

The Education Information Services Theory under Direct Democracy

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1. Introduction

In a democratic society, all citizens admit that the nature has endowed them with human rights and duties and that the society provides social rights and duties. Most of countries in the world enact the Constitution consistent with the human rights and the social rights. In this paper, we consider a citizen's rights and duties to receive compulsory (elementary and secondary) education among the social rights according to a framework of the procedure for the direct democratic decision-making[2]. We show concretely how to decide on an expenditure and taxation of the compulsory (elementary and secondary) education.

2. A Framework of the Provision for the Education Services

The right of education is one of social rights. A citizen should take an education from 7 years old to 15. The institution must promote that citizens let their children go to school. We shall consider how the committee proposes the next year's budget according to a model of direct democratic society[2, 3, 4, 5].

The committee's procedure to make a budget plan is as follows.

1. Disclosure of the information for citizens' self-assessments
2. Acceptance of the reports by citizens' self-assessments
3. Formulation of this year's budget plan

The Committee's Information Recording

According to the above procedure 1, the committee discloses the education information for the citizens' self-assessments. First, the administrators of the elementary and secondary schools submit records and the next year's plan to the committee. They have periodically testified pupils and assessed pupils' educational consequences. Each pupil is ranked to each level by the achievement tests. The administrators notify each household of the result of the achievement tests and pupils' present days to school.

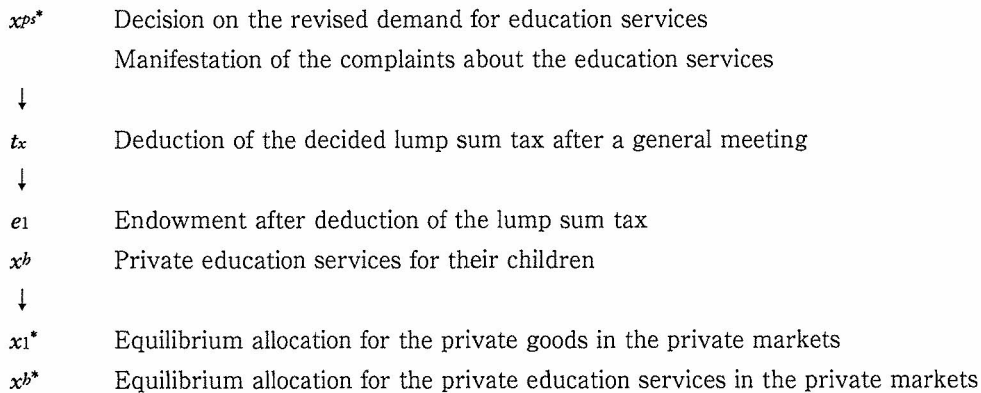
The records are each pupil's annual present days, the consequences of the achievement tests. The plan is the next year's education services amount and teachers and fixed costs.

The committee calculates the next year's education services amount and the distribution of the education services and the lump sum tax.

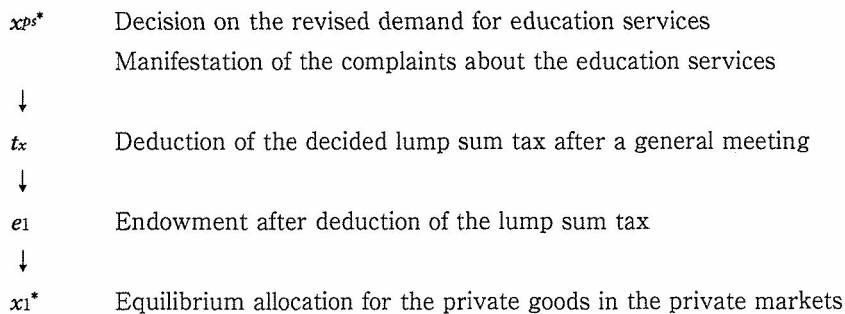
A citizen takes the education information from the committee and calculates a report of the demand for his education services. When a citizen has no pupil, he has only a duty to pay a lump sum tax, because in a democratic society, a citizen has the social right to take the education services for 9 school years but he must bear to pay for after his graduate until his retirement. When a citizen has pupils, he has only a duty to pay a lump sum tax but must bear the self benefit for his pupils. At the same time, he has the report of his pupils' learning attainments from school and manifests the complaints about the education services. A citizen makes the above report as follows.

