Tests of a rational theory of the size of government

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The extensive literature on the size and growth of government attests to the long-standing interest of social scientists in the interrelations of economic development, income distribution, political processes, bureaucracy, and tax rates. Recent surveys of parts of this literature (Peacock, 1979; Cameron, 1978; and Larkey, Stolp and Winer, 1981) show that neither theoretical nor empirical work has resolved the main issues. (See also Peltzman, 1980.) There is little agreement about a common model or framework for predicting the size of government or discussing the causes of government growth or decline. And there is no consensus about the empirical evidence on the reasons for changes in the size of government.

The disputes are not about the relevant facts for the twentieth century. Nutter (1978) shows that if the average size of government is measured by either the share of income taken in taxes or spent by government, the size of government has increased in all developed, market economies during the past quarter century. Growth is not a recent phenomenon. Data for the average tax rate or government's share of spending suggest that, judged by these measures, the size of government increased also during the first half of the century in several countries.

Many explanations of the increased size of government emphasize the role of 'suppliers' of government services. Several recent studies (Romer and Rosenthal, 1978; Niskanen, 1971; Fiorina and Noll, 1978) suggest that there is an element of monopoly power on the supply side.¹ Congress, bureaucrats, or 'interest groups' are able to raise government spending above the level that utility maximizing households or voters would choose in the absence of this monopoly power. Models of this kind posit some explicit or implicit cost of acquiring information or taking action and reject the stylized model of the fully informed maximizing voter. Models of 'supply' usually exclude the combined effects of taxes and spending on voters' choices by omitting the

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requirement that the government budget is balanced, in real terms, and other requirements of a general equilibrium solution to the voters' problem.

An earlier tradition placed greater emphasis on voters' demands. De Tocqueville's (1965) perceptive commentaries on early American political arrangements recognize that extension of the franchise to those who do not own property increases the proportion of voters who favor income redistribution. Expressed fears of 'mob rule' are an earlier, and less precise, recognition of the same problem. Unbounded fears of this kind have not been realized; governments have increased in size, but their size has been limited. Theories of the demand for government services and redistribution, or outright redistribution of income, that explain the increased size of government should also explain the forces limiting the size of government.

Following Downs (1957), many models of the demand for government services rely on a representative voter who makes the decisive choice (or choices) for society. Roberts (1977) shows that with universal suffrage and majority rule, the median voter is the decisive voter in a specific kind of single issue election. In our previous work (Meltzer and Richard, 1981), building on Robert's result, we develop a general equilibrium model in which the share of income taken in taxes rises with the difference between mean income and the income of the decisive voter. Franchise extensions and changes in relative productivity alter mean income relative to the income of the decisive voter and change the tax share. Changes in the proportion of the population receiving social security benefits, not subject to tax, increase votes for higher taxes and redistribution. But higher taxes reduce incentives to work, lower aggregate income, and, thus, reduce tax collections. All voters recognize both the costs and the benefits of changes in the size of government; the decisive voter chooses the optimum size.

This essay tests our earlier model using annual data for the United States. In the following section, we restate the model in Meltzer and Richard (1981) using a specific utility function in place of the general function used previously. Our choice of utility function permits us to test for the relation between the level of income and the share of income allocated by government. A positive relation between the two is implied by 'Wagner's law,' one of the most familiar and most frequently tested relations in the literature on the size of government. Our hypothesis qualifies Wagner's law and states the conditions under which it is expected to hold.

Throughout, we identify the size of government with the share of aggregate income allocated by government, but we neglect public goods such as defense, police protection, veterans benefits, and highway spending.² We also neglect those aspects of the political process conventionally regarded as important for allocation to specific programs. Ours is a theory of the size of the government budget, not of the distribution of the budget among specific programs; our model and empirical tests focus on the share of income redistributed and the reasons that the share is large or small.

The model

The country we consider has a large number of persons who differ in productivity and, therefore, in earned income. In other respects, people are alike. All have identical tastes, and all treat prices, wages, and tax rates as given, determined by the market process and the political process. There are no monopolies, and there is no collusion, log-rolling, or coalition formation. The model is static; there is neither capital nor uncertainty.

