<tr>
<td>Intermediate school (7-9)</td>
<td>834,221 (17.9)</td>
<td>591,645 (70.9)</td>
<td>242,576 (39.1)</td>
</tr>
<tr>
<td>High school (10 - 12)</td>
<td>856,060 (18.4)</td>
<td>373,512 (43.6)</td>
<td>482,548 (56.4)</td>
</tr>
<tr>
<td>College and University</td>
<td>1,362,952 (29.2)</td>
<td>357,516 (26.2)</td>
<td>1,005,436 (73.8)</td>
</tr>
<tr>
<td>Total</td>
<td>4,659,928 (100.0)</td>
<td>2,861,953 (61.4)</td>
<td>1,797,975 (38.6)</td>
</tr>
</tbody>
</table>

Source: Statistical Yearbook of Education (1985), Ministry of Education, Korea

In Table 4.2, elementary and intermediate education (especially, elementary schooling) is mostly provided by the public school system, while the private schools dominate at the higher education levels. Since our main concern in this paper is with elementary education, we concentrate on the two educational budgets which shoulder the elementary school financing: (1) Central government’s education budget (General account), and (2) Local public education budget (Special account).

The central government education budget (general account) was 2,492 million won in 1985. This amount corresponds to 19.9% of the central government budget and 53.5% of the public educational budget (excluding overlapping calculations). Table 4.3 shows the structure of the national budget in 1985.
<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Amount</th>
<th>Composition(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Defense</td>
<td>3,825,800</td>
<td>30.5</td>
</tr>
<tr>
<td>Education</td>
<td>2,492,308</td>
<td>19.9</td>
</tr>
<tr>
<td>Economic Development</td>
<td>2,036,750</td>
<td>16.3</td>
</tr>
<tr>
<td>General Administration</td>
<td>1,209,621</td>
<td>9.7</td>
</tr>
<tr>
<td>Grants to Local Gov't</td>
<td>1,007,594</td>
<td>8.0</td>
</tr>
<tr>
<td>Social Development</td>
<td>861,784</td>
<td>6.9</td>
</tr>
<tr>
<td>Repayment of Debt</td>
<td>1,098,505</td>
<td>8.8</td>
</tr>
<tr>
<td>&amp; Others</td>
<td>12,532,362</td>
<td>100.0</td>
</tr>
</tbody>
</table>


In Table 4.3, 'Grants to Local Governments' indicates lump-sum general grants transferred to local jurisdictions. This grant composes the main revenue source in 'Local Government Budget (general account)', which supports general activities of local governments except education.³

In each local jurisdiction, public education is supported by a separate budget, 'Local Education Special Account'. The Board of Local Education, which is independent from the local government, is responsible for the provision of education in each local jurisdiction. Most of the central government education budget is transferred to each local jurisdiction's Board of Education.

The structure of the local education budget (special account) is shown in Table 4.4. On the revenue side, we can see that the 'Grants from Central Government' is the most important revenue source (75%) in local education budget. On the expenditure side, the expenditure for elementary education takes nearly half

³ The local general account is composed of each jurisdiction's own revenue sources (local tax, users' charge, etc.) and lump-sum general grant from central government. The proportion of grant from central government was 23.5% of total revenue in 1985. The proportion is higher in smaller local units where own fiscal capacities are relatively weak.
of total education expenditure. This is because, as was shown in Table 4.2, most of the elementary education in Korea is provided by the public school system. At the elementary level, the proportion of public school is 98.9% by number of schools and 98.5% by number of students.

Table 4.4
Structure of the Local Education Budget (Special Account), 1985 (million won)

<table>
<thead>
<tr>
<th>Revenue</th>
<th>Amount</th>
<th>Composition(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grants from Central Gov’t</td>
<td>2,083,373</td>
<td>75.1</td>
</tr>
<tr>
<td>Tuition &amp; Fees</td>
<td>452,571</td>
<td>16.3</td>
</tr>
<tr>
<td>Local Education Bond</td>
<td>71,614</td>
<td>2.6</td>
</tr>
<tr>
<td>Transferred Income</td>
<td>54,399</td>
<td>2.0</td>
</tr>
<tr>
<td>Miscellaneous Income</td>
<td>110,395</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,772,353</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Amount</th>
<th>Composition(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School(1-6)</td>
<td>1,290,360</td>
<td>47.5</td>
</tr>
<tr>
<td>Other School(7-12)</td>
<td>812,140</td>
<td>29.9</td>
</tr>
<tr>
<td>School &amp; Facility</td>
<td>417,385</td>
<td>15.4</td>
</tr>
<tr>
<td>Education Administration</td>
<td>81,314</td>
<td>3.0</td>
</tr>
<tr>
<td>Others</td>
<td>117,451</td>
<td>4.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,718,652</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: *Statistical Yearbook of Education* (1985), Ministry of Education, Korea

4.2 Regional Distribution of Elementary Education Expenditure

Now, we look into the regional distribution of elementary education expenditures and compare them with other major local economic indicators. In particular, we focus on the relation between per pupil expenditures for elementary education and two major local indicators, local income and the ratio of pupil in elementary school to local population; these two data are used as the income and price variable in the simulation of our six fiscal models.

Table 4.5 exhibits these data.
### Table 4.5
Regional Distribution of Elementary Education Expenditure and Major Local Indicators (1985)

<table>
<thead>
<tr>
<th>Population (A)</th>
<th>Gross Regional Product* (B)</th>
<th># of ele. pupils (C)</th>
<th>Per capita GRP Amount** (index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL 9,645,932</td>
<td>21,593,093</td>
<td>1,090,330</td>
<td>2,239 (118.8)</td>
</tr>
<tr>
<td>PS 3,516,807</td>
<td>6,753,641</td>
<td>419,589</td>
<td>1,920 (101.9)</td>
</tr>
<tr>
<td>TG 2,030,670</td>
<td>3,485,060</td>
<td>227,318</td>
<td>1,726 ( 91.1)</td>
</tr>
<tr>
<td>IN 1,387,491</td>
<td>3,119,565</td>
<td>155,498</td>
<td>2,248 (119.3)</td>
</tr>
<tr>
<td>KG 4,794,294</td>
<td>9,144,493</td>
<td>521,713</td>
<td>1,907 (101.2)</td>
</tr>
<tr>
<td>KW 1,726,048</td>
<td>2,961,225</td>
<td>228,238</td>
<td>1,716 ( 91.0)</td>
</tr>
<tr>
<td>CHB 1,391,100</td>
<td>2,375,874</td>
<td>173,048</td>
<td>1,708 ( 90.6)</td>
</tr>
<tr>
<td>CHN 3,001,572</td>
<td>4,401,775</td>
<td>383,679</td>
<td>1,466 ( 77.8)</td>
</tr>
<tr>
<td>CB 2,202,243</td>
<td>3,225,559</td>
<td>301,214</td>
<td>1,465 ( 77.7)</td>
</tr>
<tr>
<td>CN 3,748,484</td>
<td>5,473,649</td>
<td>439,432</td>
<td>1,460 ( 77.5)</td>
</tr>
<tr>
<td>KB 3,013,310</td>
<td>5,208,205</td>
<td>373,028</td>
<td>1,728 ( 91.7)</td>
</tr>
<tr>
<td>KN 3,519,160</td>
<td>7,688,977</td>
<td>428,224</td>
<td>2,184 (115.9)</td>
</tr>
<tr>
<td>JJ 489,464</td>
<td>823,890</td>
<td>61,441</td>
<td>1,683 ( 89.3)</td>
</tr>
<tr>
<td><strong>Total</strong> 40,466,557</td>
<td>76,253,194</td>
<td>4,856,752</td>
<td>1,884^ (100.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ele. pupil-pop. ratio (C/A)</th>
<th>Ele.edu. exp. (D/C)</th>
<th>Per pupil exp. (D/C)</th>
<th># Pupil Amount** (Index) per class</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL 0.1130</td>
<td>225,353</td>
<td>206.68 ( 77.8)</td>
<td>56.2</td>
</tr>
<tr>
<td>PS 0.1193</td>
<td>87,481</td>
<td>208.49 ( 78.5)</td>
<td>53.9</td>
</tr>
<tr>
<td>TG 0.1119</td>
<td>53,070</td>
<td>233.46 ( 87.9)</td>
<td>55.1</td>
</tr>
<tr>
<td>IN 0.1121</td>
<td>33,626</td>
<td>216.25 ( 81.4)</td>
<td>56.2</td>
</tr>
<tr>
<td>KG 0.1088</td>
<td>123,322</td>
<td>236.38 ( 89.0)</td>
<td>46.1</td>
</tr>
<tr>
<td>KW 0.1322</td>
<td>77,317</td>
<td>338.75 (127.5)</td>
<td>34.9</td>
</tr>
<tr>
<td>CHB 0.1244</td>
<td>57,491</td>
<td>332.23 (125.0)</td>
<td>38.0</td>
</tr>
<tr>
<td>CHN 0.1278</td>
<td>109,996</td>
<td>286.69 (107.9)</td>
<td>41.4</td>
</tr>
<tr>
<td>CB 0.1368</td>
<td>97,142</td>
<td>322.50 (121.4)</td>
<td>39.4</td>
</tr>
<tr>
<td>CN 0.1316</td>
<td>159,451</td>
<td>323.15 (121.6)</td>
<td>38.3</td>
</tr>
<tr>
<td>KB 0.1238</td>
<td>124,519</td>
<td>333.81 (125.6)</td>
<td>36.5</td>
</tr>
<tr>
<td>KN 0.1217</td>
<td>124,620</td>
<td>291.02 (109.5)</td>
<td>40.0</td>
</tr>
<tr>
<td>JJ 0.1255</td>
<td>16,971</td>
<td>276.23 (104.0)</td>
<td>41.2</td>
</tr>
<tr>
<td><strong>Average</strong> 0.1200</td>
<td>1,290,360^#</td>
<td>265.68 (100.0)</td>
<td>44.7</td>
</tr>
</tbody>
</table>

*Million won **Thousand won ^Average "Total
Source: *Statistical Yearbook of Education* (1985), Ministry of Education, Korea
In 1985, the primary administrative units of Korea were composed of one special jurisdictional city (Seoul), three direct jurisdictional cities (Pusan, Taegu, Inchon), and nine local provinces (Kyunggi, Kwangwon, etc.). As sub-administrative units there were 46 cities and 139 sub-provinces named 'Kun'. Among these local units, our simulation will be performed with the data from 13 primary local jurisdictions as the local data (especially local income data) are available only for the 13 primary administrative units.

In Table 4.5, two relationships are evident. First, relatively wealthy (poor) jurisdictions tend to have low (high) elementary pupil-local population ratios. Among the five local jurisdictions where local income is above average (SL, PS, IN, KG, KN), four jurisdictions (except KN) have elementary pupil ratios below national average. Second, the distribution of elementary education expenditure (per pupil) is inversely related to the distribution of local income (per capita). Among the five local jurisdictions which have below average per pupil education expenditure (SL, PS, TG, IN, KG - all of them are urbanized areas), four jurisdictions (except TG) turn out to have above average per capita income.

This relationship shows that high (low) income jurisdictions tend to have low (high) student-population ratios as well as low (high) per pupil expenditure for elementary education. This implies that the underlying criterion for the distribution of educational expenditure is far from the equalization of local educational expenditure per pupil. In fact, the school operating budget has been distributed by
the school or class unit instead of per pupil measures.\textsuperscript{4}

Considering the general tendency that urban families (who are also relatively wealthy) tend to incur more private educational expenditure than those in rural areas, the current distribution of education expenditure may be more reasonable from the output point of view. Nevertheless, as already mentioned in chapter 3, we use public inputs as the proxy of education output in our models since the education output production procedure is very complicated and the factors affecting this procedure are not easily quantified.

However, if we can set up any standard, considering the potential capabilities for residents' private educational expenditures, for educational expenditures in each local jurisdiction, the target level of per pupil education expenditure (which was set to the national average of decentralized provision level in chapter 3 can be easily adjusted to this new standard within the framework of our simulation models.

\textsuperscript{4} In 1984, the basic rate of school operating cost in elementary school was set to 3,800 thousand won per school and 420 thousand won per class.
CHAPTER V
SIMULATION RESULTS

In this chapter, we compare the six fiscal models using the Korean regional income and population data. In this comparative institutional study, we employ simulation techniques (rather than comparative static analysis) since we can focus on any parameters which are potentially related to our analytical purpose.

By and large, our simulation results are divided into two parts: the central tax rate (as a main indicator for relative scale of financial cost required in each policy), and the social welfare index (as the main criterion for policy priority ranking). These variables are simulated with respect to various values of the following four parameters which are chosen based on the fundamental considerations in local public service provision: (1) income and price elasticities of the demand for education (β, α), (2) parameter for the welfare cost of distortionary taxation (λ), (3) share of educational expenditure from total income (b), and (4) inequality-aversion parameter in the Atkinson welfare function (σ).

5.1 The Endogenous Central Tax Rate - Degree of Decentralization

In our alternative fiscal models, since the central government is incorporated as an endogenous grantor subject to the full-financing constraint, the central tax rate indicates the scale of the equalizing grant that is minimally required to attain the stipulated level of categorical equity in the provision of elementary education.
Especially in the four equalizing grant-in-aid schemes, the central tax rate is
determined by the relative stimulative effect of each grant-in-aid policy.

The main question addressed in this section is whether there are any
systematic relations between demand elasticities (price and income) and the central
tax rate.\(^1\) We also test the traditional proposition concerning the stimulative effects
of matching and lump-sum grants within the framework of our models.

In each fiscal scheme, we derive the central tax rate from the central
government’s full-financing condition which is supposed to satisfy the target level of
education in each jurisdiction. In our models in chapter 3, the target level of
education expenditure was assumed to be the national average of local education
expenditures which are chosen in the perfectly decentralized fiscal system, i.e., \(G = \sum G_i/k\), where \(G_i = A(N_i^{\delta-1})^{\theta_i} G_i^{\beta}\). (Hence, the target level of expenditure is also
changed if the income and price elasticities are differently specified.) Throughout
this chapter, all the simulation results are based on the presumed target level, \(G\).

However, the simulation results are subject to change according to the target
level specified. As the target level of education set by a policy maker varies, the
absolute level of central tax rate as well as local utility indexes (and also the social
welfare indexes) will change. Other things being equal, as \(G\) increases, the central
tax rate also increases, but the absolute level of local utility and social welfare
indexes tend to decrease.\(^2\) However, the structure of both the central tax rate and

---

\(^1\) The other three system parameters \((b, \lambda, \sigma)\) are not directly related to the determination of the
central tax rate but to the determination of policy priority rankings.

\(^2\) This is because the higher the target level of education expenditure, the smaller the budget for
private consumption expenditure. As will be explained in the next section, in our Cobb-Douglas local
utility function, \(U_j = BX_j^a G_j^b\), where \(a\) and \(b\) represents the share of \(X_j\) and \(G_j\) from total income, \(a\)
and \(b\) are specified to be 0.95 and 0.05 based on the real data of elementary education expenditure in
the policy ranking structure are unaffected by the changes in the target expenditure level.

Table 5.1 presents endogenous central tax rates for each fiscal policy under nine alternative combinations of income and price elasticities. In this table, the value of A in the education demand function is assumed to be 0.05.3

<table>
<thead>
<tr>
<th></th>
<th>$\beta$=0.5</th>
<th>$\beta$=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>-0.5</td>
<td>-1.3</td>
</tr>
<tr>
<td>PC</td>
<td>$3.976*10^{-4}$</td>
<td>0.001</td>
</tr>
<tr>
<td>F</td>
<td>$1.518*10^{-5}$</td>
<td>$5.7*10^{-5}$</td>
</tr>
<tr>
<td>GL</td>
<td>0.204</td>
<td>0.255</td>
</tr>
<tr>
<td>M</td>
<td>$8.049*10^{-5}$</td>
<td>$1.643*10^{-4}$</td>
</tr>
<tr>
<td>SL</td>
<td>$4.66*10^{-5}$</td>
<td>$1.643*10^{-4}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta$=1</th>
<th>$\beta$=1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PC</td>
<td>0.050</td>
<td>0.095</td>
</tr>
<tr>
<td>F</td>
<td>$3.735*10^{-3}$</td>
<td>$7.79*10^{-3}$</td>
</tr>
<tr>
<td>GL</td>
<td>0.206</td>
<td>0.222</td>
</tr>
<tr>
<td>M</td>
<td>0.010</td>
<td>0.017</td>
</tr>
<tr>
<td>SL</td>
<td>0.010</td>
<td>0.021</td>
</tr>
</tbody>
</table>

PC: Perfect Central System  F: Foundation Aid Plan  GL: Lump-sum General Grant  M: Matching Grant  SL: Central Compensation with Lump-sum Specific Grant

Note: The perfect decentralized fiscal scheme (PD) is not included in this table since the central tax rate is always zero.

Korea. Under this given share of expenditure for education, social welfare indexes will decrease as the target level G increases. For more details, refer section 5.2.1

3 The value of A affects the absolute scale of elementary education expenditure. The larger the value of A, the larger the value of G and the smaller the value of X. It also affects the central tax rate proportionately. For example, under $A=0.01$ the central tax rate is one fifth of that under $A=0.05$.

