Abstract

This article presents a simple model of majority voting on tax shares in which voters perceive the tax structure to be chosen as a permanent institution under which each voter's tax burden will be determined throughout his or her lifetime. Young voters view the choice of tax structure as a means of allocating an anticipated tax burden over the life cycle. Middle-aged and elderly voters, on the other hand, do have the option of lowering the tax burden on themselves by shifting it onto younger voters. Preferences of different groups of voters and likely majority rule outcome with respect to choice of tax structure are examined under various assumptions about lifetime income patterns and expectations about the rate of public sector growth, and of population growth.

MAJORITY VOTING ON TAX SHARES: A SIMPLE LIFE-CYCLE MODEL

MARILYN R. FLOWERS
University of Oklahoma

INTRODUCTION

This article presents a simple model of majority voting on tax shares. Several assumptions are employed in developing the model. The first is that the tax structure to be chosen by voters is viewed by them as a permanent institution under which each voter's tax burden will be determined throughout his or her lifetime. The second is that each voter's economic status varies in a systematic way over the life cycle: all voters are given identical lifetime income patterns and utility functions. Finally, it is assumed that each individual's voting behavior is guided by pure economic self-interest. Although these assumptions are restrictive, they do allow certain interesting features of tax structure choice to be isolated and examined.

Given the above assumptions, a young voter will view the choice of tax structure not as a means of choosing his or her tax burden relative to others, but rather as a means of allocating an anticipated tax burden over the life cycle.[1] In addition, it seems

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reasonable to argue that the tax system preferred by the young voter is "fair" or "just" because it allows that voter and all future generations their most preferred allocation of tax burden over their lifetimes.[2] However, future generations cannot participate in current political process, and at the time of choice, middle-aged and elderly voters will not have the same preferences as young voters. Older voters have the possibility of lowering the tax burden over the remainder of their lifetimes by increasing the burden on voters younger than themselves. As a result, an interesting majority rule problem arises with respect to the allocation of tax burden across age groups. The preferences of young voters as well as likely majority rule outcomes with respect to tax structure will be examined in this paper under various assumptions about lifetime income patterns and expectations about the rate of public sector growth and of population growth. The model is developed initially without a capital market that would enable a voter to reallocate any nominal patterns of tax payments. Implications of the presence of a capital market are examined in a later section.

THE BASIC MODEL

Assume a society with a stable population of three voter-taxpayers. Each individual lives for three periods, so that at any point in time there are one young voter, one middle-aged voter and one elderly voter. Individual utility is assumed to be a function of private consumption, C, and of the amount of a single public good, G, provided by the government. All three individuals have have the same Cobb-Douglas utility function:

$$U(C,G) = C^{\alpha}G^{\beta}; \quad 0 < \alpha, \beta < 1. \qquad [1]$$

An individual's consumption during the i^{th} period of his life is equal to his income (Y_i) minus his tax payment, (T_i):

$$Y_i - T_i - C_i = 0; \quad i = 0, 1, 2. \qquad [2]$$

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Suppose that GNP is stable, so that the income which a young person anticipates during the middle and elderly periods of his lifetime is also the income which the current middle-aged and elderly are receiving. Assume also that individuals perceive a stable public sector. During each period, the government is expected to collect tax revenue amounting to T_A, which is used to finance $\hat{G}$ of the public good. At the time the tax structure is chosen, a young voter-taxpayer can anticipate a lifetime individual tax burden also equal to T_A. His preferences with respect to the tax share to be imposed on the current middle-aged and elderly will be affected by his perception that he will also bear that share when he is in those periods of his life. Assume initially that income increases throughout the individual's lifetime. The tax structure preferred by the young voter can be derived by assuming that the individual chooses that pattern of tax payments which maximizes the present value of the utility stream which he will experience over his lifetime. The individual will maximize:

$$PV(U_0, U_1, U_2) = \sum_{i=0}^{2} C_i^{\alpha} \hat{G}^{\beta} e^{-ir}, \qquad [3]$$

subject to the following constraints:

$$Y_i - T_i - C_i = 0; \quad i = 0, 1, 2, \qquad [4]$$

and

$$T_A - \sum_{i=0}^{2} T_i = 0. \qquad [5$$

With $Y_0 < Y_1 < Y_2$, it can unambiguously be shown that the young voter will prefer a progressive tax structure. Manipula-