The utility function is a Stone-Geary function, linear in the logarithms of the principal arguments. The Stone-Geary function is capable of showing whether the share of income taxed remains constant, increases, or decreases as income changes – that is, whether redistribution of consumption goods is viewed as a ‘luxury’ or a ‘necessity.’ Utility depends on consumption, c , and leisure, l .

$$u(c, l) = \ln(c + \gamma) + a \ln(l + \lambda), \quad \lambda > -1. \quad (1)$$

If $\gamma = \lambda = 0$, the utility function specializes to the Cobb-Douglas.

Each person allocates time to labor, n , and leisure, $l = 1 - n$. Income, y , is measured in units of consumption and is produced using a constant returns to scale technology. A person with productivity x earns pre-tax income, y .

$$y = xn(x). \quad (2)$$

The tax rate, t , is a constant fraction of earned income.³ Tax receipts, tnx , provide r units of consumption per capita; therefore, net redistribution to each household is $r - nxt$.⁴ The net payments to government rise monotonically with productivity. At low levels of productivity, net redistribution, $r - nxt$, is positive; the government subsidizes consumption, $c(x)$. There is no saving; consumption equals disposable income – earnings net of taxes plus redistribution.

$$c(x) = (1 - t)nx + r. \quad (3)$$

Each person takes x , t , and r as given and chooses n to maximize utility. Substituting eq. (3) and $l = 1 - n$ into eq. (1), we obtain

$$\max u(c, l) = \max [\ln(r + nx(1 - t) + \gamma) + a \ln(1 - n + \lambda)] \quad (4)$$

Differentiating (4) and solving the first-order conditions for n gives the labor-leisure choice for those who choose to work and those who choose full-time leisure.

$$n(x) = \begin{cases} \frac{(1 + \lambda)x(1 - t) - a(r + \gamma)}{x(1 - t)(1 + a)}, & x > x_0 \\ 0, & x \leq x_0 \end{cases} \quad (5)$$

$$\text{such that } x_0 = \frac{a(r + \gamma)}{(1 - t)(1 + \lambda)}; \quad (6)$$

x_0 is the productivity level of the last person who chooses not to work.

If there is neither taxes nor redistribution, $t = r = 0$. In this polar case, n is at a maximum, but $x_0 > 0$ if $\gamma > 0$. (This is a property of the utility function.) From (5) and (6) we see that as r increases, n falls and x_0 rises. Similarly, as the tax rate, t , rises, labor supply, n , falls and x_0 rises.

To find an equilibrium relation between taxes and income that can be estimated empirically, we must show that the system reaches equilibrium for the value of t that the voters choose. This requires three steps. First, we require that consumption and leisure are normal goods, so that increases in disposable income increase consumption and leisure. From (3) and (5), we have $\frac{\partial n}{\partial r} < 0$ and $\frac{\partial c}{\partial r} = \frac{1}{1 + a} > 0$, so these conditions are satisfied. Second, earned income – income before taxes and redistribution – must increase with productivity. If this is not so, we cannot use observed income to infer the relation between votes and productivity. The assumption that leisure and consumption are normal goods implies that

$$\frac{\partial y}{\partial x} = \frac{1 + \lambda}{1 + a} > 0, \text{ for } x > x_0, \quad (7)$$

so the ordering of productivity orders income.

The third step requires a bit more development. We want to show that the choice of the tax rate (or per capita redistribution, r) determines unique, equilibrium values for consumption, income, labor (or leisure), and the size of government. Let $F(\cdot)$ be a distribution function for individual productivity, so that $F(x)$ is the fraction of the population with productivity less than x . Per capita income, $\bar{y}$, is given by

$$\bar{y} = \int_{x_0}^{\infty} xn(x) dF(x). \quad (8)$$

Rewrite eq. (6) as $x_0(1 - t)(1 + \lambda) = a(r + \gamma)$; substitute this expression into (5), and calculate $y = nx = \frac{1 + \lambda}{1 + a}(x - x_0)$, $x \geq x_0$. Substituting into (8) yields

$$\bar{y}(x_0) = \frac{1 + \lambda}{1 + a} \int_{x_0}^{\infty} (x - x_0) dF(x). \quad (9)$$

Average income, $\bar{y}$, and therefore aggregate income, is determined once we know the productivity of the last non-worker, x_0 . From (6), we see that x_0 depends on the parameters of the utility function and on r and t . The choice of r and t determines equilibrium values of n , y , and c for each person and x_0 for society.