In this calculation, ($A=0.05$) is selected so that the central tax rates in each fiscal scheme can be placed within the range of 0 to 1 (See Table 5.1). Later in this chapter (5.4), this value will be adjusted so that the target educational expenditure can be equal to the current average level of per pupil education expenditure in Korea, 265,680 won/year.
In Table 5.1, the central tax rate turns out to be increasing as income and price elasticities (absolute value) increase, except for the lump-sum general grant-in-aid policy. Furthermore, the tax rate increases much more rapidly when the income elasticity increases than when the price elasticity increases. This means that when a local public service is more income and price elastic, horizontal inequalities of the service tend to widen and additional efforts are required to reduce the inequalities. It is also shown that the lump-sum general grant scheme (GL) requires the highest central tax rate in most cases, while the foundation plan requires the lowest intervention rate.

These results come from the simulation based on the real income and price data of Korea, which are characterized by the inverse relation between them, i.e., wealthy (poor) jurisdictions generally have a lower (higher) price variable (= student-population ratio). Therefore, the price effect differs across local jurisdictions. To measure the changes in the central tax rates more accurately, we standardize the local price effects by using a constant price variable. Table 5.2 shows the revised central tax rates calculated under a constant price variable, $N^*=0.2$.

The primary distinction of Table 5.2 from Table 5.1 is that the central tax rate under the lump-sum general grant-in-aid policy is always constant regardless of the income and price elasticities. Other relationships are almost the same as in Table 5.1.
Table 5.2
The Revised Central Tax Rate
(Constant student-population ratio, N^s-1 = 0.2)

<table>
<thead>
<tr>
<th></th>
<th>(\alpha )</th>
<th>(-0.5)</th>
<th>(-1)</th>
<th>(-1.3)</th>
<th>(-0.5)</th>
<th>(-1)</th>
<th>(-1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>5.135 \times 10^{-4}</td>
<td>0.001</td>
<td>0.002</td>
<td>0.022</td>
<td>0.135 \times 10^{-4}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>1.305 \times 10^{-5}</td>
<td>2.919 \times 10^{-5}</td>
<td>4.732 \times 10^{-4}</td>
<td>1.119 \times 10^{-3}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>8.134 \times 10^{-5}</td>
<td>9.82 \times 10^{-5}</td>
<td>1.247 \times 10^{-4}</td>
<td>0.006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>4.392 \times 10^{-5}</td>
<td>9.82 \times 10^{-5}</td>
<td>1.592 \times 10^{-4}</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(\beta = 0.5)</th>
<th>(-1)</th>
<th>(-1.3)</th>
<th>(-0.5)</th>
<th>(-1)</th>
<th>(-1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.05</td>
<td>0.081</td>
<td>0.216</td>
<td>0.483</td>
<td>0.782</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>2.529 \times 10^{-3}</td>
<td>4.148 \times 10^{-3}</td>
<td>0.015</td>
<td>0.039</td>
<td>0.087</td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.008</td>
<td>0.01</td>
<td>0.068</td>
<td>0.092</td>
<td>0.120</td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>0.008</td>
<td>0.013</td>
<td>0.041</td>
<td>0.092</td>
<td>0.149</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.1 and Figure 5.2 present the effects of price and income elasticities on the relative scale of the central tax rate in each policy scheme. In Figure 5.1, the locus of the central tax rate is displayed with respect to consecutive changes of price elasticities under three representative income elasticities (\(\beta = 0.5, 1, 1.3\)).

Figure 5.2 displays the locus of the central tax rate with respect to consecutive values of income elasticities under three different price elasticities (\(\alpha = -0.5, -1, -1.3\)).

---

4 The calculated values of the central tax rates are listed in Appendix A.

5 We choose 1.3 rather than 1.5 to avoid negative values in private consumption expenditure under \(\beta = 1.5\).
1. Income Elasticity = 0.5

Figure 5.1 The Central Tax Rate - 1
1. Price Elasticity = -0.5

2. Price Elasticity = -1

3. Price Elasticity = -1.3

Figure 5.2 The Central Tax Rate - 2
The results from these tables and figures are generally consistent with standard economic theories and can be summarized as follows.

**Result 1:** The income and price elasticities of a local public service are important in determining the degree of equalizing intervention. The central tax rate increases as the income and price elasticities (absolute value) increase. The lump-sum general grant-in-aid scheme is the exception.

More specifically, as a local public service is more income and price elastic, the horizontal inequalities of the service tend to increase and additional efforts are needed to reduce these inequalities.

**Result 2:** The income elasticity is more important than the price elasticity in determining the central tax rate for each fiscal scheme. The relative importance of the income elasticity becomes more apparent as the price variables are given smaller values and the income variables are given larger numbers.

**Result 3:** The lump-sum general grant scheme generally requires a high central tax rate since a large portion of the grant tends to leak out to private consumption. With a constant price variable, the central tax rate is always constant regardless of the magnitude of income and price elasticities.
**Result 4:** Among the alternative fiscal schemes, the foundation aid plan requires the lowest intervention rate. This is because the foundation aid is a lump-sum specific grant program targeting only a partial equalization of the service over the minimum provision level.

**Result 5:** The central tax rate in the matching grant policy \(t^M\) appears always to be less than that in the lump-sum general grant-in-aid policy \(t^{GL}\), i.e., matching grants are always more stimulative than lump-sum grants. This is because the grantee's spending is stimulated more by the matching grant than by the lump-sum general grant; this is the core proposition of traditional grant-in-aid theory. The stimulative effect tends to increase as the income and price elasticities become less elastic.

**Result 6:** The central tax rate in the matching grant scheme \(M\) appears to be greater than/ equal to/ lower than that in the lump-sum specific grant program \(SL\) as the price elasticity is less than/ equal to/ greater than 1. In other words, if a public service is price inelastic/ unit elastic/ elastic, the local spending stimulated by a matching grant is lower/ equal to/ greater than the amount of lump-sum direct transfers to the service.\(^6\)

---

\(^6\) This result is consistent with the empirical result of (A) which is summarized in section 2.2.1.
Result 6 is illustrated in the following figure.

![Diagram](image)

- The location of the price consumption curve (PCC) is determined by the price elasticity of the service. If the demand is price inelastic (elastic), PCC will pass through the points above (below) D.

**Figure 5.3** Stimulative Effects of Matching Grants

In Figure 5.3, the original equilibrium is at \( (X_o, G_o) \). Under a unit price elasticity, the matching grant stimulates CD of local public service spending which is equal to the amount of the lump-sum direct transfer. Under an inelastic price elasticity, since part of the matching grant leaks out to private consumption, the stimulated local spending is less than CD.

### 5.2 Policy Priority Rankings among Alternative Fiscal Schemes

In this section, we examine the policy priority rankings under nine combinations of income and price elasticities and three alternative evaluating criteria.\(^7\).

First, we look for general characteristics and trends of the relative priority

\(^7\)Therefore, twenty seven cases are compared in total.
rankings in various cases of income and price elasticities. Next, we consider two additional factors that may affect the policy priority rankings: the share of education expenditure and the welfare costs from the central taxation.

5.2.1 General Trends

As in the previous simulation for the central tax rate, the social welfare indexes are simulated with respect to three representative values of income and price elasticities (absolute value) each, 0.5, 1, and 1.3. The alternative equity considerations are represented by the three alternative values of the inequality-aversion parameter in the Atkinson social welfare function: $\sigma = 1$ (Utilitarian), $\sigma = -1$ (Nash), and $\sigma = -9$ (Rawlsian criterion).\(^8\)

$$W = \left(\sum U_i^\sigma\right)^{1/\sigma}, \quad \sigma \leq 1$$

$$U_i = U (X_i, G_i)$$

$$i = 1, 2, \ldots, 13$$

To derive social welfare indexes from the above relation, a particular utility function ($U_i$) needs to be specified as a common translator from the commodity to the utility dimension. For this, we assume a Cobb-Douglas utility function, $U_i = BX_i^aG_i^b$, where $a$ and $b$ represents the weights of $X_i$ and $G_i$ in total income. In our model $b$ represents the share of elementary education expenditure (per capita) from local residential income in each jurisdiction, $b = N_i \delta - G_i/I_i$.

---

\(^8\) The Atkinson welfare function converges to the Rawlsian criterion when $\sigma = -\infty$. However, $\sigma = -9$ is enough to represent the policy rankings under Rawlsian criterion. Originally, I simulated the models with respect to five cases of social welfare functions ($\sigma = 1, -1, -3, -5, -9$). However, there were few changes of policy rankings within the ranges of $\sigma$ from -3 to -9.
In Korea, the total expenditure for Korean elementary education was estimated to be about 4.4 percent of GNP (1985) as can be seen in Table 5.3.

<table>
<thead>
<tr>
<th>Public Exp.(A)</th>
<th>Private Exp.(B)</th>
<th>GNP(C)</th>
<th>(A/C)</th>
<th>(B/C)</th>
<th>(A+B)/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.547</td>
<td>1.578</td>
<td>71,262</td>
<td>2.17</td>
<td>2.21</td>
<td>4.38</td>
</tr>
</tbody>
</table>

Source: Statistical Yearbook of Education (1986), Ministry of Education
Educational Investment and Rate of Return to Education, Kong, E.B. et al., Korea Institute of Education, 1985

Following these data, we simulate the six models using the linearly homogeneous Cobb-Douglas utility function with \( a=0.95 \) and \( b=0.05 \), i.e., \( U_i = BX_i^{0.95}G_i^{0.05} \). Table 5.4 presents the policy priority rankings of six policies for twenty seven cases; this is the benchmark case of policy priority rankings. The detailed values of social welfare indexes are presented in Appendix B.

According to Table 5.4, the four equalizing grant-in-aid schemes are generally preferred to the two extreme fiscal schemes, the perfectly decentralized provision system (PD) and the perfectly centralized scheme (PC). Among the four grant-in-aid policies, the lump-sum general grant-in-aid scheme (GL) has the highest ranking and the rankings of the other three policies change according to changes in income and price elasticities.
Table 5.4
Policy Rankings under Alternative Welfare Criteria
\((B=0.01 \ a=0.95 \ b=0.05, \ U_i = BX_i^aG_i^b)\)

1. Under Utilitarian Criterion \((\sigma=1)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>PC</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>SL</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

PD: Perfectly Decentralized Fiscal System

2. Under Nash Criterion \((\sigma=-1)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SL</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

3. Under Rawlsian Criterion \((\sigma=-9)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SL</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The main characteristics from the policy ranking tables can be summarized as follows.

**Result 7:** Under the efficiency-oriented welfare criterion ($\sigma=1$, Utilitarian), the perfectly decentralized system (PD) is always preferred to the perfectly centralized provision system (PC). This relation is reversed under the equity-oriented criterion ($\sigma=-9$, Rawlsian).

**Result 8:** The matching grant scheme (M) is always more/ equally/ less preferred to the lump-sum specific grant scheme (SL) if the price elasticity (absolute value) is less than/ equal to/ greater than 1.\(^9\)

**Result 9:** Neither the perfectly decentralized (PD) nor the perfectly centralized provision policy (PC) is highly preferred. The four equalizing grant-in-aid schemes are more desirable for the provision of elementary education in Korea.

**Result 10:** The lump-sum general grant-in-aid scheme (GL) has the highest social welfare index in most cases. The foundation aid plan (F), which requires the least intervention rate, is generally preferred in the

---

\(^9\) This is because, by Result 6, part of the matching grants leak out to private consumption expenditures ($X$) under inelastic price elasticities. However, the expenditure for private consumption takes a far higher weight ($a=0.95$) than the education expenditure ($G$) in the local utility function. Therefore, the local utility index under the matching grant scheme tends to be higher than that under the lump-sum specific transfer program, and the ranking is reversed if the price elasticity is elastic.
ranges of lower income elasticities, i.e., in the ranges with a lower central tax rate. By contrast, the matching (M) and the lump-sum specific grant scheme (SL) are more preferred as income and price elasticities increase.

5.2.2 Further Considerations in the Determination of Policy Priority Rankings

In this section, we examine the policy priority rankings considering two additional factors: share of education expenditure and welfare cost of distortionary taxation.

5.2.2.1 Policy Rankings under Alternative Shares of Elementary Education

Expenditure

In this section we check whether there are any substantial changes in policy rankings as the share of educational expenditure in total income changes. To determine this, two alternative cases are examined: (1) a=0.99 and b=0.01 for the case of the lower b; (2) a=0.90 and b=0.10 for the larger b case. Details of the social welfare indexes are given in Appendix C.

Table 5.5 shows the new policy rankings when b is 0.01 (a=0.99). In Table 5.5, although there are some changes in the policy rankings as b declines, most rankings are unaffected and the four major results (Result 7 - 10) still hold.

Table 5.6 shows the policy rankings when b is assumed to be 0.1 (a=0.9). The general trends in policy rankings are almost the same as when b=0.05 and the four main results are also unaffected.
Table 5.5

Policy Rankings under Alternative Welfare Criteria
\( (B=0.01 \ a=0.99 \ b=0.01, \ U_i = B X_i G_i^b) \)

(1) Under Utilitarian Criterion \((\sigma=1)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(-0.5)</td>
<td>(-1)</td>
<td>(-1.3)</td>
</tr>
<tr>
<td>PD</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PC</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SL</td>
<td>5(6)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

* Numbers in the parenthesis are policy rankings when \(b=0.05\)

(2) Under Nash Criterion \((\sigma=-1)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(-0.5)</td>
<td>(-1)</td>
<td>(-1.3)</td>
</tr>
<tr>
<td>PD</td>
<td>3(6)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
<tr>
<td>SL</td>
<td>3</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
</tbody>
</table>

(3) Under Rawlsian Criterion \((\sigma=-0.9)\)

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta=0.5)</th>
<th>(\beta=1)</th>
<th>(\beta=1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(-0.5)</td>
<td>(-1)</td>
<td>(-1.3)</td>
</tr>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>PC</td>
<td>2(3)</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>3(2)</td>
<td>4(2)</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>2(3)</td>
<td>3</td>
<td>4(5)</td>
</tr>
<tr>
<td>SL</td>
<td>5</td>
<td>3</td>
<td>3(4)</td>
</tr>
</tbody>
</table>
Table 5.6

Policy Rankings under Alternative Welfare Criteria
(B=0.01  a=0.90  b=0.10,  \( U_i = BX_i^aG_i^b \))

(1) Under Utilitarian Criterion (\( \sigma=1 \))

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \beta=0.5 )</th>
<th>( \beta=1 )</th>
<th>( \beta=1.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PC</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SL</td>
<td>5(6)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

(2) Under Nash Criterion (\( \sigma=-1 \))

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \beta=0.5 )</th>
<th>( \beta=1 )</th>
<th>( \beta=1.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>5(3)</td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>3</td>
<td>5(3)</td>
</tr>
<tr>
<td>SL</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

(3) Under Rawlsian Criterion (\( \sigma=-9 \))

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>( \beta=0.5 )</th>
<th>( \beta=1 )</th>
<th>( \beta=1.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>5(3)</td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>SL</td>
<td>3(5)</td>
<td>3</td>
<td>3(4)</td>
</tr>
</tbody>
</table>
The result from Table 5.5 and 5.6 is summarized as follows.

**Result 11:** *Alternative shares of educational expenditure do not produce any substantial impact on the structure of policy priority rankings among the six fiscal schemes.*

5.2.2.2 Policy Rankings under Alternative Parameters for Tax Distortion

All taxes affect economic behavior. No matter what the taxes are, an increase in taxes always makes people worse off through reduced consumption of commodities, less leisure, and more working, so on. To minimize the welfare losses from taxation, individuals adjust their behavior and these adjustments result in distortions. The social cost from distortionary taxation is called ‘welfare cost’ or ‘excess burden’.

In economies of local public sector, taxation tends to produce distortionary effects for two reasons. First, since the central tax is designed to be imposed proportionately upon individual income, individuals may have less incentive to work and will substitute leisure for consumption goods; this is the substitution effect of income taxation. Second, as already mentioned in section 2.2, additional costs stem from the mobility of individuals. More specifically, differences in the fiscal residuum (i.e., grants received - taxes paid) among local jurisdictions may cause migration of residents from jurisdictions with low (or even negative) fiscal residuum to jurisdictions with high fiscal residuum. This migration, however, is unproductive from the social point of view.
In our models, the migration cost is not explicitly included since we assumed no Tieboutian migration among local jurisdictions. Therefore, the main concern of this paper lies in how to incorporate these welfare costs into our frameworks rather than in their actual size and measurement of these welfare costs, which is beyond the scope of this paper.

We incorporate the welfare cost of central taxation in the value of private consumption expenditures \((X)\) because educational expenditure \((G)\) is the main target to be equalized by each fiscal policy. In the fiscal models in chapter 3, the private consumption \((X)\) is derived as follows:

\[
X = \text{net income (after central taxation)} - \text{education expenditure (per capita)} + \text{surplus return from the central government's full-financing constraint}
\]

To consider additional welfare costs from central taxation, we use a tax distortion parameter, \(\lambda\), expressed as \(t(1 + \lambda)\). With this device, we can represent the welfare costs as a certain proportion of the central taxation imposed. With this revised central tax rate, \(t(1 + \lambda)\), new formulas for private consumption expenditure are expressed as follows:

\[
\begin{align*}
\text{PD:} & \quad X^\text{D} = I_i - N_i^{\delta-1}G^\text{D}_i \\
\text{PC:} & \quad X^\text{C} = I_i\{1 - t^F(1+\lambda)\} \\
\text{F:} & \quad X^F = I_i\{1-t^F(1+\lambda)\} - G_iN_i^{\delta-1} \\
\text{GL:} & \quad X^\text{GL} = I_i\{1-t^\text{GL}(1+\lambda)\} + Z_i/N_i - N_i^{\delta-1}G + I_iS/\Sigma N_iI_i \\
\text{M:} & \quad X^\text{M} = I_i\{1-t^\text{M}(1+\lambda)\} - (1-m_i)N_i^{\delta-1}G + I_iS/\Sigma N_iI_i \\
\text{SL:} & \quad X^\text{SL} = I_i\{1-t^\text{SL}(1+\lambda)\} - (N_i^{\delta-1})G_i + I_iS/\Sigma N_iI_i
\end{align*}
\]

\(^{10}\) This type of consideration for the welfare costs from distortionary taxation is also found in Laffont and Tirole (1987).
In the formulas above, it is generally expected that the higher the tax distortion parameter ($\lambda$), the lower the value of private consumption expenditure ($X$) and the lower the level of local utility indexes ($U_l$). With the inclusion of $\lambda$ in our model, relative policy priority rankings are also expected to change. In general, fiscal schemes with a relatively low (high) tax rate will be more (less) preferred than before.