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tion of the necessary conditions for maximization of 3, subject to 4 and 5, yields the following:

$$\frac{1 - \frac{T_i}{Y_i}}{1 - \frac{T_{i+1}}{Y_{i+1}}} = \frac{Y_{i+1}}{Y_i} e^{r/k} > 1; \quad -k = \alpha - 1; \quad i = 0, 1. \qquad [6]$$

T_i/Y_i is the average tax rate. Therefore, given that $Y_{i+1} > Y_i$, the fact that the left side of equation 6 can be shown to be greater than one, necessarily implies a preference for progression in the tax structure.

The interests of the middle-aged and elderly voters in this model lie in minimizing the tax burden they bear, for the remainder of their lifetimes. Although there is not necessarily a unique majority rule choice of tax structure in this example, it does seem clear that the two older voters will always prefer a regressive tax system over the progressive system which the young voter would most like to see adopted. In fact, if side payments are not feasible, the middle-aged and elderly voters could successfully impose the entire tax burden on the young voter, assuming that this allowed that individual some minimal subsistence income after taxes. The young voter could not form a coalition with either of the other voters to alter this outcome. If, on the other hand, there were some external, constitutional requirement that all income be taxed in some consistent fashion, i.e., consistently progressive, proportional or regressive, it still seems plausible that the two older voters would unite to impose a regressive tax. Any special exemptions from taxable income which would be utilized primarily by older voters would also be likely to win majority approval.

EFFECTS OF AN ALTERNATIVE LIFETIME INCOME PATTERN

The assumption that income increases steadily throughout the individual's lifetime is rather unrealistic. An alternative assump-

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tion which corresponds more closely to what is observed in the real world is that income increases between youth and middle age but falls in the last period of the individual's life. This lifetime income pattern is interesting in the context of the model employed in this paper, for two reasons. First, it raises some interesting questions about interpretation of the horizontal equity norm. Second, under some circumstances, the young voter can actually be the median voter with respect to the determination of tax structure.

Horizontal equity requires that equals be treated equally. If utility is employed as the relevant means of comparison, then any tax will be consistent with the norm, at least insofar as the current young and all future generations are concerned. This is because of the assumption that all individuals have identical utility functions and lifetime earnings patterns.[3] If, on the other hand, income is employed as the index of relative well-being, some interesting problems arise. Suppose $Y_0 = Y_2 < Y_1$. Income received during the individual's youth is equal to the income he anticipates during old age. A requirement that equal incomes be taxed equally would not conform to the pattern of tax payments that the young voter would prefer over his lifetime. Rather, the best tax structure, from his point of view, would require a much larger tax payment from him in his declining years than that required in his youth. To clarify, note that equation 6 remains the necessary condition for utility maximization, despite the altered assumption about the lifetime income pattern. Manipulation of equation 6 yields the following:

$$\frac{Y_1}{Y_2}\, e^{-r/k} = \frac{1 - \dfrac{T_2}{Y_2}}{1 - \dfrac{T_1}{Y_1}} < \frac{1 - \dfrac{T_0}{Y_0}}{1 - \dfrac{T_1}{Y_1}} = \frac{Y_1}{Y_0}\, e^{r/k}. \qquad [7]$$

Thus, although the difference in income between youth and middle age is the same as the difference between the old and the middle-aged, the young voter prefers a more progressive tax structure with respect to relative tax rates imposed on the young

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and the middle-aged than to the relative tax rates imposed on the elderly and the middle-aged. In fact, equation 7 suggests that the individual might even prefer that the tax structure be proportional or regressive vis-à-vis the middle and old periods of his life.