A Citizen's Decision-Making Process

Case of a household with pupils



Case of a household without a pupil



According to the above procedure 2, the committee makes the revised budget plan and

submit it to the general meeting.

3. Individual Information and Aggregation

A pupil of the i th household who has the j th pupil ($j=1, \dots, 10$) that is a years old ($a=7, \dots, 15$) is denoted by $i_j(a)$, where we assume that the maximum pupils' number of every household is 10. For example, when a pupil of the i th household is 7 years old and only one, he or she is denoted by $i_1(7)$. When two pupils ($j=2$) of the i th household are 7 years old and 8, they are denoted by $i_1(7)$ and $i_2(8)$, respectively.

Let b be the total number of households who have pupils. The aggregation of the number of the pupils' age a is as follows ;

$$n_a = \sum_{i=1}^b \sum_{j=1}^{10} i_j(a), \text{ for } a=7, \dots, 15.$$

The total pupils' number Tn in the next year is

$$Tn = \sum_{a=7}^{15} n_a.$$

The age structure of pupils is denoted by a vector $Tn^s = (n_7, \dots, n_{15})$, where the newcomers are n_7 .

The elementary and secondary schools have periodically testified pupils and assessed pupils' educational consequences. Each pupil is ranked to each level by the achievement tests. At the same time, the elementary and secondary schools notify each household of the result of the achievement tests. Basically, this ranking would depend on the rate of a pupil's presence. Some household may have no incentive to their child's education if he belongs to the last rank. The committee will also expect that the ranking will discourage pupils to commute to school. After the committee obtains the result of the achievement tests, it counsels the administrators of the elementary and secondary schools to sustain the standard average of the learning attainments by the arrangement of teachers and so on.

4. Probability Distributions

The next year's school days are d . Each pupil $i_j(a)$ may be sick, dead or depart from the home country at any date during the next year's school days. Such events that any pupil becomes to be sick, dead or depart from the home country are probable and affect the total pupils' number Tn in the next year. However, in this paper, we consider their events deterministic. Then, all Tn pupils must go to school for d days. If we consider the education services amount as a day for a pupil, the maximum education services amount is d .

We assume that any pupil is present or absent at any date. When a pupil $i_j(a)$ can go to

school at any date within the school days, the event $x_{ij}(a)$ takes 1 and the probability that he is present is $p_{ij}(a)$. When a pupil $i_j(a)$ cannot go to school at any date within the school days, the event $x_{ij}(a)$ takes 0 and the probability that he is absent is $1 - p_{ij}(a)$. This probability distribution is Bernoulli. We define the mutually independent probability variables $X_{ij}(a)_s$ ($s = 1, \dots, d$). Thus the probability distribution $\phi_{ij}(a)$ of the present days $X_{ij}(a) = \sum_{s=1}^d X_{ij}(a)_s$ of a pupil $i_j(a)$ is binominal. Then,

$$E[X_{ij}(a)] = d p_{ij}(a).$$

$$Var[X_{ij}(a)] = d p_{ij}(a) (1 - p_{ij}(a)).$$

Furthermore, the aggregation of the present days of the pupil's age a is defined by a probability variable $X(a)$.

$$X(a) = \sum_{i=1}^b \sum_{j=1}^{10} X_{ij}(a), \text{ for } a=7, \dots, 15.$$

The probability variable $X(a)$ has a binominal distribution.

$$E[X(a)] = d \sum_{i=1}^b \sum_{j=1}^{10} p_{ij}(a),$$

$$Var[X(a)] = d \sum_{i=1}^b \sum_{j=1}^{10} p_{ij}(a) (1 - p_{ij}(a)), \text{ for } a=7, \dots, 15.$$

Average aggregate present days for a pupil's age a are $E[X(a)]$. The total number of pupils is na . Average present days for a pupil's age a are $E[X(a)]/na$. The education services are provided for a pupil who is present for average present days $E[X(a)]/na$.

Furthermore, we take an average over all the age and obtain the education services over all

$$x^{ps} = (1/Tn) \sum_{a=7}^{15} E[X(a)]/na, \text{ where } 0 < x^{ps} \leq d.$$

5. Cost Functions of Education

The education services are defined by $x^{ps} = (1/Tn) \sum_{a=7}^{15} E[X(a)]/na$.