A balanced budget reduces the voter's choice to a single variable, r or t . The requirement that the budget is balanced is not an arbitrary restriction, since r is a real variable and the government (or redistributive mechanism) transfers real resources. Hence, the budget must be balanced in real terms. Formally, the budget is balanced when

$$t\bar{y} = r. \quad (10)$$

The left side of (10) is a decreasing function of r , since

$$\frac{\partial \bar{y}}{\partial r} = \int_{x_0}^{\infty} x \frac{\partial n}{\partial r} dF(x) < 0.$$

Previously, we showed that $\frac{\partial n}{\partial r} < 0$. The right side of (10) increases with r .

Since the two sides of (10) change in opposite directions as r changes, there is a unique value of r at which the budget is balanced. Equivalently, we can treat (10) as an equation that determines the t that maximizes utility and achieves budget balance for a given r .

The choice of tax rate depends on the relative valuation that the decisive voter places on taxes and redistribution and, therefore, on the productivity of the decisive voter. If the decisive voter has $x \leq x_0$, he does not work. His preferred choice is for maximum redistribution, but maximum redistribution is obtained at $t < 1$ as long as some people respond to incentives to work. In this analysis $\frac{\partial \bar{y}}{\partial r} < 0$ is sufficient to assure that the maximum tax is

below $t = 1$. A decisive voter with above average productivity recognizes that his net taxes are positive at any $t > 0$, so he chooses $t = 0$. A decisive voter between these extremes balances the utility gain from increased redistribution against the utility loss from higher taxes. In reaching his decision, he is concerned only with his own utility, but his utility depends on everyone's decision to work, because all taxpayers contribute to the budget and the amount available for redistribution.⁵

Formally, the decisive voter chooses a tax rate that balances the budget and maximizes utility, eq. (4), subject to his budget constraint, eq. (3). Let x_d and n_d

denote the productivity and hours of work for the decisive voter; $y_d = x_d n_d$ is then the earned income of the decisive voter. The preferred tax rate is the rate t that satisfies⁶

$$\bar{y} + t \frac{d\bar{y}}{dt} - y_d = 0. \quad (11)$$

By differentiating (9) and using (6) and (10), we find that⁷

$$\frac{d\bar{y}}{dt} = - \frac{a(1 - F(x_0))(\bar{y} + \gamma)}{(1 - t)[1 + a - t(1 + aF(x_0))]}, \quad (12)$$

such that $F(x_0)$ is the fraction of the population that does not work. Substituting (12) into (11) and denoting $g = \frac{\gamma}{y_d}$ and $m = \frac{\bar{y}}{y_d}$, we find

$$0 = \frac{1 + aF(x_0)}{a(1 - F(x_0))} (m - 1)(1 - t)^2 + (2m + g - 1)(1 - t) - (m + g). \quad (13)$$

The solution to equation (13) is the optimal tax rate for a decisive voter who works and chooses $t > 0$.

Equation (13) is an equilibrium relation between t , m and F . For given productivity and tastes, the decisive voter's choice of t determines x_0 , $\bar{y}$, and m , and all other endogenous variables follow. When making his choice, the decisive voter is aware that he cannot treat (13) as a quadratic function in t . The reason is that m and x_0 depend on the choice of t .

Empirical tests

To estimate equation (13), we take a linear approximation, specify a decisive voter, and choose empirical counterparts for m , $F(x_0)$, g , and t . This section discusses the choices – and compromises – we make, derives the expected signs of coefficients, and presents the results of our estimation.

Roberts (1977) shows that the voter with median income is decisive in single issue elections to choose a linear tax rate. His results do not consider the effect of turnout.⁸ In practice, differential turnout and restrictions on voting drive a wedge between the person with median income and the median voter defined in voting models. We cannot locate comprehensive time series data on the distribution of voters' earned income, so we use the income of the median income earner as a proxy for the income of the median voter. We assume that the person with median income is decisive in elections to choose the tax rate, so m is the ratio of mean to median income and g is the ratio of γ to median income.