If the notion is accepted that the young voters' preferred tax system is the "fair" tax system, income as a determinant of equality or inequality for tax purposes, is sufficient. Age also should be considered. Specifically, old persons with the same income as young persons should be taxed at a higher rate. Again it would appear that the choice of tax structure by majority rule will defeat the equity norm. In actual practice, elderly taxpayers are actually given preferential treatment. Given the discussion in the preceding section, this seems a plausible outcome of majority rule because it provides a means for middle-aged and elderly voters to shift a greater portion of tax burden onto the young.

It is interesting to examine the implications of imposing a rule of horizontal equity in the standard sense on the choice of tax base. There are two relevant results. First, given this additional constraint, the young voter's preferred tax structure is no longer necessarily progressive, even with respect to relative tax rates imposed on young and middle-aged taxpayers. Second, the young voter will become the median voter. If we assume $Y_0 = Y_2$ and require that $T_0 = T_2$, the tax structure preferred by the young voter now fulfills condition 8:

$$\frac{1 - \dfrac{T_{0(2)}}{Y_{0(2)}}}{1 - \dfrac{T_1}{Y_1}} = \frac{Y_1}{Y_{0(2)}} e^{r/k} \left(\frac{1 + e^{-2r}}{2} \right)^{1/k} . \qquad [8]$$

The last term on the right side of equation 8 is less than one. Thus, even though the product of the last two terms is greater than one,[4] the young voter prefers a less progressive tax structure than before. Given the assumption that $Y_2 = Y_0$, the tax burden borne by the middle-aged voter over the remainder of his lifetime is now tied directly to that assigned the young taxpayer. The tax

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structure preferred by the middle-aged individual can be derived by maximizing:

$$PV(U_1, U_2) = C_1^{\alpha} \hat{G}_2^{\beta} + C_2^{\alpha} \hat{G}^{\beta} e^{-r5}. \quad [9]$$

subject to:

$$Y_i - T_i - C_i = 0; \quad i = 1, 2, \quad [10]$$

and:

$$T_A - T_1 - 2T_2 = 0, \quad [11]$$

the preferred tax structure works out to be:

$$\frac{1 - \frac{T_1}{Y_1}}{1 - \frac{T_2}{Y_2}} = \frac{Y_2}{Y_1} 2^{1/k} e^{r/k}. \quad [12]$$

Because T_2 and Y_2 equal T_0 and Y_0, respectively, this tax structure can be written in a manner which can be easily compared to that preferred by a young voter. For the middle-aged voter, the preferred distribution of tax burden between income Y_0 and Y_1 is the following:

$$\frac{1 - \frac{T_0}{Y_0}}{1 - \frac{T_1}{Y_1}} = \frac{Y_1}{Y_0} 2^{-1/k} e^{-r/k}. \quad [13]$$

This can be compared to condition 8 (the tax structure preferred by the young voter). The young voter prefers a more progressive tax structure than does the middle-aged voter. The elderly voter will clearly prefer the most progressive tax structure. Therefore, the young voter is now the median voter with respect to choice of tax structure.

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IMPLICATIONS OF PUBLIC SECTOR AND POPULATION GROWTH

Two other situations are worth examining with respect to the effect on the young voter's preferred tax structure. The first is the case in which, although GNP is anticipated to remain stable, the public sector is expected to increase over time. The second situation is that in which population is growing at some steady rate. Two examples will be examined here: The first is that of anticipation by the young voter that tax rates, once set, will remain unchanged; the second assumes that public expenditures are expected to remain constant.