Using these new formulas for private consumption ($X$), we simulate the six fiscal schemes with respect to five alternative values of tax distortion parameters which range from 0.1 to 0.5 with intervals of 0.1. The following tables (5.7 - 5.9) display the policy rankings under three representative values of the tax distortion parameters: $\lambda = 0.2$, 0.3, and 0.5.

The tables show that consideration of the welfare costs of central taxation brings forth systematic changes in the policy rankings as $\lambda$ increases. At lower values of $\lambda$, the general structure of the policy ranking is maintained except for a few minor changes in the relative rankings of the PD and the PC plans. The four equalizing grant-in-aid schemes generally take high rankings, while the PD and the PC plans still retain low rankings.

However, as $\lambda$ increases beyond 0.3, the policy priorities are totally changed. The most preferred fiscal scheme (GL) in the original rankings falls to the lowest ranking and the fiscal schemes with a relatively low central tax rate (especially, the foundation aid scheme) improve their rankings. Other relations continue to hold regardless of the size of $\lambda$; the PD is always preferred to the PC under Utilitarian criterion, while the PC is always preferred to the PD under Rawlsian criterion.
Table 5.7
Policy Rankings under Alternative Parameters of Tax Distortion
\((\lambda = 0.2, \ U_1 = 0.01X_t^{0.95}G_t^{0.05})\)

(1) Under Utilitarian Criterion (\(\sigma = 1\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>3</td>
<td>3</td>
<td>3(5)</td>
</tr>
<tr>
<td>PC</td>
<td>6(5)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>5(6)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>SL</td>
<td>5(6)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

* Numbers in the parenthesis are policy rankings when \(\lambda = 0\)

(2) Under Nash Criterion (\(\sigma = -1\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>5(6)</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>5(3)</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SL</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

(3) Under Rawlsian Criterion (\(\sigma = -9\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>6</td>
<td>6</td>
<td>5(6)</td>
</tr>
<tr>
<td>PC</td>
<td>3</td>
<td>5(3)</td>
<td>4(3)</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>2</td>
<td>1(2)</td>
</tr>
<tr>
<td>GL</td>
<td>1</td>
<td>1</td>
<td>6(1)</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
<td>3</td>
<td>2(5)</td>
</tr>
<tr>
<td>SL</td>
<td>3(5)</td>
<td>3</td>
<td>2(4)</td>
</tr>
</tbody>
</table>
### Table 5.8

Policy Rankings under Alternative Parameters of Tax Distortion

\((\lambda = 0.3, \ U_i = 0.01X_i^{0.95}G_i^{0.05})\)

(1) Under Utilitarian Criterion (\(\sigma = 1\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>2 (3)</td>
<td>2 (5)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>PC</td>
<td>5 (6)</td>
<td>5 (6)</td>
<td>6 (5)</td>
</tr>
<tr>
<td>F</td>
<td>1 (2)</td>
<td>1 (2)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>GL</td>
<td>6 (1)</td>
<td>6 (1)</td>
<td>5 (1)</td>
</tr>
<tr>
<td>M</td>
<td>3 (4)</td>
<td>3 (2)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>3 (6)</td>
<td>3 (4)</td>
<td>2 (3)</td>
</tr>
</tbody>
</table>

(2) Under Nash Criterion (\(\sigma = -1\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>5 (6)</td>
<td>5 (6)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>PC</td>
<td>2 (3)</td>
<td>6 (4)</td>
<td>6 (4)</td>
</tr>
<tr>
<td>F</td>
<td>1 (2)</td>
<td>2 (3)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>GL</td>
<td>6 (1)</td>
<td>1 (2)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>M</td>
<td>2 (3)</td>
<td>3 (2)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>2 (3)</td>
<td>3 (2)</td>
<td>2 (3)</td>
</tr>
</tbody>
</table>

(3) Under Rawlsian Criterion (\(\sigma = 0.9\))

<table>
<thead>
<tr>
<th>(\alpha)</th>
<th>(\beta = 0.5)</th>
<th>(\beta = 1)</th>
<th>(\beta = 1.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>6 (5)</td>
<td>5 (6)</td>
<td>5 (6)</td>
</tr>
<tr>
<td>PC</td>
<td>5 (3)</td>
<td>5 (4)</td>
<td>6 (4)</td>
</tr>
<tr>
<td>F</td>
<td>2 (1)</td>
<td>4 (5)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>GL</td>
<td>1 (6)</td>
<td>1 (2)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>M</td>
<td>3 (2)</td>
<td>2 (3)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>3 (5)</td>
<td>2 (3)</td>
<td>3 (2)</td>
</tr>
</tbody>
</table>
Table 5.9  
Policy Rankings under Alternative Parameters for Tax Distortion  
($\lambda = 0.5, \ U_i = 0.01X_i^{0.95}G_i^{0.05}$)

(1) Under Utilitarian Criterion ($\sigma = 1$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>2(3)</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
<tr>
<td>PC</td>
<td>5</td>
<td>5(6)</td>
<td>5(6)</td>
</tr>
<tr>
<td>F</td>
<td>1(2)</td>
<td>1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td>GL</td>
<td>6(1)</td>
<td>6(1)</td>
<td>6(1)</td>
</tr>
<tr>
<td>M</td>
<td>3(4)</td>
<td>3(4)</td>
<td>4(5)</td>
</tr>
<tr>
<td>SL</td>
<td>3(6)</td>
<td>3(4)</td>
<td>3(4)</td>
</tr>
</tbody>
</table>

(2) Under Nash Criterion ($\sigma = -1$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>5(6)</td>
<td>4(6)</td>
<td>4(6)</td>
</tr>
<tr>
<td>PC</td>
<td>2(3)</td>
<td>4(3)</td>
<td>4(3)</td>
</tr>
<tr>
<td>F</td>
<td>1(2)</td>
<td>1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td>GL</td>
<td>6(1)</td>
<td>6(1)</td>
<td>6(1)</td>
</tr>
<tr>
<td>M</td>
<td>2(3)</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
<tr>
<td>SL</td>
<td>2(3)</td>
<td>2(3)</td>
<td>2(3)</td>
</tr>
</tbody>
</table>

(3) Under Rawlsian Criterion ($\sigma = -9$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
</tr>
<tr>
<td>PD</td>
<td>5(6)</td>
<td>5(6)</td>
<td>5(6)</td>
</tr>
<tr>
<td>PC</td>
<td>4(3)</td>
<td>4(3)</td>
<td>4(3)</td>
</tr>
<tr>
<td>F</td>
<td>1(2)</td>
<td>1(2)</td>
<td>1(2)</td>
</tr>
<tr>
<td>GL</td>
<td>6(1)</td>
<td>6(1)</td>
<td>6(1)</td>
</tr>
<tr>
<td>M</td>
<td>2(3)</td>
<td>2(3)</td>
<td>2(5)</td>
</tr>
<tr>
<td>SL</td>
<td>2(5)</td>
<td>2(3)</td>
<td>2(4)</td>
</tr>
</tbody>
</table>
However, Result 8 (relative preference between the policy M and SL) no longer holds. In our benchmark case (Table 5.4), when price elasticities are inelastic, the matching grant-in-aid scheme (M) is always more preferred to the lump-sum specific grant-in-aid scheme (SL) with a relatively low central tax rate. However, once the additional welfare costs are considered, this relation is disturbed by welfare costs of policy which are expressed as additional deductions from the value of private consumption expenditure (X).

In Table 5.9 (where $\lambda = 0.5$), relative rankings between the M and the SL are reversed against the original ranking. The main changes prompted by the tax distortion parameter can be summarized as follows.

**Result 12:** The incorporation of welfare costs from central taxation results in substantial changes in the policy priority rankings among fiscal schemes.

Fiscal schemes that have a low tax rate (especially, the foundation aid plan) are more preferred than before, while fiscal schemes with a relatively high tax rate (e.g. the lump-sum general grant-in-aid scheme) are less preferred. This phenomenon is more apparent as income and price elasticities increase.

However, since the final policy rankings depend greatly on the size of the tax distortion parameter ($\lambda$), the importance of $\lambda$ depends on the actual degree of distortion measured in a particular economy.
5.3 The Demand for Local Public Education

According to the simulation results above, there were no major changes in policy rankings by alternative values of share of educational expenditure (b) and inequality-aversion parameter (\(a\)). Major changes result from the changes in income and price elasticities and the tax distortion parameters (especially over high values).

However, since the welfare costs of distortionary taxation are not easily measurable, our primary concern is on the income and price elasticity of demand. In particular, income elasticity turns out to be the most critical parameter for the determination of the central tax rate and policy priority rankings in our simulation. In this section, we estimate the income elasticity of Korean education demand, following a brief review of existing empirical estimation studies.

5.3.1 Empirical Studies on the Estimation of Income and Price Elasticity

In the empirical studies of traditional local public finance, the main concern was on cross-sectional variations of per capita public spending and various socio-economic and demographic factors determining them. The models in early studies are no more than an ad hoc collection of variables that seem to work; there is no theoretical basis for fiscal choice and no hypothesis to be tested.

One of the most plausible dangers in such studies is that key variables may be omitted. If the included variables are correlated with omitted variables, the estimated coefficients may be biased. This problem can be avoided by formally modelling the budgetary process, generating hypotheses about model specification
and variable effects, and then testing the effects econometrically.

The median voter model emerged as a methodological framework for the analysis of local fiscal behavior. As already reviewed in chapter 2, this model views the process of local fiscal choice as an 'as if' preference maximization subject to a budget constraint. The typical median voter model for local fiscal choice was already introduced in chapter 2.

In the empirical studies using the median voter model, the main parameters to be estimated are the demand elasticities for a service with respect to the median voter's income and his tax-price. The tax-price term was introduced by the median voter model; it is supposed to represent the median voter's share of total costs in providing a particular local public service. The most common form of price variable in previous estimations was the median voter's share of the local property tax base. Several different forms of the price variable are summarized in Table 5.10 along with results of the estimation.

Bradford and Oates (1974), using the Cobb-Douglas demand equation, estimate income and price elasticities for local education expenditure (per pupil) with the data of 53 school districts in New Jersey. The income and price elasticities are estimated to be 0.65 and -0.36 respectively. In their equation the pupil-population ratio \((N_s/N)\) is specified as the price variable.

Feldstein (1975) estimates the demand elasticity of local public education with data from 105 towns in Massachusetts. In his estimation, the price of local public education expenditure was chosen as the local share of school financing, 1-\(m\), where \(m\) is the matching rate. His results show a relatively high price elasticity \((-0.940\) to \(-1.599\)) and low of income elasticity \((0.152\) to \(0.639\)).
In Peterson (1975), income and price elasticities of education are estimated with data from five different areas: California (138 school districts), Michigan (187 school districts), New Jersey (270 school districts), New York (196 school districts), and Kansas City SMSA (38 school districts). He uses the ratio of the median voter's property tax base (H) to per pupil property value (V) as the tax-price term in each school district. In his five equations, the price elasticities are estimated to be rather low (-0.36 to -0.70) while income elasticities are fairly high (0.84 to 1.35).

Ladd (1975), using school expenditure data from 78 school districts in the Boston SMSA, estimates demand elasticities. In her equation, price elasticities are estimated with two different price variables: the residential fraction of the assessed local property tax base ($P_1$) and the local tax share after a matching grant-in-aid ($P_2 = 1 - m$). The results are rather inelastic both in price and income elasticities: $\alpha_1 = -0.3091$, $\alpha_2 = -0.4853$, and $\beta = 0.4590$.

Perkins (1977) estimates a demand equation of school expenditure for 38 school districts in Massachusetts. Unlike previous estimations, total school expenditure was regressed on median family income and a price variable specified as the per capita burden of total school expenditures. The result of this estimation shows that income and price elasticities are elastic: $\alpha = -1.29$ to -1.86, $\beta = 1.02$ to 1.07.

In Lovell (1978), the school expenditure equation is estimated with data from 136 school districts in Connecticut. He uses the ratio of housing value to total property value as the representative resident's price for local school expenditure. The elasticity of school expenditure estimated with respect to median family income is 0.247 to 0.386, while the price elasticity is -0.143 to -0.169.
Table 5.10 summarizes the empirical results for the income and price elasticities of the demand for local public education.

Table 5.10

Estimation of Income and Price Elasticity of Education

<table>
<thead>
<tr>
<th>Author</th>
<th>$\beta$</th>
<th>$-\alpha$</th>
<th>Price variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradford &amp; Oates (1974)</td>
<td>0.65</td>
<td>0.36</td>
<td>$\frac{N_d}{N}$</td>
</tr>
<tr>
<td>Feldstein (1975)</td>
<td>0.15-0.64</td>
<td>0.94-1.60</td>
<td>$1-m$</td>
</tr>
<tr>
<td>Peterson (1975)</td>
<td>0.84-1.35</td>
<td>0.36-0.70</td>
<td>$\frac{H}{V}$</td>
</tr>
<tr>
<td>Ladd (1975)</td>
<td>0.459</td>
<td>0.309</td>
<td>$\frac{b}{BN}$</td>
</tr>
<tr>
<td>Perkins (1977)</td>
<td>1.02-1.07</td>
<td>1.29-1.86</td>
<td>$\frac{C}{N}$</td>
</tr>
<tr>
<td>Lovell (1978)</td>
<td>0.247-0.386</td>
<td>0.143-0.169</td>
<td>$\frac{b}{BN}$</td>
</tr>
</tbody>
</table>

$N_d$: Number of pupil, $N$: Local population
$m$: Matching rate
$H$: Median voter's housing value
$V$: Per pupil property value in the locality
$b$: Median voter's tax base
$B$: Aggregate tax base per resident
$C$: Total costs for school expenditure

In the empirical results above, both income and price elasticities are estimated in widely different ranges according to the data used. However, the estimated income and price elasticities are generally less than one; this phenomenon is almost the same in the estimation results for other local public services. What is encouraging for this demand framework is that most of the estimation results are within the range of estimates obtained with individual household data of the same region.

---

11 For the empirical results of demand elasticities for various public services, see Inman (1979) pp.286-288.

12 In education, refer to the results obtained in the micro-voting studies of Peterson (1975) and Rubinfeld (1977). For examples of other services, see Inman (1979) p.289.
5.3.2 Income Elasticity of Education in Korea

In this section, we estimate the income elasticity of education in Korea. As already shown in chapter 4, since the financing and spending for education (both public and private) are actually controlled by Korea's central government, the local data for cross-sectional estimation of local public education are not available. Instead, we use family income and expenditure data surveyed by the National Bureau of Statistics in Korea (1987).

It should be mentioned again that this estimation is different from those studies reviewed in the previous section both in the data used and the parameter to be estimated. The data used in our estimation are individual family income and expenditure data which cover 3,700 households residing in 50 cities.\footnote{The data are monthly survey report and the number of observations totals 52,462. From this data, we first drop the observations which have zero education expenditure regarding those households as none pupil households. Next, we select 30\% of them by random sampling, leaving 5,353 in the final sample. Table 5.11 shows the means of major variables in the final sample.}

The parameter, income elasticity of education, is not exactly consistent with

<table>
<thead>
<tr>
<th>Table 5.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means of the Major Variables in Family Income and Expenditure Survey Data (1987)</td>
</tr>
<tr>
<td>Earners per household = 1.33</td>
</tr>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>1) INC (won)</td>
</tr>
<tr>
<td>2) ED (won)</td>
</tr>
<tr>
<td>3) NUM</td>
</tr>
<tr>
<td>4) AGE</td>
</tr>
<tr>
<td>5) EY</td>
</tr>
<tr>
<td>6) 2(\ln(1))</td>
</tr>
</tbody>
</table>

Male (Female): Male (Female) headed household
INC: Average monthly income
ED: Expenditure for education
NUM: Number of family member
AGE: Age of household head
EY: Household head's year of education

One of the distinct features of this table is that male household heads tend to have more education and higher income level, but spend a lower portion of income on education expenditures. This phenomenon will appear again in the regression results of the next section.
the one needed for our simulation study, i.e., the income elasticity of local demand for elementary education. Moreover, since our estimation is different from those based on the median voter model, no price variable is specified in our estimation equation. Nevertheless, our estimation is expected to reveal some useful information on the education demand in Korea, since no other studies ever provided the information.