To obtain a linear approximation of (13), we solve for $1 - t$.

$$1 - t = \frac{-2m + 1 - g + (1 + g) \left[1 + \frac{4b}{1 + g}(m - 1) + \frac{4b}{(1 + g)^2}(m - 1)^2 \right]^{1/2}}{2(m - 1)(b - 1)},$$

such that $b = \frac{(1 + a)}{a(1 - F)}$. Expanding by means of a first-order approximation in $m - 1$ and g gives as an approximation⁹

$$t \approx \left(\frac{1 + a}{a} \right) \frac{m - 1}{1 - F} \frac{1}{1 + g}.$$

Taking logs and letting g approximate $\ln(1 + g)$ for small g , we have

$$\ln t + \ln(1 - F) = \ln \frac{1 + a}{a} + \ln(m - 1) - \frac{\gamma}{y_d}. \quad (14)$$

Two problems remain in estimating (14). The first is the possibility of simultaneous equations bias. This possibility arises because (14) is an equilibrium relation containing t and $F(x_0)$, and the same process determines both. We avoid this problem by using $\ln t + \ln(1 - F)$ as the dependent variable.¹⁰ The second problem is the specification of a measure of the distribution of income that is not subject to large reporting bias and is available for a period long enough to induce a noticeable change in the size of government. We use data from social security payments to compute m as the ratio of mean to median income from labor services and measure y_d . War years are omitted. $F(x_0)$ is measured by the proportion of the population receiving payments for old age, disability, blindness, and aid to families with dependent children. The share of earned income used for redistribution (t) is computed from Federal, state, and local data. (The appendix describes the data and our procedures more fully.) Public goods are omitted.

Table 1 shows the estimates of the parameters of eq. (14). The data generally support the hypothesis, but we must note some reservations. Eq. (14) implies that the coefficient of $\ln(m - 1)$ is plus one. We obtain the expected sign, but the coefficient is much below unity. Some of the problem undoubtedly results from our use of a linear approximation. The derivative of t with respect to m from eq. (13) is not constant and bears no obvious relation to unity. Further, the estimated elasticity of $t(1 - F)$ with respect to $m - 1$, 0.48, implies that, at current values of net national product, a one percent change in $m - 1$, holding $F(x_0)$ constant, changes total spending on redistribution by \$1.5 billion. A \$3

billion increase, implied by a unit coefficient on $\ln(m-1)$, seems too large, suggesting that the linear approximation overstates the response.¹¹

Table 1. Least squares estimates of equation (14)

Dependent variable	$\ln(m-1)$	$\frac{1}{y_d}$	Constant	R ²	DW	HL
$\ln t(1-F)$	.57 (9.1)	-1081 (5.0)	-1.09	0.80	1.30	—
$\ln t(1-F)$	.48 (5.5)	-1402 (4.3)	-1.13	.81	1.61 ^u	.3
$\ln t_2(1-F)$	.48 (9.2)	28.3 (.16)	-1.95	.73	1.09	—
$\ln t_2(1-F)$	.34 (6.0)	-219 (1.0)	-2.08	.80	1.72 ^u	.3
$\ln t_3(1-F)$	.67 (5.5)	-3461 (8.1)	-1.37	.79	1.71 ^u	—
$\ln t_3(1-F)$	.71 (4.0)	-3781 (5.8)	-1.25	.79	1.90 ^u	.3

t-statistics are shown in parentheses. DW is the Durbin-Watson statistic; superscript *u* on DW denotes that serial correlation is rejected or indeterminate at .05 level for the value of ρ shown under HL using a one-tail test. HL indicates the value of ρ in the Hildreth-Lu procedure. $t = t_2 + t_3$ is the sum of publicly supplied private goods (t_2) and 'pure' redistribution (t_3). Data period 1937-40 and 1946-76 inclusive. HL correction loses two observations, 1937 and 1946.

Wagner's law is one of the oldest and most frequently tested explanations of the growth of government. This law has been interpreted in two ways. The traditional interpretation is that government services are a luxury good, so a positive relation exists between the relative size of government and the level of real income. Recently, Alt (1980: 4) has questioned this interpretation of Wagner's idea. He notes that Wagner stated that there is 'a proportion between public expenditure and national income which may not be permanently overstepped.' This suggests an equilibrium relative size of government rather than an ever-growing government sector.

The traditional statement of Wagner's law – that government grows more rapidly than income – has been tested many times, but with mixed results. Recent surveys discuss tests of Wagner's law applied to different areas of government activity (Cameron, 1978; Larkey, Stolp and Winer, 1981).