Suppose that individuals anticipate that during their lifetimes, although GNP will not grow, public expenditures will grow at some steady rate δ. Suppose also that the young voter anticipates that the tax structure chosen will be maintained insofar as to the degree of progressivity or regressivity. This requires that taxes be increased over time in proportion to the growth of the public sector. Therefore, the young voter seeks that tax structure which maximizes:

$$PV(U_0, U_1, U_2) = C_0^{\alpha} G_0^{\beta} + C_1^{\alpha} (\delta G_0)^{\beta} e^{-r} + C_2^{\alpha} (\delta^2 G_0)^{\beta} e^{-2r}, \quad [14]$$

subject to:

$$Y_i - \delta^i T_i - C_i = 0, 1, 2, \quad [15]$$

and

$$T_A - T_0 - T_1 - T_2 = 0. \quad [16]$$

Maximization of 14 is subject to the constraints in 15, and 16 yields the following necessary condition:

$$\frac{1 - \frac{T_i}{Y_i}}{1 - \frac{T_{i+1}}{Y_{i+1}}} = \frac{Y_{i+1}}{Y_i} e^{r/k} \delta^{-\left(\frac{1+\beta}{k}\right)}; \quad i = 0, 1. \quad [17]$$

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Comparison of 17 with equations 6 and 7 clearly suggests a less progressive tax structure will be preferred by the young voter if public sector growth is anticipated. This result has an intuitive explanation. The expanding size of the public sector implies that private consumption in any future period will be smaller under a given tax structure than would be the case with a stable public sector. This raises the relative marginal utility of future private consumption. Hence, the desire for a less progressive tax structure.

Population growth has some interesting implications for tax structure choice. Suppose that the individual's income grows throughout his lifetime and that population is growing at rate γ. Assume initially that the young voter anticipates that tax rates, once set, will not be altered. Public expenditures will grow at the same rate as population and GNP are growing (γ). With changing size, it is important to make some assumptions about the degree of divisibility of the good being publicly provided. If the good is purely public (indivisible) actual public consumption enjoyed by the individual will grow through his lifetime. If the good is purely private (divisible), public consumption will remain constant. The expansion of public expenditures will, in this case, be just sufficient to provide the new members of the population with the same public consumption enjoyed by everyone else. If the good is a congestible public good, individual consumption will grow over time, given the assumption of constant tax rates, but per capita consumption will grow less rapidly than expenditures. Replace $\hat{G}$ in the previous examples with g_i to denote the per capita public goods consumption during the i^{th} period of the individual's life.

The younger voter now wants the tax structure which maximizes:

$$\sum_{i=0}^{2} C_i^{\alpha} g_i^{\beta} e^{-ir}, \qquad [18]$$

subject to:

$$Y_i - T_i - C_i = 0; \quad i = 0, 1, 2, \qquad [19]$$

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and

$$T_A - N_0T_0 - N_1T_1 - N_2T_2 = 0. \qquad [20]$$

with N_1 denoting the number of taxpayers in the relevant population group at the time the individual is voting on tax structure. Given steady population growth, it is also the case the $N_{i+1}/N_i = \gamma$.

The tax structure preferred by the young voter is characterized by the following condition:

$$\frac{1 - \frac{T_i}{Y_i}}{1 - \frac{T_{i+1}}{Y_{i+1}}} = \frac{Y_{i+1}}{Y_i} e^{r/k} \gamma^{-k} \left(\frac{g_i}{g_{i+1}}\right)^{\beta/k} ; \quad i = 0, 1. \qquad [21]$$

The first two factors on the right side of equation 21 are greater than one. However, the product of the third and fourth terms is less than one.[6] Therefore, it cannot be unambiguously determined whether a progressive tax structure is preferred by the young voter in this example. Comparison of 21 with 6, however, indicates that a less progressive tax structure is preferred by the young voter now than was the case with no population growth.

It is interesting to note that this model might also be adapted to a situation in which population is stable but in which government programs provide different consumption benefits, depending on the individual's age. Stable population is implied by $\gamma = 1$ in equation 21. $(g_i/g_{i+1}) > 1$ implies government programs are youth oriented. $(g_i/g_{i+1}) < 1$ implies programs that are of greater benefit to older members of the population. Youth-oriented programs strengthen the younger voters preference for progressivity. Old age programs have the opposite effect.