Following standard demand estimation as reviewed in section 2.1, we use a log-log demand equation assuming constant income elasticity of education expenditure (ED).¹⁴

\[
\log(\text{ED}) = \alpha + \beta \log(\text{INC}) + S + u,
\]

\(S: \) Vector of control variables

Followings are the results of OLS regression of \(\text{ED}\) with respect to income and other chosen control variables:

\[
\begin{align*}
\log(\text{ED}) & = 1.0400 + 0.5285 \log(\text{INC}) + 0.3033(\text{SEX}) + 0.0437(\text{EY}) \\
 & + 0.0426(\text{NUM}) + 0.0189(\text{AGE}) \\
R^2 & = 0.1146
\end{align*}
\]

\(\text{SEX} = 0,\) for male headed household
\(\text{SEX} = 1,\) for female headed household

From the equation, the income elasticity of education expenditure is estimated to be 0.5285. This figure is rather inelastic compared with other

---

¹⁴ Since tuition is not a normal expenditure item expended monthly, we exclude tuition from the category of ED. ED is mainly composed of private educational expenditures such as expenditures for extra-curricular activities, instructional materials, stationery, etc.
expenditure items. In Table 5.12, we compare income elasticities of each expenditure item and their shares from total consumption expenditure.

Table 5.12 shows that the education expenditure is one of the most inelastic items; only Utility and Food are more inelastic. Considering the general trends that essential goods are usually income inelastic, we can conclude that education in Korea is regarded as one of the most 'essential goods'.

Using these data, we also estimate the 'Engel curve' of education expenditure. The details are presented in Appendix E.

Table 5.12

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>Share(%)</th>
<th>Income Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>34.7</td>
<td>0.4598</td>
</tr>
<tr>
<td>Housing</td>
<td>4.5</td>
<td>0.5405</td>
</tr>
<tr>
<td>Utility &amp; Energy</td>
<td>6.4</td>
<td>0.3580</td>
</tr>
<tr>
<td>Furniture &amp; Utensils</td>
<td>5.3</td>
<td>0.7914</td>
</tr>
<tr>
<td>Clothing</td>
<td>7.8</td>
<td>0.8643</td>
</tr>
<tr>
<td>Medical Care</td>
<td>7.1</td>
<td>0.5998</td>
</tr>
<tr>
<td>Education(^3)</td>
<td>8.1</td>
<td>0.5285</td>
</tr>
<tr>
<td>Recreation</td>
<td>3.5</td>
<td>0.7410</td>
</tr>
<tr>
<td>Transportation &amp;</td>
<td>6.6</td>
<td>0.7368</td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>16.1</td>
<td></td>
</tr>
<tr>
<td>Total Consumption</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

1) Shares are calculated from the whole data.
2) Income elasticities are estimated by log-log demand equation with 5,160 sample. The control variables are a little different equation by equation. For instance, a dummy variable (OWN) that represents the status of housing ownership was introduced in the Housing and Utility demand equations. In most equations, NUM and SEX are commonly controlled.
3) The share of education expenditure is different from that in Table 5.11. This is because actual revenue of the month surveyed was used in this table instead of average monthly income.
5.4 The Optimal Policy for the Provision of Elementary Education in Korea

In the previous section, the income elasticity of education in Korea is estimated fairly inelastic as 0.5285. This figure comes from the estimation with whole educational expenditure data, but the main concern of our paper is on elementary education.

In general, since lower levels of educations are regarded as a more essential commodity, the income elasticity tends to be more inelastic in elementary education which is generally provided by the public sector. Therefore, differences in private educational expenditures at the elementary education level are likely to be less than for general education. For this reason, we choose $\beta = 0.5$, the lowest income elasticity among our three representative values, as our benchmark estimate for elementary education in Korea.

The price elasticity is relatively less important in policy ranking determination; only minor changes occur when price elasticities change. Considering the general trends that essential goods are usually price inelastic, we choose $\alpha = -0.5$ as a hypothetical price elasticity of elementary education in Korea.

5.4.1 The Optimal Policy - The Foundation Aid Plan

Among the nine alternative combinations of income and price elasticity, we select $(\alpha = -0.5, \beta = 0.5)$ as the typical case for elementary education in Korea. Based on these demand parameters we examine the six alternative fiscal policies to select the optimal policy.
Table 5.13 summarizes the policy rankings of six fiscal schemes under eight different cases when $\alpha = -0.5$ and $\beta = 0.5$.

### Table 5.13

Policy Rankings of Alternative Fiscal Schemes  
($\alpha = -0.5$, $\beta = 0.5$)

- **b**: Share of education expenditure from total income, $U = BX^aG^b$
- **$\lambda$**: Distortion parameter for central taxation, $t(1+\lambda)$

#### 1. Under Utilitarian Criterion ($\sigma = 1$)

<table>
<thead>
<tr>
<th>Fiscal</th>
<th>$b$ ($\lambda = 0$)</th>
<th>$\lambda$ ($b = 0.05$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme</td>
<td>0.01 0.05 0.1</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
</tr>
<tr>
<td>PD</td>
<td>3 3 3</td>
<td>3 3 2 2 2</td>
</tr>
<tr>
<td>PC</td>
<td>5 5 6</td>
<td>6 6 5 5 5</td>
</tr>
<tr>
<td>F</td>
<td>2 2 2</td>
<td>2 2 1 1 1</td>
</tr>
<tr>
<td>GL</td>
<td>1 1 1</td>
<td>1 1 6 6 6</td>
</tr>
<tr>
<td>M</td>
<td>4 4 4</td>
<td>4 4 3 3 3</td>
</tr>
<tr>
<td>SL</td>
<td>5 6 4</td>
<td>5 5 3 3 3</td>
</tr>
</tbody>
</table>

#### 2. Under Nash Criterion ($\sigma = -1$)

<table>
<thead>
<tr>
<th>Fiscal</th>
<th>$b$ ($\lambda = 0$)</th>
<th>$\lambda$ ($b = 0.05$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme</td>
<td>0.01 0.05 0.1</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
</tr>
<tr>
<td>PD</td>
<td>3 6 6</td>
<td>6 6 5 5 5</td>
</tr>
<tr>
<td>PC</td>
<td>3 3 3</td>
<td>3 3 2 2 2</td>
</tr>
<tr>
<td>F</td>
<td>2 2 2</td>
<td>2 2 1 1 1</td>
</tr>
<tr>
<td>GL</td>
<td>1 1 1</td>
<td>1 1 6 6 6</td>
</tr>
<tr>
<td>M</td>
<td>3 3 3</td>
<td>3 3 2 2 2</td>
</tr>
<tr>
<td>SL</td>
<td>3 3 3</td>
<td>3 3 2 2 2</td>
</tr>
</tbody>
</table>

#### 3. Under Rawlsian Criterion ($\sigma = -9$)

<table>
<thead>
<tr>
<th>Fiscal</th>
<th>$b$ ($\lambda = 0$)</th>
<th>$\lambda$ ($b = 0.05$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme</td>
<td>0.01 0.05 0.1</td>
<td>0.1 0.2 0.3 0.4 0.5</td>
</tr>
<tr>
<td>PD</td>
<td>6 6 6</td>
<td>6 6 6 6 5</td>
</tr>
<tr>
<td>PC</td>
<td>2 3 3</td>
<td>4 3 5 5 4</td>
</tr>
<tr>
<td>F</td>
<td>2 2 2</td>
<td>2 2 2 2 1</td>
</tr>
<tr>
<td>GL</td>
<td>1 1 1</td>
<td>1 1 1 1 1</td>
</tr>
<tr>
<td>M</td>
<td>2 3 3</td>
<td>3 3 3 3 2</td>
</tr>
<tr>
<td>SL</td>
<td>5 3 3</td>
<td>4 3 3 3 2</td>
</tr>
</tbody>
</table>
In Table 5.13, although there are some variations in rankings according to the criterion adopted, the lump-sum general grant-in-aid scheme (GL) is ranked highest in most cases until it falls to the lowest ranking as the tax distortion parameter counted is over 0.3. Meanwhile, the foundation aid program (F) is ranked second best next to the GL, but the foundation plan rises up to the top ranking as \( \lambda \) increases beyond 0.3. This ranking structure changes little under other values (-1 or -1.3) of the price elasticity.

Since the basic purpose of our equalizing grant-in-aid policies is in reducing the underlying horizontal inequalities in a particular public service, those policies are generally expected to improve the overall income distribution although the degree of redistribution differs policy by policy.

However, the lump-sum general grant-in-aid scheme has so strong a redistribution power that it results in an inverted final income distribution after the policy is implemented.

To examine this problem in more detail, we compare the four equalizing grant-in-aid policies in Table 5.14 and Table 5.15, focusing on the redistributive effects of each scheme. The final incomes are compared in a standard case where \( \alpha = -0.5 \), \( \beta = 0.5 \), \( b = 0.05 \), \( \lambda = 0 \). In particular, the value of \( A \) in the demand function of education expenditure, \( G = A(N^{\delta-1})^\beta \), is assumed to be 2.1851. With this value, the target level of education expenditure can be equal to the per pupil education expenditure in 1985, 265.68 thousand won.\(^\text{15}\)

\(^{15}\) The amount 265.68 thousand won is the national average of (per pupil) elementary education expenditure in 1985. If \( A \) is still assumed to be 0.05, the target level of education expenditure is 6,079 won. But under this value, all the other variables are unrealistic. For example, the required central tax rate is 0.0015\% and the largest amount of grant is not more than 1,000 won.
Table 5.14

Initial vs. Final Income under Four Grant-in-aid Policies
\((\alpha=-0.5, \beta=0.5, b=0.05, \gamma=0, G=2.18531(N^{d-1})^{g/2})\)

<table>
<thead>
<tr>
<th>Initial Income (index)*</th>
<th>Final Income (index)</th>
<th>GL ((t=0.204))</th>
<th>M ((0.004))</th>
<th>SL ((0.002))</th>
<th>F ((0.00067))</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>2238 (99.6)</td>
<td>1802 (100.7)</td>
<td>2231 (99.6)</td>
<td>2234 (99.6)</td>
<td>2237 (99.6)</td>
</tr>
<tr>
<td>PS</td>
<td>1920 (85.4)</td>
<td>1876 (104.9)</td>
<td>1920 (85.7)</td>
<td>1920 (85.6)</td>
<td>1919 (85.4)</td>
</tr>
<tr>
<td>TG</td>
<td>1716 (76.3)</td>
<td>1755 (98.1)</td>
<td>1717 (76.6)</td>
<td>1716 (76.5)</td>
<td>1715 (76.9)</td>
</tr>
<tr>
<td>IN</td>
<td>2248 (100)</td>
<td>2240 (100)</td>
<td>2244 (100)</td>
<td>2247 (100)</td>
<td>2247 (100)</td>
</tr>
<tr>
<td>KG</td>
<td>1907 (84.8)</td>
<td>1904 (85.0)</td>
<td>1905 (84.9)</td>
<td>1906 (84.8)</td>
<td>1906 (84.8)</td>
</tr>
<tr>
<td>KW</td>
<td>1715 (76.3)</td>
<td>1722 (76.9)</td>
<td>1719 (76.6)</td>
<td>1717 (76.4)</td>
<td>1717 (76.4)</td>
</tr>
<tr>
<td>CHB</td>
<td>1707 (76.0)</td>
<td>1712 (76.4)</td>
<td>1710 (76.2)</td>
<td>1708 (76.0)</td>
<td>1708 (76.0)</td>
</tr>
<tr>
<td>CHN</td>
<td>1466 (65.2)</td>
<td>1476 (65.9)</td>
<td>1472 (65.6)</td>
<td>1470 (65.4)</td>
<td>1470 (65.4)</td>
</tr>
<tr>
<td>CB</td>
<td>1464 (65.1)</td>
<td>1476 (65.9)</td>
<td>1471 (65.6)</td>
<td>1469 (65.4)</td>
<td>1469 (65.4)</td>
</tr>
<tr>
<td>CN</td>
<td>1460 (64.9)</td>
<td>1470 (65.6)</td>
<td>1466 (65.3)</td>
<td>1464 (65.2)</td>
<td>1464 (65.2)</td>
</tr>
<tr>
<td>KB</td>
<td>1728 (76.9)</td>
<td>1732 (77.3)</td>
<td>1730 (77.1)</td>
<td>1728 (76.9)</td>
<td>1728 (76.9)</td>
</tr>
<tr>
<td>KB</td>
<td>2184 (97.2)</td>
<td>2180 (97.3)</td>
<td>2182 (97.3)</td>
<td>2183 (97.2)</td>
<td>2183 (97.2)</td>
</tr>
<tr>
<td>JJ</td>
<td>1683 (74.9)</td>
<td>1688 (75.4)</td>
<td>1686 (75.1)</td>
<td>1684 (74.9)</td>
<td>1684 (74.9)</td>
</tr>
</tbody>
</table>

* Income indexes are calculated with \(\text{IN}=100\).

** Central tax rate in each policy scheme.


Table 5.15

Final to Initial Income Ratio under Four Grant-in-aid Policies

<table>
<thead>
<tr>
<th></th>
<th>GL</th>
<th>M</th>
<th>SL</th>
<th>F</th>
<th>GL</th>
<th>M</th>
<th>SL</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>0.805</td>
<td>0.996</td>
<td>0.996</td>
<td>0.999</td>
<td>PS</td>
<td>0.977</td>
<td>0.999</td>
<td>0.999</td>
</tr>
<tr>
<td>TG</td>
<td>1.022</td>
<td>1.000</td>
<td>1.000</td>
<td>0.999</td>
<td>IN</td>
<td>0.796</td>
<td>0.996</td>
<td>0.998</td>
</tr>
<tr>
<td>KG</td>
<td>0.902</td>
<td>0.998</td>
<td>0.999</td>
<td>0.999</td>
<td>KW</td>
<td>1.198</td>
<td>1.004</td>
<td>1.002</td>
</tr>
<tr>
<td>CHB</td>
<td>1.135</td>
<td>1.002</td>
<td>1.001</td>
<td>1.000</td>
<td>CHN</td>
<td>1.347</td>
<td>1.006</td>
<td>1.004</td>
</tr>
<tr>
<td>CB</td>
<td>1.439</td>
<td>1.008</td>
<td>1.005</td>
<td>1.003</td>
<td>CN</td>
<td>1.391</td>
<td>1.007</td>
<td>1.004</td>
</tr>
<tr>
<td>KB</td>
<td>1.117</td>
<td>1.002</td>
<td>1.001</td>
<td>0.999</td>
<td>KN</td>
<td>0.882</td>
<td>0.998</td>
<td>0.999</td>
</tr>
<tr>
<td>JJ</td>
<td>1.161</td>
<td>1.003</td>
<td>1.002</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The two tables compare each locality's initial income with the final income level which is expected from each policy. In Table 5.15, the lump-sum general grant-in-aid scheme (GL) has the widest, while the foundation aid program (F) has the narrowest variation of final income from initial income level. This implies that the fiscal scheme GL has the strongest, and the policy F has the weakest redistributive effect. This redistributive performances are also closely related to the central tax rate presented in Table 5.14; the higher the central tax rate, the stronger the redistributive power. In each fiscal scheme, the central tax rate required to achieve the stipulated level of categorical equity in elementary education provision (= 265.68 thousand won per pupil per year) turns out to be 20.4% (GL), 0.4% (M), 0.2% (SL), and 0.067% (F).

In particular, the final income indexes in Table 5.14 show that the final income distribution under the GL plan is inverted against the initial income distribution. In other words, wealthy jurisdictions turn into poor and poor jurisdictions turn into wealthy jurisdictions under a policy that intends an equalization of a particular public service, elementary education.

This inverted income distribution is mainly due to the distinctive distribution of the student-population ratio (N6-1) for each jurisdiction in Korea. As was already shown in Table 4.5, relatively poor (wealthy) jurisdictions in Korea tend to have a high (low) price variable for the local expenditures on elementary education, N6-1. Because of the relatively high level of the price variable, poor jurisdictions generally

\[\text{16 This means that a high central tax rate may cause tax resistance or tax avoidance (especially in a local economy) from the residents. This is the main reason we additionally consider the welfare cost of tax distortion in the previous section, 5.3.2.}\]
need a larger amount of money than wealthy jurisdictions to provide a given level of elementary education. This is supported by the fact that final income distribution is no longer inverted under a constant price variable.\(^{17}\)

The final income distribution under the GL plan inverts more as the tax distortion parameter \((\lambda)\) is introduced into the model; the higher the value of parameter '\(\lambda\)', the more inverted the final income distribution. However, the inverted final income distribution is unaffected by variations in \(b\), the relative share of education expenditure from total income.

In any cases, since the lump-sum general grant scheme (GL) inverts the final income distribution, we exclude it from the optimal fiscal policy for the elementary education in Korea. Any equalizing fiscal policies, tax or expenditure policy, which are intended to improve the existing state of distribution cannot be expected to invert the original state of distribution. Under the current situation of Korea, which is characterized by the opposite distribution of local income against pupil-population ratio, the lump-sum general grant-in-aid scheme is an unacceptable policy.

Now, according to the policy rankings in Table 5.13, next candidate is the 'Foundation Aid Plan'. Unlike other equalizing grant-in-aid policies, this policy leads to a partial equalization; each jurisdiction is guaranteed to have the minimal provision level of the service, i.e., the foundation level. Therefore, it is natural that the foundation aid scheme has the lowest rate of central government's intervention for the equalizing purpose.