Our model suggests that previous tests of Wagner's law may suffer for two reasons. First, they omit a key explanatory variable, some measure of the relative income distribution. Second, they use aggregate income or average income as an explanatory variable instead of the reciprocal of median income.

Equation (14) implies a relation between the ratio of mean to median income, m , and the share of income allocated by government, but it also implies a relation between the reciprocal of median income and the share of income allocated by government. The direction of the effect and its existence depends on γ . When $\gamma = 0$, the size of government is independent of the level of income, because the marginal utility of consumption is independent of income. A positive value of γ lowers the marginal utility of consumption at each level of income. The decisive voter, with $\gamma > 0$, votes for higher taxes and more redistribution despite the reduction in aggregate income and consumption that results. A negative value of γ implies that taxes and redistribution decline as median income rises.

The use of aggregate income instead of the reciprocal of median income is not a serious source of misspecification in our test of Wagner's law. Table 2 shows that if we substitute the log of real GNP for $1/y$, the qualitative results remain unaffected. Therefore, we may treat our result as a test of Wagner's law and treat our findings as evidence that Wagner's law must be amended to include the effect of relative income.

Table 2. The effect of aggregate income^a

Dependent variable	$\ln(m-1)$	$\ln y$	Constant	R ²	DW	HL
¹ $\ln t(1-F)$	.51 (7.8)	.19 (5.2)	-2.75	.81	1.31	—
² $\ln t(1-F)$	.35 (4.0)	.25 (5.0)	-3.33	.83	1.67 ^a	.3
³ $\ln t_2(1-F)$	.49 (8.8)	-0.01 (.3)	-1.87	.74	1.10	—
⁴ $\ln t_2(1-F)$	.31 (5.2)	.05 (1.6)	-2.53	.81	1.70 ^a	.3
⁵ $\ln t_3(1-F)$	.46 (3.8)	.62 (9.1)	-6.69	.82	1.62 ^a	—
⁶ $\ln t_3(1-F)$	.38 (2.06)	.64 (6.0)	-6.89	.80	1.93 ^a	.3

^a See footnotes to Table 1. y is real GNP.

The findings support three conclusions about redistribution. First, the share of income redistributed increases with income, but the size of the response depends on the level of (median) income. The reason is that the two components of redistribution that we study – 'pure' redistribution (t_3) and publicly supplied private goods (t_2) – respond differently to income.¹² Income has considerably larger and a statistically more reliable effect on t_3 than on t_2 . Increases in real income appear to stimulate demand for t_3 and t , and reductions of income appear to reduce the demand for t_3 and t but do not affect t_2 .

Second, Wagner's law is not a general law but must be qualified. The conflicting evidence for and against various versions of Wagner's law, found in previous studies, may reflect a failure to allow for changes in the composition of redistribution. As income rises, people choose relatively more redistribution in cash, which permits maintenance of consumption with less work. The growth of social security transfers and unemployment compensation, major programs redistributing cash, are consistent with this finding.

Third, the results generally support our hypothesis and suggest that a substantial part of the growth of government is a response to voter demand. Although we have not tested, and cannot exclude, other plausible explanations – including the much discussed pressure groups, bureaucrats, and politicians – our findings support an explanation based on rational choice, and assign a non-negligible weight to voters' choice of the size of government as an explanation of observed changes in the relative size of government.

Conclusion

In many countries, the political party holding power changes more frequently than the trend growth rates in government spending and taxes. Shifts of political power are often preceded by rhetoric about 'meeting needs' or cutting taxes, which post-election performances rarely match. Yet, changes in the size of government, up and down, occur. On average, the size of government, measured by the share of taxes or spending to output, has increased in many countries during the past century, but changes in size occur at different rates and, at times, the relative size of government declines.

In recent work (Meltzer and Richard, 1981), we develop a general equilibrium model in which people choose consumption and leisure and, as voters, decide on income redistribution or the (average) tax rate. The model implies that the size of government changes with the ratio of mean income to the income of the decisive voter and with the voting rule or qualifications for voting. Extensions of the franchise that increase the number of voters who benefit from income redistribution increase votes for redistribution. The size of government increases. Changes in the age composition of the population that increase the proportion of the population receiving old age assistance also increase redistribution paid from taxes on labor income. The relation is symmetric. Changes in productivity, or in labor force participation, that lower mean income relative to the income of the decisive voter, reduce the size of government.