Consider a second example in which the individual anticipates that tax rates will be reduced during his lifetime in order to main-

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tain a constant level of public expenditures. The young voter now prefers that tax structure which maximizes 18 subject to 20 and:

$$Y_i - \frac{T_i}{\gamma_i} - C_i = 0; \quad i = 0, 1, 2. \qquad [22]$$

The preferred tax structure is now characterized by the following conditions:

$$\frac{1 - \frac{T_i}{Y_i}}{1 - \frac{T_{i+1}}{Y_{i+1}}} = \frac{Y_{i+1}}{Y_i} e^{r/k} \left(\frac{g_i}{g_{i+1}} \right)^{\beta/k}; \quad i = 0, 1. \qquad [23]$$

In this case, a progressive tax structure is unambiguously preferred as the third term on the right in both cases is equal to or greater than one, depending on whether the good being provided is purely (or less than purely) public. The greater the degree of indivisibility, the less progressive is the preferred tax structure.

IMPLICATIONS OF ACCESS TO A BOND MARKET

The preceding analysis was developed with the assumption that individual taxpayers did not have access to a bond market which would allow them to reallocate any nominal distribution of tax burden over their lifetimes. Such an assumption may not be wholly unrealistic if there are substantial transactions costs associated with participation in the bond market or if there are problems with individuals obtaining unsecured loans. However, it is interesting to examine how costless access to a bond market would effect the voter's preferred distribution of tax burden. There are two separate cases to be examined here. The first is that in which the young voter anticipates that his lifetime tax

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burden will be equal to the aggregate tax burden during any single period, i.e., the stable population/stable public expenditures situation initially discussed in this paper. Given this expectation, the young voter would clearly prefer that lifetime pattern of taxation which minimizes the present value of his tax burden. This would require postponing all tax payments until the final period of his life.[7] In this example, the interests of young, middle-aged, and elderly voters clearly conflict. The young voter's desire to postpone his tax payment until the end of his life will be frustrated by the middle-aged and elderly individuals voting to concentrate tax burdens on the young.

A second, interesting example arises if the young voter anticipates expanding public expenditures and expanding tax burden on each age group as time progresses. In this case the young voter would prefer that his lifetime tax burden be concentrated in the first or last period of his life, depending on whether the interest rate is less than or greater than the expected rate of growth of individual tax burden in each income/age class. An example can clarify this. Suppose, for simplicity, that voters live only two periods instead of three, that population is stable and that public expenditures are expected to grow 10% every year. During the first period of the voter's life, public expenditures total $100; during the second period they are expected to rise to $110. The young voter can pay $100 tax in the first period of his life and none in the second or he can pay nothing during the first period and levied taxes of $110 during the last period. Suppose the interest rate is 8%. Clearly the young voter would prefer to pay his taxes during the first period of his life. He could borrow the $100 to meet his tax obligation and only pay $108 principal plus interest during the second period rather than simply postponing his tax obligation, in which case he would pay $110 during period two. If, on the other hand the interest rate were 12%, the individual voter would want to postpone his tax obligation until period two. In the former example, young and old voters would have identical preferences with respect to the allocation of tax burden. In the latter example, their preferences would conflict.

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NOTES

1. Buchanan (1967) has also examined voter preferences with respect to tax structure under similar assumptions.

2. For another use of this normative criterion see Browning (1975).

3. Feldstein (1976) has advanced this interpretation of the equity norm.

4. $e^{r/k}\left(\frac{1+e^{-2r}}{2}\right)^{1/k}\left(\frac{e^{r}+e^{-r}}{2}\right)^{1/k} = \cos r > 1$. I am indebted to an anonymous referee for pointing out an earlier error in my interpretation of this term.

5. Assume that r does not change with age.

6. $^{3}\gamma^{-k} < 1$; $g_i/g_{i+1} \leqslant 1$.

7. The voter will undoubtedly save during the earlier stages of his life in anticipation of taxes to be collected when he is old. Thus, the private consumption foregone in order to meet his tax obligation will be spread over his entire lifetime rather than being concentrated in the last period of his life. However, the possibility of saving at a positive interest rate reduced the total consumption which must be given up if actual tax payment is not required until the final period of the taxpayer's life.

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Marilyn R. Flowers is Associate Professor of Economics at the University of Oklahoma.

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