---

\(^{17}\) Under the national average price variable, \(N^{5-1}=0.12\), the final income indexes are as follows: \(SL=99.9, PS=99.2, TG=98.7, IN=100, KG=99.1, KW=98.6, CHB=98.6, CHN=98.0, CB=98.0, CN=98.0, KB=98.7, KN=99.8, JJ=98.6\), and the central tax rate is \(t=0.154\).
The foundation aid plan has been practiced (in several different versions) in the United States as a policy for equalizing the local provision of education.\(^{18}\) The equalization aid is typically computed by the following formula:

\[
GF_i = F - rV_i
\]

GF\(_i\) : Grants per pupil to the jurisdiction \(i\)

F : Foundation level of education expenditure per pupil

r : Mandated tax rate\(^{19}\)

V\(_i\) : Fiscal base per pupil in jurisdiction \(i\)

The grant is calculated as the difference between the foundation level and the local government's contribution to the fund. However, if \(GF\) is negative in the above formula, the equalization aid is zero. Under this scheme, since the effective degree of equalization depends on the pre-determined foundation level, education expenditure per pupil still remains a function of wealth in part, especially in the wealthier jurisdictions where no aid is needed. In general, the higher the foundation level is, the stronger the equalization effect would be.

In our model, the foundation level is set equal to the national average of decentralized provision of elementary education, which is temporarily equated to the average value of current education expenditure per pupil in Korea (=256.68 thousand won in 1985). Therefore, only the jurisdictions under the national average level of provision would receive the foundation aid.

---

\(^{18}\) During 1977-78, forty two states operated some version of the foundation aid plan in the U.S. For details, see Cohn (1979).

\(^{19}\) The mandated tax rate may be calculated on the basis of the tax levy that would yield the foundation level of support (\(F\)) in the wealthiest district, \(h\). Then, \(r = F/V_h\), where \(V_h\) is the per pupil property valuation in the wealthiest district. \(V_h\) can be replaced by average per pupil valuation of fiscal base (\(V_i\)). With this rate, the formula is: \(GF_i = F^*(1-V_i/V_h)\).
5.4.2 Optimal Values under the Foundation Aid Plan

Next, we look into the optimal values of main variables under the foundation aid policy in our model in Table 5.16.

Table 5.16

| SL | 2,202 | 307.48 | 307.48 | 0 | 0 | 1.49 | -1.49 |
| PS | 1,886 | 277.17 | 277.17 | 0 | 0 | 1.28 | -1.28 |
| TG | 1,685 | 270.55 | 270.55 | 0 | 0 | 1.14 | -1.14 |
| IN | 2,212 | 309.39 | 309.39 | 0 | 0 | 1.50 | -1.50 |
| KG | 1,875 | 289.25 | 289.25 | 0 | 0 | 1.27 | -1.27 |
| KW | 1,682 | 265.68 | 268.87 | 16.81 | 2.22 | 1.14 | 1.08 |
| CHB | 1,675 | 265.68 | 255.97 | 9.71 | 1.21 | 1.14 | 0.07 |
| CHN | 1,436 | 265.68 | 234.02 | 31.66 | 4.05 | 0.98 | 3.07 |
| CB | 1,433 | 265.68 | 226.05 | 39.63 | 5.42 | 0.97 | 4.45 |
| CN | 1,429 | 265.68 | 230.12 | 35.56 | 4.68 | 0.97 | 3.71 |
| KB | 1,695 | 265.68 | 258.13 | 7.55 | 0.94 | 1.15 | -0.21 |
| KN | 2,148 | 292.72 | 292.71 | 0 | 0 | 1.45 | -1.45 |
| JJ | 1,650 | 265.68 | 253.00 | 12.68 | 1.59 | 1.12 | 0.47 |


Under the foundation aid plan as a policy to subsidize poor local districts for the equitable provision of elementary education in Korea, seven local districts (KW, CHB, CHN, CB, CN, KB, JJ) are expected to receive lump-sum specific grants which increase their elementary education expenditure to the pre-determined foundation level, 265,680 won per pupil. Chonbuk (CB) will receive the largest amount of grant 39,630 won per pupil and Kyungbuk (KB) will receive the least foundation aid, 7550 won per pupil. The other six districts (SL, PS, IN, TG, KG, KG, ...
KN) need no grants, instead they can spend additional expenditures for their provision of elementary education after paying the central taxation.

By this scheme, the six relatively wealthy jurisdictions have negative fiscal residuum which is defined as the difference between the tax paid and the grants received, while the seven poor jurisdictions have a surplus in fiscal residuum. This differences in fiscal residuum may cause Tiboutian inter-jurisdictional migration, which is not explicitly considered in our model. However, the parameter representing the welfare costs of distortionary taxation ($\lambda$) (which was designed to be reflected in the private consumption expenditure ($X$)) was introduced to consider this migration cost in addition to the traditional welfare costs of taxation. Details of the other equalizing policies are presented in Appendix D.

In conclusion, our policy recommendation is that the foundation aid plan is the most desirable fiscal policy for the provision of elementary education in Korea both from the categorical equity and efficiency point of view. In other words, the target level of education expenditure can be attained most desirably (in terms of social welfare) by the foundation aid policy.
CHAPTER VI
CONCLUSIONS

One of the main problems in the economics of the local public sector is how to reconcile the trade-offs between efficiency and equity goals in the provision of local public goods or services. Since the relative emphasis between efficiency and equity is critically dependent upon the choice of a particular fiscal scheme\(^1\), it is important to establish normative guidelines for the selection of particular fiscal schemes for the provision of particular local public services.

This paper presents policy evaluation models operating with simulation techniques. The purpose of this study is to search for any normative guidelines which are useful in the evaluation of alternative fiscal institutions and policy schemes for the provision of particular local public services. For this purpose, we concentrate on discovering any systematic relation between the major policy variables determining the choice of a particular fiscal scheme and the parameters potentially influencing this decision.

As basic frameworks of the study, we propose four alternative fiscal schemes (in addition to a perfectly decentralized and a perfectly centralized provision system) in which a target level of equity goal can be achieved with various intergovernmental grant-in-aid policies. They are: (1) foundation aid plan, (2) lump-sum general grant-in-aid, (3) lump-sum specific grant-in-aid, and (4) matching grant-in-aid policy. We

---

\(^1\) It is generally recognized that the more decentralized (centralized) a fiscal system is, the more emphasis tends to be placed on the efficiency (equity) goal in the provision of local public services.
model each of the six fiscal schemes and simulate them using Korean elementary education data.

In simulation, five variables are selected as main parameters to be examined: (1) demand characteristics of the service, i.e., income and price elasticity ($\beta$ and $\alpha$); (2) relative share of expenditure for the service ($b$); (3) social planner's alternative views on horizontal inequality ($\sigma$); and (4) welfare cost of each policy ($\lambda$). These variables are selected to reflect the main considerations in choosing a particular fiscal scheme for the provision of a particular local public service.

By and large, the contribution of this paper can be divided into two parts; one is the simulation models and the normative results from them, and the other is policy implications specifically for Korean elementary education.

The primary contribution of this paper is the construction of the simulation models for comparative institutional analysis. The models are basically median voter models. However, they are distinguished from the traditional framework by incorporating the central government into the model as an endogenous grantor cum tax collector - this is the most distinct feature of our fiscal models. The central government is assumed to be concerned with equalizing (or reducing) the underlying inequalities among local jurisdictions in the provision of a particular public service. In each fiscal scheme, the central government is also subject to the full-financing condition, i.e., revenue from central taxation should be equal to expenditure for equalizing grants. Under this framework, the central tax rate is endogenously determined along with the amount of grants transferred in each fiscal scheme.

This new aspect of the model enables our models to produce many useful
results which could not be obtained in traditional models. In traditional models of intergovernmental grant-in-aid, grants are perceived to be given with no additional cost. In our models, however, grants are transferred at the direct expense of residents' income, although changes in fiscal residuum are different among local jurisdictions and across policies. With this theoretical structure, the endogenous central tax rate can reflect the relative scale for financial cost of each fiscal scheme as well as the different stimulative effects of each grant-in-aid policy.

The results concerning the central tax rate are summarized in Result 1-6, which come from the simulation with respect to various combinations of income and price elasticities. The main results are as follows.

The central tax rate increases as the demand for education becomes more income and price elastic. In particular, income elasticity turns out to be the most important parameter in determining the scale of equalizing grants-in-aid (therefore, the central tax rate). In the simulation it is also confirmed that matching grants tend to stimulate local spending more than lump-sum general grants do.

Among the six fiscal schemes, the lump-sum general grant-in-aid policy generally requires a high central tax rate, since a large portion of the grants received tends to leak out for other expenditures. In particular, the central tax rate turns out to be always constant if the price variable is constant. On the other hand, the foundation aid plan requires the lowest central tax rate among the four grant-in-aid policy schemes. The central tax rate under the matching grant-in-aid policy is always

---

2 In this simulation, the other three parameters \( (b, \sigma, \lambda) \) are not directly related to the determination of the central tax rate.
higher (lower) than that under the lump-sum specific grant-in-aid policy if the public service is price inelastic (elastic).

Next, the simulation results regarding the relative preferences of each fiscal scheme are summarized in Results 7-12, which come from the simulation with respect to five system parameters: \( \beta, \alpha, \sigma, b, \lambda \). The results are summarized as follows.

Neither the perfectly decentralized (PD) nor the centralized provision system (PC) is preferred under most demand elasticities. The matching (M) and the lump-sum specific grant-in-aid schemes (SL) are relatively favored under elastic ranges of income and price elasticities, while the foundation aid plan (F) is relatively preferred under an inelastic range of income and price elasticities. The lump-sum general grant-in-aid scheme (GL), which has the highest ranking in most cases, has the strongest redistribution effect just beyond the equalization of local expenditures on elementary education. However, this scheme results in an inverted final income distribution; this phenomenon is due to the unique relation between local income and the pupil-population ratio (which was set to the price variable of local elementary education) in Korea.

In the simulation with respect to alternative values of \( \sigma \), the general direction of the policy ranking change is as anticipated; the fiscal schemes with a relatively high rate of intervention (PC, GL) are favored under a pro-equity welfare criterion (Rawlsian), while fiscal schemes with a relatively low degree of intervention (PD, F) are relatively preferred under a pro-efficiency criterion (Utilitarian). These results are generally consistent with economic common sense.
The parameters for the share of educational expenditure (b) induce no major changes in the overall structure of policy rankings. However, the parameter for the welfare cost of taxation (λ) brings forth rather considerable changes in policy ranking as λ increases. In particular, when λ increases over 0.3, the initial ranking structure is totally changed; the mostly preferred lump-sum general grant-in-aid scheme (GL) falls to the lowest ranking, while the fiscal schemes with a relatively low intervention rate (PD,F) become more favored. The matching (M) and lump-sum specific grant policies (SL) still remain high in the rankings. However, since the policy priority rankings depend critically on the size of the tax distortion parameter, the importance of parameter ‘λ’ relies on the actual value measured in a particular economy. But the estimation of parameter λ is beyond the scope of this paper.

Now, if we consider every possible combination of the five main parameters (α, β, σ, b, λ), the total number of simulation would be very large.¹ To select an optimal fiscal policy for a particular public service in a particular economy (elementary education in Korea), we have to specify parameter values.

According to the simulation results, the main parameters which have a substantial effect on the policy ranking determination are the demand elasticities (α, β) and the tax distortion parameter (λ). In particular, income elasticity turns out to be the most important variable both for the determination of the central tax rate and the policy priority rankings. However, in Korea, it is impossible to estimate the demand function with cross-section data, since elementary education is fully financed

---
¹ If we just count the cases which are explicitly presented in this paper, total number of simulation is 243 (3*3*3*3*3) under the following parameters: $α = -0.5, -1, -1.3; β = 0.5, 1, 1.3; σ = 1, -1, -9; b = 0.01, 0.05, 0.10; λ = 0.2, 0.3, 0.5$
and provided by the central government. Instead, we use individual household data (family income and expenditure survey, 1987) for the estimation of income elasticity of education expenditure. Although there are some limitations in this estimation\(^4\) we expect useful information on the demand characteristics of education in Korea from this estimation.

The income elasticity of education expenditure in 1987 was estimated as rather inelastic, \(\beta = 0.5285\); this value is relatively inelastic compared with other expenditure items. Considering the general tendency for essential goods to be price inelastic, we choose \((\beta=0.5, \alpha=-0.5)\) as the most plausible case among our nine cases of income and price elasticity combination.

Under this specification of demand parameters, the lump-sum general grant-in-aid policy (GL) has the highest ranking for any value of \(b\) and \(\sigma\), unless \(\lambda\) is over 0.3. However, in the Korean case, the lump-sum general grant-in-aid scheme is excluded from the potential 'optimal' policy since this scheme has too strong a redistribution effect to be generally accepted as a real policy. More specifically, this scheme inverts the initial states of income distribution, i.e., it turns wealthy jurisdictions into poor and poor jurisdictions into the wealthy jurisdictions. This phenomenon is mainly due to the unique distribution of the price variable (student-population ratio) in local jurisdictions of Korea.

The main conclusion of our simulation for policy priority rankings is to recommend the foundation aid plan, which is ranked next to lump-sum general

\(^4\)The estimation equation is not derived from the median voter model (therefore, no price variable is specified) and the educational expenditure estimated is not limited to elementary education only.
grant-in-aid scheme, as the 'optimal' policy for the provision of elementary education in Korea. Since the foundation aid plan requires the lowest central tax rate among the four grant-in-aid policies, it tends to sacrifice the least efficiency to obtain a target level of categorical equity in elementary education. Thus, the foundation aid plan is most preferred when we explicitly take into account the welfare costs of distortionary taxation.

Another strength of the foundation aid scheme is that we can achieve various degrees of equalization by varying the foundation level. In our model, since the foundation level was set to the national average of education expenditure which would have been resulted under the perfectly decentralized provision scheme, all the jurisdictions with below average education expenditures are supposed to receive some amount of lump-sum specific grants-in-aid. However, if the target level is set to the highest expenditure level among jurisdictions, all but the wealthiest jurisdiction will receive the foundation aid. In general, the higher the foundation level, the larger the number of jurisdictions receiving equalizing grants and the higher the effective degree of equalization.

According to the foundation aid program for Korean elementary education, seven out of 13 primary local jurisdictions (KW, CHB, CHN, CB, CN, KB, JJ) will receive the foundation aid from the central government. The other six relatively wealthy jurisdictions (IN, SL, PS, TG, KG, KN) will not receive any grants, since they prefer to make additional education expenditures above the foundation level even after paying the central taxation. For this partial equalization policy, 0.067% of central taxation is enough since the policy is confined to one local public service
only, i.e., elementary education.

This policy implication is derived from our benchmark case where $\alpha = -0.5$ and $\beta = 0.5$. Of course, the results are subject to change if the target level of education expenditure changes, or the parameters are differently specified, or exogenous variables are differently endowed. For example, if income elasticity is estimated to be elastic (e.g., $\beta = 1.3$), the matching grant-in-aid policy would be more preferred to the foundation aid plan.

Our study is intended to produce some useful normative guidelines for the evaluation of alternative fiscal institutions and policy schemes. In this study, we mainly focus on intergovernmental grant-in-aid schemes and do not consider other policy schemes and further complications in the local public sector (such as Tieboutian migration and capitalization of local public goods). We hope our model can provide a step towards a more extensive evaluation framework for comparative policy analysis.
APPENDIX A

The Central Tax Rate under Various Demand Elasticities

A.1 Income elasticity ($\beta = 0.5$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>0</th>
<th>-0.1</th>
<th>-0.3</th>
<th>-0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>$2.296 \times 10^{-4}$</td>
<td>$2.697 \times 10^{-4}$</td>
<td>$3.722 \times 10^{-4}$</td>
<td>$5.135 \times 10^{-4}$</td>
</tr>
<tr>
<td>F</td>
<td>$5.839 \times 10^{-6}$</td>
<td>$6.856 \times 10^{-6}$</td>
<td>$9.459 \times 10^{-6}$</td>
<td>$1.305 \times 10^{-5}$</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>N.A.</td>
<td>$1.278 \times 10^{-4}$</td>
<td>$8.532 \times 10^{-5}$</td>
<td>$8.134 \times 10^{-5}$</td>
</tr>
<tr>
<td>SL</td>
<td>$1.964 \times 10^{-5}$</td>
<td>$2.307 \times 10^{-5}$</td>
<td>$3.183 \times 10^{-5}$</td>
<td>$4.392 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

A.2 Income elasticity ($\beta = 1$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>0</th>
<th>-0.1</th>
<th>-0.3</th>
<th>-0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.01</td>
<td>0.012</td>
<td>0.016</td>
<td>0.022</td>
</tr>
<tr>
<td>F</td>
<td>$4.985 \times 10^{-4}$</td>
<td>$5.859 \times 10^{-4}$</td>
<td>$8.098 \times 10^{-4}$</td>
<td>$1.119 \times 10^{-3}$</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>N.A.</td>
<td>0.0069</td>
<td>6.08 $\times 10^{-3}$</td>
<td>0.006</td>
</tr>
<tr>
<td>SL</td>
<td>0.0016</td>
<td>0.0018</td>
<td>0.0025</td>
<td>0.0035</td>
</tr>
</tbody>
</table>