The tests of the model reported here treat the person with median income as the decisive voter. We find that the ratio of government spending for redistribution to aggregate income, and the share of aggregate income redistributed in cash, rise and fall with the ratio of mean to median income and

the level of (median) income. Redistribution in kind – the provision of education, health care, fire protection, and other services – also rises and falls with the ratio of mean to median income, but it appears to be independent of the level of income.

Our model implies, and the data suggest, that Wagner's law – relating the size of government to the level of income – must be amended. The relation is not simple and direct, as many tests of Wagner's law presuppose, but depends, in our model, on shape of the income distribution – more specifically on the ratio of mean to median income. Failure to hold the distribution of income constant renders many previous tests meaningless. Further, our results suggest that voters' choice of the nature of redistribution – in cash or in kind – affects the results. Although we do not derive the relation between size of government and voters' choice of cash or in-kind benefits (and we neglect public goods), our results suggest that Wagner's law is more likely to find support if redistribution is in cash.

Our hypothesis is parsimonious. There is no uncertainty. Taxes are linear, and all redistribution is by lump sum transfer. The decisive voter is fully cognizant of the costs and benefits of the redistribution he demands, including the effects on incentives to work and consume. We neglect most features of the political process, including any influence of interest groups, bureaucrats, and other monopoly elements that affect 'supply.' We recognize that a useful extension of our model would incorporate the allocation of funds to specific programs and thereby incorporate 'supply' factors. In our empirical work, we rely on a linear approximation to a non-linear equation and obtain our estimates from an equilibrium relation, not a structural equation. Despite the model's parsimony, the neglect of supply factors, the use of a linear approximation, and data interpolation, the hypothesis explains much of the trend in the relative size of spending for redistribution and a considerable part of the annual variation observed in the United States during a recent forty-year period.

During the period we studied, our measure of government spending for redistribution increased, in nominal value, from \$10 billion to more than \$350 billion and the share of total income redistributed rose from 12% to 22%. A considerable part of the observed increase in the size of government appears to be consistent with rational choice by maximizing voters who benefit from redistribution and are able to shift a disproportionate share of the cost to people with incomes above the mean.

NOTES

1. An alternative demand-for-government model developed by Aranson and Ordeshook (1977) treats the political process as a mechanism through which individual demands are revealed.
2. The appendix describes our classification of government spending as public goods, publicly supplied private goods, and pure redistribution. The appendix also lists nominal values of the data used and a description of sources and methods. We recognize that we have not developed a theory of allocation, so our classifications involve judgment. The data are available upon request.
3. By assumption, productivity is not directly observable, so income is taxed instead of productivity.
4. A finding that beneficiaries of particular programs, for example, college education, have average incomes above the population mean does not invalidate our theory. We predict net redistribution and the size of government, not the redistributive effects of particular programs.
5. Everyone who works receives a wage equal to his marginal (and average) productivity, as can be seen from eq. (2), and pays a tax.
6. To derive (11) substitute (10) and $y_d = n_d x_d$ into (4), to get

$$u = \ln(t\bar{y} + y_d(1-t) + \gamma) + a \ln(1 - n_d + \lambda).$$

Then,

$$\frac{du}{dt} = \frac{\bar{y} + t \frac{d\bar{y}}{dt} - y_d}{t\bar{y} + y_d(1-t) + \gamma} + \frac{dn_d}{dt} \left[\frac{x_d(1-t)}{t\bar{y} + y_d(1-t) + \gamma} - \frac{a}{1 - n_d + \lambda} \right].$$

The second term is zero for a non-worker, since $\frac{dn_d}{dt} = 0$; it is also zero for a worker, as can be seen by substituting (5) into the coefficient of $\frac{dn_d}{dt}$:

$$\begin{aligned} \text{coefficient of } \frac{dn_d}{dt} &= \frac{x_d(1-t)[1 + \lambda - n_d] - a(r + \gamma + x_d n_d(1-t))}{D} \\ &= \frac{1}{D} [x_d(1-t)(1 + \lambda) - x_d n_d(1-t)(1 + a) - a(r + \gamma)] \\ &= \frac{1}{D} [x_d(1-t)(1 + \lambda) - (1 + \lambda)x_d(1-t) + a(r + \gamma) - a(r + \gamma)] = 0, \end{aligned}$$

where $D = [r + \gamma + x_d n_d(1-t)][1 + \lambda - n_d]$.