Let the regular class per teacher c pupils. The necessary teachers are $t = Tn/c$.

Let the average rate of teacher's wage w^p . The regular school has k classes. There are t/k schools in the country. Each school needs some school officers. The necessary fixed costs FC include the wages of the school officers. The increase of fixed costs depends on the increase of pupils. Therefore, the annual total cost function of the education services TC is denoted by

$$TC = w^p \cdot x^{ps} \cdot t + FC.$$

Since all schools have the duty to serve all the pupils during the school days d , they must keep school open for d days. However, the administrator obeys the real education services amount x^{ps} .

The administration sector of schools informs the committee of the estimate of the education services in the next year and the cost. The procedure to calculate the cost is as follows.

Let the estimate $e x^{ps}$. The total cost of the education services is $TC = w^p \cdot e x^{ps} \cdot t + FC$. According to the Principle of Budget Equality, the expenditure is TC and the revenue is $t_x \cdot (n_0 + b)$, where t_x is the lump sum tax, n_0 is the total number of citizens without pupils, b is the total number of citizens with pupils and $n_0 + b$ is the number of all the tax payers. Therefore, the equation of the budget is

$$TC = t_x \cdot (n_0 + b).$$

Then, we obtain the lump sum tax $t_x = TC / (n_0 + b)$.

The committee obtains the result of the achievement tests from all the schools. If the learning attainment of any school is less than the standard average of the learning attainments in the country, from the Principle of the Equality, the committee counsels the administrator of the school to sustain the standard average of the learning attainments by the arrangement of teachers and so on. For its sake, he may increase the fixed cost to care for the arrangement. At the same time, the administrator would obtain the complaints about the education services at the school and he will make the revised plan and submit it to the committee.

6. Optimization for an Impersonal Citizen

The education sector reports the pupils' assessment annually. The committee considers that an impersonal citizen assesses the education services by the utility function $u(x^{ps})$ subject to his budget equation.

The committee calculates the next year's education services x^{ps} for a pupil and the other public services y^{ps} according to impersonal distributions ϕ and ψ as follows.

$$\begin{aligned} \max_{\{x^{ps}, y^{ps}\}} \quad & \int u(x^{ps}, y^{ps}) d\phi d\psi, \\ \text{subject to :} \quad & w^p x^{ps} + p_y y^{ps} = t_x + ot_x, \end{aligned}$$

where p_y is the price of the other public services and ot_x is the lump sum tax. The committee obtains an optimal x^{ps*} .

7. Individual Optimization and Self-assessment

A citizen without a pupil pays only for a lump sum tax. He or she doesn't need to report the next year's education services demand, but can manifest the complaints about the education services, since he is afraid of deteriorating the quality of the cultivation. After pupils' graduation, all the citizens collaborate with them. If the graduates are deteriorating, the citizens must care for their additional work learning.

A household with pupils pays for a lump sum tax per each citizen and bears direct self costs for their children.

The elementary and secondary schools give the i th household their children's assessment. A citizen without a pupil trusts the assessment report by the elementary and secondary schools. The household with pupils assesses their consequence of the education. A self-assessment function is defined by $u_{ija}(x^{ps}, y^{ps})$ for each pupil.

$$\begin{aligned} \max_{\{x^{ps}, y^{ps}\}} \quad & \int u_{ija}(x^{ps}, y^{ps}) d\phi_{ij}(a) d\psi_i, \\ \text{subject to:} \quad & w^p x^{ps} + p_y y^{ps} = t_x + o t_x, \end{aligned}$$

where $\phi_{ij}(a)$ and ψ_i are the i th household's distributions.

The household obtains an optimal $ij^a x^{ps*}$. He reports the optimal demand vector for the public services and manifests the complaints about the public services to the committee. If the household does not think that the school improves his complaints, he will move his child to another school.

8. Recollection

Finally, the committee aggregates all the citizens' reports and obtain the number of all the pupils $Tn^* = \sum_{a=1}^{15} n_a^*$ and the revised demand $x^{ps**} = (1/Tn^*) \sum_{a=1}^{15} \sum_{j=1}^{10} ij^a x^{ps*}$. The administrators report the revised plans to the committee. The committee calculates the revised lump sum tax $t_x^* = TC^*/(n_0^* + b^*)$.

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