A.3 Income elasticity ($\beta = 1.3$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>0</th>
<th>-0.1</th>
<th>-0.3</th>
<th>-0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.0965</td>
<td>0.1134</td>
<td>0.1564</td>
<td>0.2158</td>
</tr>
<tr>
<td>F</td>
<td>0.0064</td>
<td>0.00759</td>
<td>0.0107</td>
<td>0.0152</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>N.A.</td>
<td>0.069</td>
<td>0.067</td>
<td>0.068</td>
</tr>
<tr>
<td>SL</td>
<td>0.018</td>
<td>0.022</td>
<td>0.030</td>
<td>0.041</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>0.75</th>
<th>-1</th>
<th>-1.3</th>
<th>-1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.033</td>
<td>0.05</td>
<td>0.081</td>
<td>0.112</td>
</tr>
<tr>
<td>F</td>
<td>$1.682 \times 10^{-3}$</td>
<td>$2.529 \times 10^{-3}$</td>
<td>$4.148 \times 10^{-3}$</td>
<td>$5.79 \times 10^{-3}$</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>0.0052</td>
<td>0.00775</td>
<td>0.01</td>
<td>0.012</td>
</tr>
<tr>
<td>SL</td>
<td>0.0052</td>
<td>0.00775</td>
<td>0.01255</td>
<td>0.0173</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>0</th>
<th>-0.1</th>
<th>-0.3</th>
<th>-0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.3228</td>
<td>0.4826</td>
<td>0.7822</td>
<td>N.A.</td>
</tr>
<tr>
<td>F</td>
<td>0.0240</td>
<td>0.0392</td>
<td>0.0866</td>
<td>N.A.</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>0.077</td>
<td>0.0916</td>
<td>0.120</td>
<td>0.146</td>
</tr>
<tr>
<td>SL</td>
<td>0.061</td>
<td>0.092</td>
<td>0.149</td>
<td>0.205</td>
</tr>
</tbody>
</table>
A.4 Price elasticity ($\alpha = -0.5$)

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>0</th>
<th>0.1</th>
<th>0.3</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>$1.187 \times 10^{-5}$</td>
<td>$2.52 \times 10^{-5}$</td>
<td>$1.137 \times 10^{-4}$</td>
<td>$5.135 \times 10^{-4}$</td>
</tr>
<tr>
<td>$F$</td>
<td>0.00</td>
<td>$1.30 \times 10^{-7}$</td>
<td>$1.76 \times 10^{-6}$</td>
<td>$1.305 \times 10^{-5}$</td>
</tr>
<tr>
<td>GL</td>
<td>N.A.</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>N.A.</td>
<td>$9.198 \times 10^{-7}$</td>
<td>$1.159 \times 10^{-5}$</td>
<td>$8.134 \times 10^{-5}$</td>
</tr>
<tr>
<td>SL</td>
<td>N.A.</td>
<td>$4.674 \times 10^{-7}$</td>
<td>$6.074 \times 10^{-6}$</td>
<td>$4.392 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

A.5 Price elasticity ($\alpha = -1$)

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>0.75</th>
<th>1</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>$3.39 \times 10^{-5}$</td>
<td>0.022</td>
<td>0.048</td>
<td>0.101</td>
<td>0.216</td>
</tr>
<tr>
<td>$F$</td>
<td>$1.275 \times 10^{-4}$</td>
<td>0.00112</td>
<td>0.00263</td>
<td>0.00625</td>
<td>0.0152</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>$7.391 \times 10^{-4}$</td>
<td>0.006</td>
<td>0.014</td>
<td>0.031</td>
<td>0.068</td>
</tr>
<tr>
<td>SL</td>
<td>$4.132 \times 10^{-4}$</td>
<td>0.0035</td>
<td>0.00795</td>
<td>0.018</td>
<td>0.041</td>
</tr>
</tbody>
</table>

A.6 Price elasticity ($\alpha = -1.3$)

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>0</th>
<th>0.1</th>
<th>0.3</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>$4.3 \times 10^{-5}$</td>
<td>$9.131 \times 10^{-5}$</td>
<td>$4.12 \times 10^{-4}$</td>
<td>$0.00186$</td>
</tr>
<tr>
<td>$F$</td>
<td>0.00</td>
<td>$4.70 \times 10^{-7}$</td>
<td>$6.30 \times 10^{-6}$</td>
<td>$4.732 \times 10^{-5}$</td>
</tr>
<tr>
<td>GL</td>
<td>N.A.</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>N.A.</td>
<td>$1.308 \times 10^{-5}$</td>
<td>$1.712 \times 10^{-5}$</td>
<td>$1.247 \times 10^{-4}$</td>
</tr>
<tr>
<td>SL</td>
<td>N.A.</td>
<td>$1.694 \times 10^{-5}$</td>
<td>$2.201 \times 10^{-5}$</td>
<td>$1.59 \times 10^{-4}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>0.75</th>
<th>1</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>0.012</td>
<td>0.081</td>
<td>0.172</td>
<td>0.367</td>
<td>0.782</td>
</tr>
<tr>
<td>$F$</td>
<td>$4.65 \times 10^{-4}$</td>
<td>$4.148 \times 10^{-3}$</td>
<td>$0.0101$</td>
<td>$0.0257$</td>
<td>$0.0866$</td>
</tr>
<tr>
<td>GL</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td>M</td>
<td>0.00118</td>
<td>0.01</td>
<td>0.023</td>
<td>0.053</td>
<td>0.120</td>
</tr>
<tr>
<td>SL</td>
<td>0.0015</td>
<td>0.01255</td>
<td>0.029</td>
<td>0.066</td>
<td>0.149</td>
</tr>
</tbody>
</table>
APPENDIX B


B.1 $a=0.99$ $b=0.01$, (where $U = 0.01X^aY^b$, $W = (SU^a)^rac{1}{a}$)

B.1.1 Under Utilitarian Rule ($\sigma = 1$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta=0.5$</th>
<th></th>
<th>$\beta=1$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>221.358(3)</td>
<td>223.538(3)</td>
<td>224.728(3)</td>
<td>225.958(5)</td>
</tr>
<tr>
<td>FC</td>
<td>221.340(5)</td>
<td>223.523(6)</td>
<td>224.716(6)</td>
<td>225.971(4)</td>
</tr>
<tr>
<td>F</td>
<td>221.443(2)</td>
<td>223.648(2)</td>
<td>224.843(2)</td>
<td>225.869(6)</td>
</tr>
<tr>
<td>GL</td>
<td>234.628(1)</td>
<td>240.914(1)</td>
<td>244.653(1)</td>
<td>237.770(1)</td>
</tr>
<tr>
<td>M</td>
<td>221.342(4)</td>
<td>223.526(4)</td>
<td>224.722(5)</td>
<td>226.251(2)</td>
</tr>
<tr>
<td>SL</td>
<td>221.340(5)</td>
<td>223.526(4)</td>
<td>224.727(4)</td>
<td>226.108(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta=1.3$</th>
<th></th>
<th>$\beta=1$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-1$</td>
<td>$-1.3$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>220.955(4)</td>
<td>212.012(4)</td>
<td>196.585(4)</td>
<td>125.318(4)</td>
</tr>
<tr>
<td>FC</td>
<td>220.835(5)</td>
<td>211.869(5)</td>
<td>196.405(5)</td>
<td>123.742(5)</td>
</tr>
<tr>
<td>F</td>
<td>220.221(6)</td>
<td>210.567(6)</td>
<td>194.162(6)</td>
<td>120.522(6)</td>
</tr>
<tr>
<td>GL</td>
<td>234.793(1)</td>
<td>227.171(1)</td>
<td>207.830(1)</td>
<td>137.263(1)</td>
</tr>
<tr>
<td>M</td>
<td>221.398(2)</td>
<td>212.855(3)</td>
<td>200.096(2)</td>
<td>131.684(2)</td>
</tr>
<tr>
<td>SL</td>
<td>221.398(2)</td>
<td>213.128(2)</td>
<td>198.581(3)</td>
<td>131.684(2)</td>
</tr>
</tbody>
</table>

B.1.2 Under Nash rule ($\sigma = -1$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta=0.5$</th>
<th></th>
<th>$\beta=1$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>1.282(3)</td>
<td>1.294(6)</td>
<td>1.301(6)</td>
<td>1.308(5)</td>
</tr>
<tr>
<td>FC</td>
<td>1.282(3)</td>
<td>1.295(2)</td>
<td>1.302(2)</td>
<td>1.309(4)</td>
</tr>
<tr>
<td>F</td>
<td>1.283(2)</td>
<td>1.295(2)</td>
<td>1.302(2)</td>
<td>1.308(5)</td>
</tr>
<tr>
<td>GL</td>
<td>1.383(1)</td>
<td>1.404(1)</td>
<td>1.410(1)</td>
<td>1.406(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.282(3)</td>
<td>1.295(2)</td>
<td>1.302(2)</td>
<td>1.311(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.282(3)</td>
<td>1.295(2)</td>
<td>1.302(2)</td>
<td>1.310(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta=1$</th>
<th></th>
<th>$\beta=1.3$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-1$</td>
<td>$-1.3$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>1.279(4)</td>
<td>1.228(4)</td>
<td>1.139(4)</td>
<td>0.733(4)</td>
</tr>
<tr>
<td>FC</td>
<td>1.279(4)</td>
<td>1.227(5)</td>
<td>1.138(5)</td>
<td>0.717(5)</td>
</tr>
<tr>
<td>F</td>
<td>1.275(6)</td>
<td>1.220(6)</td>
<td>1.126(6)</td>
<td>0.705(6)</td>
</tr>
<tr>
<td>GL</td>
<td>1.384(1)</td>
<td>1.335(1)</td>
<td>1.230(1)</td>
<td>0.812(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.282(2)</td>
<td>1.232(3)</td>
<td>1.167(2)</td>
<td>0.768(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.282(2)</td>
<td>1.235(2)</td>
<td>1.151(3)</td>
<td>0.768(2)</td>
</tr>
</tbody>
</table>
B.1.3 Under Rawlsian rule ($\sigma = -9$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>11.704 (6)</td>
<td>11.932 (6)</td>
</tr>
<tr>
<td>PC</td>
<td>11.717 (2)</td>
<td>11.962 (4)</td>
</tr>
<tr>
<td>F</td>
<td>11.716 (4)</td>
<td>11.941 (5)</td>
</tr>
<tr>
<td>GL</td>
<td>13.333 (1)</td>
<td>13.700 (1)</td>
</tr>
<tr>
<td>M</td>
<td>11.717 (2)</td>
<td>11.996 (2)</td>
</tr>
<tr>
<td>SL</td>
<td>11.716 (4)</td>
<td>11.964 (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 1$</th>
<th>$\beta = 1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>11.665 (5)</td>
<td>6.877 (4)</td>
</tr>
<tr>
<td>PC</td>
<td>11.690 (4)</td>
<td>6.550 (5)</td>
</tr>
<tr>
<td>F</td>
<td>11.548 (6)</td>
<td>6.618 (6)</td>
</tr>
<tr>
<td>GL</td>
<td>13.333 (1)</td>
<td>7.906 (1)</td>
</tr>
<tr>
<td>M</td>
<td>11.720 (2)</td>
<td>7.158 (2)</td>
</tr>
<tr>
<td>SL</td>
<td>11.720 (2)</td>
<td>7.158 (2)</td>
</tr>
</tbody>
</table>

B.2 $a = 0.95$, $b = 0.05$, (where $U = 0.01X^aG^b$, $W = (\Sigma_i \sigma_i^{1/\sigma})$)

B.2.1 Under Utilitarian Rule ($\sigma = 1$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>176.274 (3)</td>
<td>191.482 (3)</td>
</tr>
<tr>
<td>PC</td>
<td>176.196 (5)</td>
<td>191.407 (6)</td>
</tr>
<tr>
<td>F</td>
<td>176.625 (2)</td>
<td>192.068 (2)</td>
</tr>
<tr>
<td>GL</td>
<td>186.400 (1)</td>
<td>207.657 (1)</td>
</tr>
<tr>
<td>M</td>
<td>176.198 (4)</td>
<td>191.412 (5)</td>
</tr>
<tr>
<td>SL</td>
<td>176.196 (5)</td>
<td>191.415 (4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 1$</th>
<th>$\beta = 1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>213.621 (5)</td>
<td>135.814 (4)</td>
</tr>
<tr>
<td>PC</td>
<td>213.531 (6)</td>
<td>134.170 (5)</td>
</tr>
<tr>
<td>F</td>
<td>213.747 (4)</td>
<td>131.232 (6)</td>
</tr>
<tr>
<td>GL</td>
<td>226.545 (1)</td>
<td>148.268 (1)</td>
</tr>
<tr>
<td>M</td>
<td>214.055 (2)</td>
<td>142.444 (2)</td>
</tr>
<tr>
<td>SL</td>
<td>214.055 (2)</td>
<td>142.444 (2)</td>
</tr>
</tbody>
</table>
### B.2.2 Under Nash rule ($\sigma = -1$)

<table>
<thead>
<tr>
<th>$\beta$=0.5</th>
<th>$\beta$=0.5</th>
<th>$\beta$=0.5</th>
<th>$\beta$=0.5</th>
<th>$\beta$=0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
<td>$-1.3$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>1.021(6)</td>
<td>1.076(6)</td>
<td>1.109(6)</td>
<td>1.211(6)</td>
</tr>
<tr>
<td>PC</td>
<td>1.022(3)</td>
<td>1.077(3)</td>
<td>1.111(3)</td>
<td>1.214(4)</td>
</tr>
<tr>
<td>F</td>
<td>1.024(2)</td>
<td>1.079(2)</td>
<td>1.113(2)</td>
<td>1.215(3)</td>
</tr>
<tr>
<td>GL</td>
<td>1.099(1)</td>
<td>1.164(1)</td>
<td>1.199(1)</td>
<td>1.299(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.022(3)</td>
<td>1.077(2)</td>
<td>1.111(3)</td>
<td>1.216(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.022(3)</td>
<td>1.077(2)</td>
<td>1.111(3)</td>
<td>1.214(4)</td>
</tr>
</tbody>
</table>

### B.2.3 Under Rawlsian rule ($\sigma = -9$)

<table>
<thead>
<tr>
<th>$\beta$=1</th>
<th>$\beta$=1</th>
<th>$\beta$=1</th>
<th>$\beta$=1</th>
<th>$\beta$=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1.3$</td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PD</td>
<td>1.236(6)</td>
<td>1.220(5)</td>
<td>1.161(5)</td>
<td>0.793(4)</td>
</tr>
<tr>
<td>PC</td>
<td>1.239(4)</td>
<td>1.222(4)</td>
<td>1.162(4)</td>
<td>0.779(5)</td>
</tr>
<tr>
<td>F</td>
<td>1.239(4)</td>
<td>1.218(6)</td>
<td>1.153(6)</td>
<td>0.768(6)</td>
</tr>
<tr>
<td>GL</td>
<td>1.336(1)</td>
<td>1.324(1)</td>
<td>1.251(1)</td>
<td>0.877(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.242(2)</td>
<td>1.226(3)</td>
<td>1.190(2)</td>
<td>0.832(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.242(2)</td>
<td>1.229(2)</td>
<td>1.175(3)</td>
<td>0.832(2)</td>
</tr>
</tbody>
</table>
B.3  \( a=0.9 \)  \( b=0.1 \), (where \( U = 0.01X^bG^b \), \( W = (\Sigma U_i^b)^{1/\alpha} \))

### B.3.1 Under Utilitarian Rule \((\alpha = 1)\)

<table>
<thead>
<tr>
<th></th>
<th>( \beta=0.5 )</th>
<th></th>
<th></th>
<th>( \beta=1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>(-0.5)</td>
<td>(-1)</td>
<td>(-1.3)</td>
<td>(-0.5)</td>
</tr>
<tr>
<td>PD</td>
<td>132.604(3)</td>
<td>147.269(3)</td>
<td>156.755(3)</td>
<td>190.061(4)</td>
</tr>
<tr>
<td>PC</td>
<td>132.492(5)</td>
<td>147.146(6)</td>
<td>156.633(6)</td>
<td>189.910(6)</td>
</tr>
<tr>
<td>F</td>
<td>133.137(2)</td>
<td>148.069(2)</td>
<td>157.737(2)</td>
<td>191.206(2)</td>
</tr>
<tr>
<td>GL</td>
<td>139.808(1)</td>
<td>157.561(1)</td>
<td>169.186(1)</td>
<td>199.075(1)</td>
</tr>
<tr>
<td>M</td>
<td>132.494(4)</td>
<td>147.149(4)</td>
<td>156.638(5)</td>
<td>190.129(3)</td>
</tr>
<tr>
<td>SL</td>
<td>132.492(5)</td>
<td>147.149(4)</td>
<td>156.640(4)</td>
<td>190.014(5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>( \beta=1 )</th>
<th></th>
<th></th>
<th>( \beta=1.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>(-1)</td>
<td>(-1.3)</td>
<td>(-0.5)</td>
<td>(-1)</td>
</tr>
<tr>
<td>PD</td>
<td>204.913(5)</td>
<td>209.144(5)</td>
<td>205.518(4)</td>
<td>150.186(4)</td>
</tr>
<tr>
<td>PC</td>
<td>204.751(6)</td>
<td>208.900(6)</td>
<td>205.210(5)</td>
<td>148.457(5)</td>
</tr>
<tr>
<td>F</td>
<td>205.924(2)</td>
<td>209.562(4)</td>
<td>204.748(6)</td>
<td>145.970(6)</td>
</tr>
<tr>
<td>GL</td>
<td>216.644(1)</td>
<td>222.710(1)</td>
<td>216.226(1)</td>
<td>163.274(1)</td>
</tr>
<tr>
<td>M</td>
<td>205.228(3)</td>
<td>209.779(3)</td>
<td>208.772(2)</td>
<td>157.153(2)</td>
</tr>
<tr>
<td>SL</td>
<td>205.228(3)</td>
<td>210.037(2)</td>
<td>207.283(3)</td>
<td>157.153(2)</td>
</tr>
</tbody>
</table>