Utility maximization requires that $\frac{du}{dt} = 0$, which implies (11).

7. Differentiating (9) we get

$$\frac{d\bar{y}}{dt} = -\frac{1 + \lambda}{1 + a} \int_{x_0}^{\infty} \frac{dx_0}{dt} dF(x) = -\frac{1 + \lambda}{1 + a} \frac{dx_0}{dt} (1 - F(x_0)). \quad (F1)$$

Differentiating (6) we find

$$\frac{dx_0}{dt} = \frac{a \left[\frac{dr}{dt} (1-t) + r + \gamma \right]}{(1 + \lambda)(1-t)^2}. \quad (\text{F2})$$

Now $r = t\bar{y}$ can be differentiated to yield

$$\frac{dr}{dt} = \bar{y} + t \frac{d\bar{y}}{dt}. \quad (\text{F3})$$

Substituting (F3) and $r = t\bar{y}$ into (F2) gives

$$\frac{dx_0}{dt} = \frac{a \left[\left(\bar{y} + t \frac{d\bar{y}}{dt} \right) (1-t) + t\bar{y} + \gamma \right]}{(1 + \lambda)(1-t)^2}. \quad (\text{F4})$$

Finally substitute (F4) into (F1) and collect the term in $\frac{d\bar{y}}{dt}$ to get (12).

8. Several papers show that median voter theorems require strong restrictions on tastes. A recent summary of this literature is in Aranson and Ordeshook (1981). Empirical work yields ambiguous conclusions. Romer and Rosenthal (1979) show that many of the tests do not distinguish between the median and other fractiles, so no firm conclusion can be drawn from them. Cooter and Helpman (1974) estimate the shape of the social welfare function implicit in U.S. data and conclude that the data are consistent with the median voter rule.
9. We use the following approximation for small x .

$$(1 + px + qx^2)^{1/2} \approx 1 + \frac{p}{2}x + \frac{1}{2} \left(q - \frac{p^2}{4} \right) x^2 + o(x^3)$$

10. An additional aspect of this problem arises from our use of $m-1$ and y_4 as independent variables. To avoid this problem, we require a theory of the (simultaneously determined) distribution of income, a task far beyond this paper. We chose to treat $m-1$ and y_4 as determinants of the levels of t and x_0 for our preliminary test. The converse has little appeal to us.
11. Regressions with $1-F$ on the right side of the equation produce the expected signs for $\ln(m-1)$ and $\ln(1-F)$, but the coefficient differs from unity, the value implied by (14). The use of a linear approximation may explain some of the difference between implied and computed values.
12. We do not provide a theory of the distribution of expenditures between t_2 and t_3 , so our classification is judgmental. We do not try to reclassify between t_2 , t_3 , and public goods, so we can only conjecture about the extent to which reclassification would affect our results. As noted elsewhere in note 2, the data are available for those who wish to reestimate.

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Data appendix*

I. Main sources of data

- (1) Government Spending. Fiscal years 1936-72: U.S. Bureau of the Census, *Census of Governments*, Vol. 6, no. 4. Historical Statistics on Government Finances and Unemployment, Tables 1, 3, and 4. Fiscal Years 1972-77: U.S. Bureau of the Census, currently unpublished data to appear in 1977 *Census of Governments*. Data were available for all years 1952-77 and for even years 1936-50. Three sources were used to interpolate the odd numbered years 1937 to 1951 inclusive.
 - (a) The Budget of the U.S. Government, Summary Budget Statements and Message of the President for Fiscal Years 1946, 1948, 1952, and 1955;
 - (b) Bureau of the Census, *Compendium of State Government Finances*. (Also published as *Financial Statistics of States* [year] and as *State Finances* [year]);
 - (c) Bureau of the Census, *Compendium of City Government Finances* [year].
- (2) Welfare recipients, including old age, disability, blindness, and families receiving aid to families with dependent children, 1937-49: *Annual Statistical Supplement to Social Security Bulletin*, Table 60 'Public Assistance and Federal work programs,' various years; 1950-77: *Statistical Abstract of the U.S.* Table 562, Public Aid, various years.
- (3) Mean and Median income: 1937-1976, *Social Security Bulletin, Annual Statistical Supplement*, various years, for example 1974, Table 37 for median earnings all workers and

*All data used are available upon request.

Table 34 for mean earnings. 1949-64, Bureau of the Census, Technical Paper 17; 1964-76, Current Population Reports, Series P. 60.

- (4) Gross national product 1937-38: *Economic Report of the President*, Jan. 1971, 1939-76, *ibid.* Jan. 1980.

II. Definitions of government spending

- (1) Public supply of private goods includes:
 - (a) postal service,
 - (b) higher education,
 - (c) local schools,
 - (d) other education,
 - (e) hospitals,
 - (f) local fire,
 - (g) local sanitation,
 - (h) other natural resources,
 - (i) non-highway transportation,
 - (j) utilities and liquor stores.
- (2) Redistribution includes:
 - (a) public assistance,
 - (b) public welfare,
 - (c) stabilization of farm prices and incomes,
 - (d) housing and urban renewal,
 - (e) unemployment compensation,
 - (f) old age, disability and survivors insurance,
 - (g) other insurance.
- (3) Public goods: Remaining items, mainly police, defense, veterans benefits, and highways are classified as public goods. These items are *not* used in our statistical estimation.
- (4) Remaining items include 'other and unallocable' and employee retirement.

III. Interpolation and adjustment

- (1) General interpolation for odd numbered years between 1936 and 1952. Data for state and local spending was not available for these odd numbered years. Data were taken from the *Budget of the United States Government*, Summary Budget Statements, the Census Bureau's Annual *Compendium of State Government Finances* and the annual *Compendium of City Government Finances*. Data were deflated by an index of wages for full-time equivalent employees in federal, state, and local government using data from the national income account. (*National Income and Product Accounts of the United States, 1927-74*, p. 210). Public supply of private goods and redistribution were treated separately. A linear regression was run using the deflated data as independent variable and the longer, more comprehensive time series from the *Census of Governments* as independent variables. Observations for the eight *even* years 1938-52 inclusive were used to estimate coefficients, and the coefficients were used with data based on the *Compendium of State Government Finances* and the *Compendium of City Government Finances* to interpolate the odd numbered years 1937-1951 inclusive that were not available in the *Census of Governments* data base. The interpolated data were then transformed to nominal terms. The proportion of the series adjusted using the nominal wage of Federal employees was computed using the share of Federal expenditure in the unadjusted series for both major categories of spending. Data for war years 1941-45 inclusive were computed but not used.
 - (2) Specific adjustments – public supply of private goods. Merchant marine expenditure was highly correlated with war-time spending. These data were removed from the series used in the regression. Data were added back to the interpolated series. Data for utility and
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liquor stores could not be obtained from *Compendium* with sufficient comparability to data in *Census of Governments*. Linear interpolation of the *Census of Governments* were used for odd numbered years between 1936 and 1952.

- (3) Shares of income redistributed were computed by deflating spending by fiscal year nominal net national product.

IV. Data in billions of dollars

Fiscal year	Public supply of private goods (1)	Redistribution (2)
1937	8.3	2.2
1938	7.2	2.0
1939	7.6	3.0
1940	8.3	3.0
1946	10.5	5.6
1947	13.3	5.7
1948	16.5	5.0
1949	18.8	8.7
1950	20.9	12.5
1951	22.1	7.4
1952	23.0	9.0
1953	24.0	11.0
1954	25.4	14.1
1955	27.4	15.6
1956	30.1	16.1
1957	32.4	17.2
1958	35.7	20.3
1959	38.3	24.3
1960	40.8	24.4
1961	44.8	29.4
1962	47.2	31.8
1963	49.9	32.6
1964	54.8	33.9
1965	59.4	35.8
1966	67.1	37.8
1967	74.6	44.5
1968	80.3	49.8
1969	90.2	58.1
1970	99.2	67.1
1971	114.4	80.8
1972	127.2	89.9
1973	135.0	104.8
1974	149.6	115.4
1975	174.2	142.4
1976	194.1	164.5
1977	210.4	182.1