### B.3.2 Under Nash Rule \((\alpha = -1)\)

<table>
<thead>
<tr>
<th></th>
<th>( \beta=0.5 )</th>
<th></th>
<th></th>
<th>( \beta=1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>(-0.5)</td>
<td>(-1)</td>
<td>(-1.3)</td>
<td>(-0.5)</td>
</tr>
<tr>
<td>PD</td>
<td>0.769(6)</td>
<td>0.853(6)</td>
<td>0.908(6)</td>
<td>1.100(6)</td>
</tr>
<tr>
<td>PC</td>
<td>0.770(3)</td>
<td>0.856(3)</td>
<td>0.911(3)</td>
<td>1.104(5)</td>
</tr>
<tr>
<td>F</td>
<td>0.773(2)</td>
<td>0.859(2)</td>
<td>0.915(2)</td>
<td>1.109(2)</td>
</tr>
<tr>
<td>GL</td>
<td>0.825(1)</td>
<td>0.921(1)</td>
<td>0.979(1)</td>
<td>1.177(1)</td>
</tr>
<tr>
<td>M</td>
<td>0.770(3)</td>
<td>0.856(3)</td>
<td>0.911(3)</td>
<td>1.106(3)</td>
</tr>
<tr>
<td>SL</td>
<td>0.770(3)</td>
<td>0.856(3)</td>
<td>0.911(3)</td>
<td>1.105(4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>( \beta=1 )</th>
<th></th>
<th></th>
<th>( \beta=1.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>(-1)</td>
<td>(-1.3)</td>
<td>(-0.5)</td>
<td>(-1)</td>
</tr>
<tr>
<td>PD</td>
<td>1.185(6)</td>
<td>1.209(6)</td>
<td>1.189(5)</td>
<td>0.876(4)</td>
</tr>
<tr>
<td>PC</td>
<td>1.190(5)</td>
<td>1.215(5)</td>
<td>1.193(4)</td>
<td>0.863(5)</td>
</tr>
<tr>
<td>F</td>
<td>1.194(2)</td>
<td>1.216(4)</td>
<td>1.188(6)</td>
<td>0.854(6)</td>
</tr>
<tr>
<td>GL</td>
<td>1.278(1)</td>
<td>1.311(1)</td>
<td>1.279(1)</td>
<td>0.965(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.193(3)</td>
<td>1.219(3)</td>
<td>1.220(2)</td>
<td>0.919(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.193(3)</td>
<td>1.221(2)</td>
<td>1.206(3)</td>
<td>0.919(2)</td>
</tr>
</tbody>
</table>
### B.3.3 Under Rawlsian Rule ($\sigma = -9$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 0.5$</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>7.042(6)</td>
<td>7.797(6)</td>
<td>8.283(6)</td>
<td>10.009(6)</td>
</tr>
<tr>
<td>PC</td>
<td>7.111(3)</td>
<td>7.898(5)</td>
<td>8.407(3)</td>
<td>10.193(4)</td>
</tr>
<tr>
<td>F</td>
<td>7.116(2)</td>
<td>7.905(2)</td>
<td>8.416(2)</td>
<td>10.185(5)</td>
</tr>
<tr>
<td>GL</td>
<td>7.969(1)</td>
<td>8.578(1)</td>
<td>8.852(1)</td>
<td>11.478(1)</td>
</tr>
<tr>
<td>M</td>
<td>7.111(3)</td>
<td>7.898(3)</td>
<td>8.406(5)</td>
<td>10.219(2)</td>
</tr>
<tr>
<td>SL</td>
<td>7.111(3)</td>
<td>7.898(3)</td>
<td>8.407(3)</td>
<td>10.195(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 1$</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha$</td>
<td>$-1$</td>
<td>$-1.3$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>10.763(6)</td>
<td>10.983(6)</td>
<td>10.809(6)</td>
<td>8.147(4)</td>
</tr>
<tr>
<td>PC</td>
<td>10.990(4)</td>
<td>11.212(4)</td>
<td>11.014(4)</td>
<td>7.968(6)</td>
</tr>
<tr>
<td>F</td>
<td>10.965(5)</td>
<td>11.172(5)</td>
<td>10.934(5)</td>
<td>8.039(5)</td>
</tr>
<tr>
<td>GL</td>
<td>12.342(1)</td>
<td>12.533(1)</td>
<td>12.499(1)</td>
<td>9.412(1)</td>
</tr>
<tr>
<td>M</td>
<td>11.015(2)</td>
<td>11.231(3)</td>
<td>11.436(2)</td>
<td>8.628(2)</td>
</tr>
<tr>
<td>SL</td>
<td>11.015(2)</td>
<td>11.286(2)</td>
<td>11.149(3)</td>
<td>8.628(2)</td>
</tr>
</tbody>
</table>
### Social Welfare Indexes and Policy Rankings of Each Fiscal Scheme under Alternative Degrees of Tax Distortion

#### C.1 Under Utilitarian Rule (σ=1)

\[ U_i = 0.01R^{0.85}G^{0.15}, \quad W = \sum(U_i)^{1/\sigma} \]

#### C.1.1 Tax Distortion (λ) = 0.1

<table>
<thead>
<tr>
<th></th>
<th>α</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>PD</td>
<td>176.274(3)</td>
<td>185.695(3)</td>
<td>191.482(3)</td>
<td>209.235(4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>176.190(6)</td>
<td>185.595(6)</td>
<td>191.367(6)</td>
<td>208.815(6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>176.625(2)</td>
<td>186.190(2)</td>
<td>192.066(2)</td>
<td>209.725(2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>182.001(1)</td>
<td>193.880(1)</td>
<td>201.333(1)</td>
<td>215.124(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>176.197(4)</td>
<td>185.615(4)</td>
<td>191.408(5)</td>
<td>209.305(3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>176.195(5)</td>
<td>185.615(4)</td>
<td>191.409(4)</td>
<td>209.220(5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### C.1.2 Tax Distortion (λ) = 0.2

<table>
<thead>
<tr>
<th></th>
<th>α</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>PD</td>
<td>213.621(5)</td>
<td>210.731(4)</td>
<td>200.505(4)</td>
<td>135.814(4)</td>
<td>29.273(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>212.463(6)</td>
<td>208.444(6)</td>
<td>196.471(6)</td>
<td>122.247(5)</td>
<td>N.A. (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>213.667(4)</td>
<td>209.945(5)</td>
<td>198.474(5)</td>
<td>129.908(6)</td>
<td>31.331(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>221.100(1)</td>
<td>219.194(1)</td>
<td>206.561(1)</td>
<td>142.406(1)</td>
<td>35.816(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>213.834(2)</td>
<td>211.108(3)</td>
<td>202.541(2)</td>
<td>139.611(2)</td>
<td>35.763(3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>213.835(3)</td>
<td>211.285(2)</td>
<td>201.564(3)</td>
<td>139.627(2)</td>
<td>37.967(1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### C.1.3 Tax Distortion (λ) = 0.3

<table>
<thead>
<tr>
<th></th>
<th>α</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
<th>β=0.5</th>
<th>β=1</th>
<th>β=1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
<td>-1</td>
<td>-1.3</td>
<td>-0.5</td>
</tr>
<tr>
<td>PD</td>
<td>213.621(5)</td>
<td>210.731(4)</td>
<td>200.505(4)</td>
<td>135.814(4)</td>
<td>29.273(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>211.395(6)</td>
<td>206.348(6)</td>
<td>192.672(6)</td>
<td>110.263(6)</td>
<td>N.A. (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>213.587(5)</td>
<td>209.772(5)</td>
<td>198.150(5)</td>
<td>128.582(5)</td>
<td>26.945(5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>215.647(1)</td>
<td>213.204(1)</td>
<td>201.596(1)</td>
<td>136.531(3)</td>
<td>28.922(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>213.614(3)</td>
<td>210.738(3)</td>
<td>201.177(2)</td>
<td>136.793(1)</td>
<td>30.658(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>213.614(3)</td>
<td>210.828(2)</td>
<td>200.729(3)</td>
<td>136.793(1)</td>
<td>31.716(3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### C.1.3 Tax Distortion ($\lambda = 0.3$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PD</td>
<td>176.274(2)</td>
<td>185.695(2)</td>
</tr>
<tr>
<td>PC</td>
<td>176.176(5)</td>
<td>185.554(5)</td>
</tr>
<tr>
<td>F</td>
<td>176.625(1)</td>
<td>186.189(1)</td>
</tr>
<tr>
<td>GL</td>
<td>173.186(6)</td>
<td>182.658(6)</td>
</tr>
<tr>
<td>M</td>
<td>176.194(3)</td>
<td>185.609(3)</td>
</tr>
<tr>
<td>SL</td>
<td>176.194(3)</td>
<td>185.609(3)</td>
</tr>
</tbody>
</table>

### C.1.4 Tax Distortion ($\lambda = 0.5$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PD</td>
<td>213.621(2)</td>
<td>210.731(1)</td>
</tr>
<tr>
<td>PC</td>
<td>210.327(5)</td>
<td>204.251(6)</td>
</tr>
<tr>
<td>F</td>
<td>213.507(1)</td>
<td>209.599(4)</td>
</tr>
<tr>
<td>GL</td>
<td>210.186(6)</td>
<td>207.204(5)</td>
</tr>
<tr>
<td>M</td>
<td>213.394(3)</td>
<td>210.368(3)</td>
</tr>
<tr>
<td>SL</td>
<td>213.394(3)</td>
<td>210.371(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 1$</th>
<th>$\beta = 1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>213.621(2)</td>
<td>210.731(1)</td>
</tr>
<tr>
<td>PC</td>
<td>219.189(5)</td>
<td>208.054(5)</td>
</tr>
<tr>
<td>F</td>
<td>213.47(2)</td>
<td>209.253(4)</td>
</tr>
<tr>
<td>GL</td>
<td>199.342(6)</td>
<td>195.176(6)</td>
</tr>
<tr>
<td>M</td>
<td>212.953(3)</td>
<td>209.629(2)</td>
</tr>
<tr>
<td>SL</td>
<td>212.953(3)</td>
<td>209.458(3)</td>
</tr>
</tbody>
</table>
C.2 Under Nash Rule ($\sigma=-1$)

C.2.1 Tax Distortion ($\lambda = 0.1$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>-0.5</td>
<td>-1</td>
</tr>
<tr>
<td>PD</td>
<td>1.021 (6)</td>
<td>1.076 (6)</td>
</tr>
<tr>
<td>PC</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
<tr>
<td>F</td>
<td>1.024 (2)</td>
<td>1.079 (2)</td>
</tr>
<tr>
<td>GL</td>
<td>1.073 (1)</td>
<td>1.129 (1)</td>
</tr>
<tr>
<td>M</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta=1$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td></td>
<td>-0.5</td>
</tr>
<tr>
<td>PD</td>
<td>1.236 (5)</td>
<td>1.220 (4)</td>
</tr>
<tr>
<td>PC</td>
<td>1.233 (6)</td>
<td>1.209 (6)</td>
</tr>
<tr>
<td>F</td>
<td>1.238 (4)</td>
<td>1.217 (5)</td>
</tr>
<tr>
<td>GL</td>
<td>1.333 (1)</td>
<td>1.288 (1)</td>
</tr>
<tr>
<td>M</td>
<td>1.241 (2)</td>
<td>1.224 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.241 (2)</td>
<td>1.226 (2)</td>
</tr>
</tbody>
</table>

C.2.2 Tax Distortion ($\lambda = 0.2$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>-0.5</td>
<td>-1</td>
</tr>
<tr>
<td>PD</td>
<td>1.021 (6)</td>
<td>1.076 (6)</td>
</tr>
<tr>
<td>PC</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
<tr>
<td>F</td>
<td>1.024 (2)</td>
<td>1.079 (2)</td>
</tr>
<tr>
<td>GL</td>
<td>1.046 (1)</td>
<td>1.095 (1)</td>
</tr>
<tr>
<td>M</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.022 (3)</td>
<td>1.077 (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta=1$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td></td>
<td>-0.5</td>
</tr>
<tr>
<td>PD</td>
<td>1.236 (5)</td>
<td>1.220 (4)</td>
</tr>
<tr>
<td>PC</td>
<td>1.227 (6)</td>
<td>1.197 (6)</td>
</tr>
<tr>
<td>F</td>
<td>1.238 (4)</td>
<td>1.216 (5)</td>
</tr>
<tr>
<td>GL</td>
<td>1.270 (1)</td>
<td>1.252 (1)</td>
</tr>
<tr>
<td>M</td>
<td>1.239 (2)</td>
<td>1.222 (3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.239 (2)</td>
<td>1.224 (2)</td>
</tr>
</tbody>
</table>
### C.2.3 Tax Distortion ($\lambda = 0.3$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>1.021(5)</td>
<td>1.211(5)</td>
</tr>
<tr>
<td>PC</td>
<td>1.022(2)</td>
<td>1.208(6)</td>
</tr>
<tr>
<td>F</td>
<td>1.024(1)</td>
<td>1.215(2)</td>
</tr>
<tr>
<td>GL</td>
<td>1.020(6)</td>
<td>1.217(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.022(2)</td>
<td>1.214(3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.022(2)</td>
<td>1.213(4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>1.236(5)</td>
<td>1.220(2)</td>
</tr>
<tr>
<td>PC</td>
<td>1.220(6)</td>
<td>1.204(5)</td>
</tr>
<tr>
<td>F</td>
<td>1.237(3)</td>
<td>1.215(4)</td>
</tr>
<tr>
<td>GL</td>
<td>1.237(3)</td>
<td>1.215(4)</td>
</tr>
<tr>
<td>M</td>
<td>1.238(1)</td>
<td>1.212(2)</td>
</tr>
<tr>
<td>SL</td>
<td>1.238(1)</td>
<td>1.212(2)</td>
</tr>
</tbody>
</table>

### C.2.4 Tax Distortion ($\lambda = 0.5$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>1.021(5)</td>
<td>1.211(5)</td>
</tr>
<tr>
<td>PC</td>
<td>1.022(2)</td>
<td>1.208(6)</td>
</tr>
<tr>
<td>F</td>
<td>1.024(1)</td>
<td>1.215(2)</td>
</tr>
<tr>
<td>GL</td>
<td>1.020(6)</td>
<td>1.217(1)</td>
</tr>
<tr>
<td>M</td>
<td>1.022(2)</td>
<td>1.214(3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.022(2)</td>
<td>1.213(4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD</td>
<td>1.236(1)</td>
<td>1.220(1)</td>
</tr>
<tr>
<td>PC</td>
<td>1.220(5)</td>
<td>1.204(5)</td>
</tr>
<tr>
<td>F</td>
<td>1.236(1)</td>
<td>1.215(4)</td>
</tr>
<tr>
<td>GL</td>
<td>1.171(6)</td>
<td>1.141(4)</td>
</tr>
<tr>
<td>M</td>
<td>1.236(1)</td>
<td>1.215(3)</td>
</tr>
<tr>
<td>SL</td>
<td>1.236(1)</td>
<td>1.212(2)</td>
</tr>
</tbody>
</table>
### C.3 Under Rawlsian Rule ($\sigma=-9$)

#### C.3.1 Tax Distortion ($\lambda=0.1$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PC</td>
<td>9.385(4)</td>
<td>9.886(5)</td>
</tr>
<tr>
<td>F</td>
<td>9.388(2)</td>
<td>9.890(2)</td>
</tr>
<tr>
<td>GL</td>
<td>10.335(1)</td>
<td>10.417(1)</td>
</tr>
<tr>
<td>M</td>
<td>9.386(3)</td>
<td>9.887(3)</td>
</tr>
<tr>
<td>SL</td>
<td>9.385(4)</td>
<td>9.887(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-1$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>11.255(6)</td>
<td>11.113(5)</td>
</tr>
<tr>
<td>PC</td>
<td>11.317(5)</td>
<td>11.103(6)</td>
</tr>
<tr>
<td>GL</td>
<td>12.546(1)</td>
<td>12.252(1)</td>
</tr>
<tr>
<td>M</td>
<td>11.390(2)</td>
<td>11.214(3)</td>
</tr>
<tr>
<td>SL</td>
<td>11.390(2)</td>
<td>11.269(2)</td>
</tr>
</tbody>
</table>

#### C.3.2 Tax Distortion ($\lambda=0.2$)

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PC</td>
<td>9.385(3)</td>
<td>9.885(5)</td>
</tr>
<tr>
<td>F</td>
<td>9.388(2)</td>
<td>9.890(2)</td>
</tr>
<tr>
<td>GL</td>
<td>10.060(1)</td>
<td>10.040(1)</td>
</tr>
<tr>
<td>M</td>
<td>9.385(3)</td>
<td>9.886(3)</td>
</tr>
<tr>
<td>SL</td>
<td>9.385(3)</td>
<td>9.886(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta=0.5$</th>
<th>$\beta=1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$-1$</td>
<td>$-0.5$</td>
</tr>
<tr>
<td>PD</td>
<td>11.255(6)</td>
<td>11.113(5)</td>
</tr>
<tr>
<td>F</td>
<td>11.331(4)</td>
<td>11.146(4)</td>
</tr>
<tr>
<td>GL</td>
<td>12.205(1)</td>
<td>11.867(1)</td>
</tr>
<tr>
<td>M</td>
<td>11.379(2)</td>
<td>11.194(3)</td>
</tr>
<tr>
<td>SL</td>
<td>11.379(2)</td>
<td>11.244(2)</td>
</tr>
</tbody>
</table>
### C.3.3 Tax Distortion ($\lambda = 0.3$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PC</td>
<td>9.384(5)</td>
<td>9.884(4)</td>
</tr>
<tr>
<td>F</td>
<td>9.388(2)</td>
<td>9.890(1)</td>
</tr>
<tr>
<td>GL</td>
<td>9.783(1)</td>
<td>9.658(6)</td>
</tr>
<tr>
<td>M</td>
<td>9.385(3)</td>
<td>9.886(2)</td>
</tr>
<tr>
<td>SL</td>
<td>9.385(2)</td>
<td>9.886(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 1$</th>
<th>$\beta = 1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>11.255(5)</td>
<td>11.113(5)</td>
</tr>
<tr>
<td>PC</td>
<td>11.204(6)</td>
<td>10.880(6)</td>
</tr>
<tr>
<td>F</td>
<td>11.327(4)</td>
<td>11.137(4)</td>
</tr>
<tr>
<td>GL</td>
<td>11.861(1)</td>
<td>11.477(1)</td>
</tr>
<tr>
<td>M</td>
<td>11.367(2)</td>
<td>11.174(3)</td>
</tr>
<tr>
<td>SL</td>
<td>11.367(2)</td>
<td>11.220(2)</td>
</tr>
</tbody>
</table>

### C.3.4 Tax Distortion ($\lambda = 0.5$)

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 0.5$</th>
<th>$\beta = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-0.5$</td>
<td>$-1$</td>
</tr>
<tr>
<td>PC</td>
<td>9.384(4)</td>
<td>9.882(4)</td>
</tr>
<tr>
<td>F</td>
<td>9.388(1)</td>
<td>9.890(1)</td>
</tr>
<tr>
<td>GL</td>
<td>9.219(6)</td>
<td>8.880(6)</td>
</tr>
<tr>
<td>M</td>
<td>9.385(2)</td>
<td>9.886(2)</td>
</tr>
<tr>
<td>SL</td>
<td>9.385(2)</td>
<td>9.886(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$\beta = 1$</th>
<th>$\beta = 1.3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>$-1$</td>
<td>$-1.3$</td>
</tr>
<tr>
<td>PD</td>
<td>11.255(4)</td>
<td>11.113(4)</td>
</tr>
<tr>
<td>PC</td>
<td>11.090(6)</td>
<td>10.656(6)</td>
</tr>
<tr>
<td>F</td>
<td>11.319(3)</td>
<td>11.119(3)</td>
</tr>
<tr>
<td>GL</td>
<td>11.161(5)</td>
<td>10.684(5)</td>
</tr>
<tr>
<td>M</td>
<td>11.343(1)</td>
<td>11.135(2)</td>
</tr>
<tr>
<td>SL</td>
<td>11.343(1)</td>
<td>11.171(1)</td>
</tr>
</tbody>
</table>
### APPENDIX D

#### Optimal Values under Alternative Grant-in-aid Policies

**D.1 Optimal Values under the Lump-sum General Grant-in-aid Policy**

\( \alpha = -0.5, \beta = 0.5, \lambda = 0, A = 2.1583, G_i = A(N_i^{a-1}]t[\beta] \)

<table>
<thead>
<tr>
<th>Private cons. (X)</th>
<th>Total(A+B)</th>
<th>Local(A)*</th>
<th>Grants(B)</th>
<th>Grants(C)</th>
<th>Tax(D)</th>
<th>Fiscal residuum(C-D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>1,772</td>
<td>265.68</td>
<td>84.27</td>
<td>181.41</td>
<td>20.51</td>
<td>457.38</td>
</tr>
<tr>
<td>PS</td>
<td>1,844</td>
<td>265.68</td>
<td>-2,651.46</td>
<td>2,917.14</td>
<td>348.10</td>
<td>392.37</td>
</tr>
<tr>
<td>TG</td>
<td>1,725</td>
<td>265.68</td>
<td>-3,210.95</td>
<td>3,476.63</td>
<td>389.20</td>
<td>350.65</td>
</tr>
<tr>
<td>IN</td>
<td>1,759</td>
<td>265.68</td>
<td>265.68</td>
<td>0</td>
<td>0</td>
<td>459.38</td>
</tr>
<tr>
<td>KG</td>
<td>1,691</td>
<td>265.68</td>
<td>-1,955.30</td>
<td>1,860.98</td>
<td>202.50</td>
<td>389.71</td>
</tr>
<tr>
<td>KW</td>
<td>2,020</td>
<td>265.68</td>
<td>-4,948.17</td>
<td>5,213.85</td>
<td>689.68</td>
<td>350.53</td>
</tr>
<tr>
<td>CHB</td>
<td>1,906</td>
<td>265.68</td>
<td>-4,397.19</td>
<td>4,662.87</td>
<td>580.07</td>
<td>348.96</td>
</tr>
<tr>
<td>CHN</td>
<td>1,941</td>
<td>265.68</td>
<td>-6,057.31</td>
<td>6,322.99</td>
<td>808.23</td>
<td>299.63</td>
</tr>
<tr>
<td>CB</td>
<td>2,072</td>
<td>265.68</td>
<td>-6,626.43</td>
<td>6,892.11</td>
<td>942.60</td>
<td>299.26</td>
</tr>
<tr>
<td>CN</td>
<td>1,996</td>
<td>265.68</td>
<td>-6,335.03</td>
<td>6,600.71</td>
<td>869.01</td>
<td>298.35</td>
</tr>
<tr>
<td>KB</td>
<td>1,898</td>
<td>265.68</td>
<td>-4,227.28</td>
<td>4,492.96</td>
<td>556.10</td>
<td>353.14</td>
</tr>
<tr>
<td>KN</td>
<td>2,895</td>
<td>265.68</td>
<td>-1,284.68</td>
<td>1,550.36</td>
<td>188.65</td>
<td>446.41</td>
</tr>
<tr>
<td>JJ</td>
<td>1,920</td>
<td>265.68</td>
<td>-4,630.07</td>
<td>4,895.75</td>
<td>614.50</td>
<td>343.92</td>
</tr>
</tbody>
</table>

*The amount of grants (per pupil) which leaks to private consumption

**D.2 Optimal Values under the Matching Grant-in-aid Policy**

\( \alpha = -0.5, \beta = 0.5, \lambda = 0, A = 2.1583, G_i = A(N_i^{a-1}]t[\beta] \)

<table>
<thead>
<tr>
<th>Private cons. (X)</th>
<th>Total(A+B)</th>
<th>Local(A)*</th>
<th>Grants(B)</th>
<th>Grants(C)</th>
<th>Tax(D)</th>
<th>Fiscal residuum(C-D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>2,201</td>
<td>265.68</td>
<td>262.34</td>
<td>3.34</td>
<td>0.378</td>
<td>8.227</td>
</tr>
<tr>
<td>PS</td>
<td>1,888</td>
<td>265.68</td>
<td>213.21</td>
<td>52.47</td>
<td>6.259</td>
<td>7.058</td>
</tr>
<tr>
<td>TG</td>
<td>1,687</td>
<td>265.68</td>
<td>203.08</td>
<td>62.60</td>
<td>7.004</td>
<td>6.307</td>
</tr>
<tr>
<td>IN</td>
<td>2,210</td>
<td>265.68</td>
<td>265.68</td>
<td>0</td>
<td>0</td>
<td>8.263</td>
</tr>
<tr>
<td>KG</td>
<td>1,875</td>
<td>265.68</td>
<td>232.18</td>
<td>33.50</td>
<td>3.645</td>
<td>7.010</td>
</tr>
<tr>
<td>KW</td>
<td>1,687</td>
<td>265.68</td>
<td>171.86</td>
<td>93.82</td>
<td>12.402</td>
<td>6.305</td>
</tr>
<tr>
<td>CHB</td>
<td>1,679</td>
<td>265.68</td>
<td>181.87</td>
<td>83.81</td>
<td>10.426</td>
<td>6.277</td>
</tr>
<tr>
<td>CHN</td>
<td>1,442</td>
<td>265.68</td>
<td>151.97</td>
<td>113.71</td>
<td>14.532</td>
<td>5.389</td>
</tr>
<tr>
<td>CB</td>
<td>1,440</td>
<td>265.68</td>
<td>141.85</td>
<td>123.83</td>
<td>16.940</td>
<td>5.383</td>
</tr>
<tr>
<td>CN</td>
<td>1,436</td>
<td>265.68</td>
<td>146.94</td>
<td>118.74</td>
<td>15.626</td>
<td>5.366</td>
</tr>
<tr>
<td>KB</td>
<td>1,699</td>
<td>265.68</td>
<td>184.95</td>
<td>80.73</td>
<td>9.995</td>
<td>6.352</td>
</tr>
<tr>
<td>KN</td>
<td>2,148</td>
<td>265.68</td>
<td>237.85</td>
<td>27.83</td>
<td>3.387</td>
<td>8.030</td>
</tr>
<tr>
<td>JJ</td>
<td>1,655</td>
<td>265.68</td>
<td>177.63</td>
<td>88.05</td>
<td>11.050</td>
<td>6.186</td>
</tr>
</tbody>
</table>
D.3 Optimal Values under the Lump-sum Specific Grant-in-aid Policy

\[(\alpha=-0.5, \beta=0.5, \lambda=0, A=2.1583, G_l = A(N_l^{6.1})^{\sigma_l})\]

<table>
<thead>
<tr>
<th></th>
<th>Private Per pupil edu. expenditure</th>
<th>Per capita Fiscal residuum (C-D)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cons. (X) Total (A+B) Local (A)</td>
<td>Grants (B) Grants (C) Tax (D)</td>
</tr>
<tr>
<td>SL</td>
<td>2,204 265.68 264.04 1.64</td>
<td>0.185 4.477 -4.292</td>
</tr>
<tr>
<td>PS</td>
<td>1,888 265.68 238.01 2.77</td>
<td>3.300 3.841 -0.541</td>
</tr>
<tr>
<td>TG</td>
<td>1,687 265.68 232.33 33.35</td>
<td>3.372 3.432 -0.059</td>
</tr>
<tr>
<td>IN</td>
<td>2,214 265.68 265.68 0</td>
<td>0.00 4.497 -4.497</td>
</tr>
<tr>
<td>KG</td>
<td>1,876 265.68 248.39 17.29</td>
<td>1.881 3.815 -1.934</td>
</tr>
<tr>
<td>KW</td>
<td>1,684 265.68 213.71 51.97</td>
<td>6.870 3.431 3.439</td>
</tr>
<tr>
<td>CHB</td>
<td>1,677 265.68 219.81 45.87</td>
<td>5.706 3.416 2.290</td>
</tr>
<tr>
<td>CHN</td>
<td>1,438 265.68 200.96 64.72</td>
<td>8.272 2.933 5.279</td>
</tr>
<tr>
<td>CB</td>
<td>1,435 265.68 194.11 71.57</td>
<td>9.790 2.929 6.861</td>
</tr>
<tr>
<td>CN</td>
<td>1,431 265.68 197.61 68.07</td>
<td>8.958 2.920 6.038</td>
</tr>
<tr>
<td>KB</td>
<td>1,697 265.68 221.66 44.02</td>
<td>5.449 3.457 1.992</td>
</tr>
<tr>
<td>KN</td>
<td>2,150 265.68 251.36 14.32</td>
<td>1.743 4.370 -2.627</td>
</tr>
<tr>
<td>JJ</td>
<td>1,653 265.68 217.25 48.42</td>
<td>6.077 3.367 2.710</td>
</tr>
</tbody>
</table>
APPENDIX E

Estimation of Engel Curve of Educational Expenditure in Korea (1987)

Based on family income and expenditure survey data, we also estimate the Engel curve of educational expenditure to see the changes of income elasticity by income level. For this, we divide the family income into eight brackets and estimate demand for education expenditures by the following equation, a piece-wise linear regression.  

\[
ED = \alpha_1 + \beta_1(INC)*D_1 + \alpha_2 + \beta_2(INC-300,000)*D_2 + \alpha_3 + \beta_3(INC-500,000)*D_3 + \alpha_4 + \beta_4(INC-700,000)*D_4 + \alpha_5 + \beta_5(INC-900,000)*D_5 + \alpha_6 + \beta_6(INC-1,100,000)*D_6 + \alpha_7 + \beta_7(INC-1,300,000)*D_7 + \alpha_8 + \beta_8(INC-1,500,000)*D_8 + \gamma_1(SEX) + \gamma_2(EY) + \gamma_3(NUM) + \gamma_4(AGE) + u
\]

where, \( D_i = 1 \), if \( INC_{i-1} \leq INC \leq INC_i \) 
\( = 0 \), Otherwise, \( 1 \leq i \leq 8 \)

The coefficients are constrained to obviate the discontinuity of the estimated line:

\[
\alpha_i = \alpha_{i-1} + \beta_{i-1}(INC_i - INC_{i-2}), 2 \leq i \leq 8
\]

1 If the estimation is just for the Engel curve, the spline regression method may result in better fit. Refer Suit, D., Mason, A., and Chan, L. (1978) for the specification of spline function. In this paper, however, since the main concern of our estimation lies in the income elasticity by income bracket, piece-wise linear regression is preferred for the calculation of income elasticity.

2 Substituting this constraint into (1) simplifies the estimation equation as follows:

\[
ED = \alpha_1 + \beta_1*(INC)*D_1 + 300,000*(D_2 + 200,000*(D_3 + ... + D_9)]
+ \beta_2*(INC-300,000)*D_2 + 200,000*(D_3 + ... + D_9)]
+ \beta_3*(INC-500,000)*D_3 + 200,000*(D_4 + ... + D_9)]
+ \beta_4*(INC-700,000)*D_4 + 200,000*(D_5 + ... + D_9)]
+ \beta_5*(INC-900,000)*D_5 + 200,000*(D_6 + ... + D_9)]
+ \beta_6*(INC-1,100,000)*D_6 + 200,000*(D_7 + D_9)]
+ \beta_7*(INC-1,300,000)*D_7 + 200,000*(D_9)]
+ \beta_8*(INC-1,500,000)*D_8 + Control variables + u \quad (2)
\]
The following table summarizes the estimated coefficients of equation (1) by OLS regression and the income elasticity in each income bracket.

Table E.1

<table>
<thead>
<tr>
<th>Income bracket (won)</th>
<th>$a_i$</th>
<th>$\beta_i$ (t-value)</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 300,000</td>
<td>14,589</td>
<td>0.0018 (0.205)</td>
<td>0.018</td>
</tr>
<tr>
<td>300,000 - 500,000</td>
<td>15,129</td>
<td>0.0412 (6.837)</td>
<td>0.856</td>
</tr>
<tr>
<td>500,000 - 700,000</td>
<td>23,369</td>
<td>0.0171 (2.222)</td>
<td>0.409</td>
</tr>
<tr>
<td>700,000 - 900,000</td>
<td>26,789</td>
<td>0.0323 (3.415)</td>
<td>0.861</td>
</tr>
<tr>
<td>900,000 - 1,100,000</td>
<td>33,249</td>
<td>0.0291 (2.063)</td>
<td>0.805</td>
</tr>
<tr>
<td>1,100,000 - 1,300,000</td>
<td>39,069</td>
<td>0.0779 (3.837)</td>
<td>1.995</td>
</tr>
<tr>
<td>1,300,000 - 1,500,000</td>
<td>54,649</td>
<td>-0.0236 (-1.207)</td>
<td>-0.631</td>
</tr>
<tr>
<td>Over 1,500,000</td>
<td>42,922</td>
<td>0.0109 (4.341)</td>
<td>0.394</td>
</tr>
</tbody>
</table>

Note 1. The intercept term in equation (2) is estimated to be -13,663 (t=-3.881). The intercept terms in this table are calculated by using the average value of control variables.

Note 2. Income elasticities are calculated at the middle income level of each bracket.

Note 3. $R^2 = 0.4382$

In Table E.1, income elasticities are estimated 0.41 to 0.86 in the middle income ranges. In one particular income bracket which can be regard as the border line between middle and high income class, education expenditure turns out to be exceptionally elastic. Afterwards, income elasticities are very low value, even negative (although it is insignificant).

The variables controlled in this estimation are the year of household head's education (EY), sex of household head (SEX), number of house family (NUM), and age of household head (AGE). The estimation result is:

$$ED = -13663 + (SLOPES: \beta_1, \beta_2, \ldots) + 944(EY) + 6447(SEX) + 237(NUM)$$
$$(-3.88)^*$$
$$+ 389(AGE)$$
$$9.68) ,$$
$$* (t-value)$$

Among the control variables, the household head's sex influences on the level
of education expenditure. Other things being equal, female-headed households (SEX = 1) generally tend to spend more for the educational purposes compared with male headed households, which was already expected in Table 5.11.

Figure E.1 presents the Engel curve of education expenditure based on the estimated coefficients in Table E.1. The coefficient is calculated with the mean value of control variables: EY = 11.000, SEX = 0.166, NUM = 4.512, AGE = 40.30.

Figure E.1
Engel Curve of Educational Expenditure in Korea (1987)
BIBLIOGRAPHY


Inman, R.P., "Testing Political Economy's 'as if' Proposition: is the Median Income Voter Really Decisive?", *Public Choice* 33, 1978, pp.45-65


———, "Gibangjaejungkwa Giyuckbyol Sodukbunpo (Local Public Finance and Regional Distribution of Income)", in *Kukkayesankwa Chungchaekmokpyo (National Budget and Policy Objective)*, Hankuk Kaebal Yeonkuwon (Korea Development Institute), 1988, pp.135-176


__________________________, "The Elusive Median Voter", *Journal of Public Economics* 12, 1979a, pp.143-170


