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A CROSS-COUNTRY STUDY OF GROWTH, SAVING, AND GOVERNMENT

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ABSTRACT

Models of endogenous economic growth can generate long-term growth without relying on exogenous changes in technology or population. A general feature of these models is the presence of constant or increasing returns in the factors that can be accumulated. I use some models of this type to study the determination of per capita growth, investment in physical and human capital, and population growth. The determinants of these variables involve aspects of government policy -- including public infrastructure services, maintenance of property rights, government consumption, and taxation -- and the initial level of per capita income.

I examine the predicted relationships by using a cross-country sample that expands on the Summers-Heston set of about 120 countries. Aside from their data on levels of per capita GDP and the breakdown of GDP into components, I have added information about the composition of government expenditures, proxies for economic freedom and property rights, measures of political stability, and so on. This expansion in variables reduced the number of countries to 72.

The findings verify some of the predictions about the determination of growth and investment/saving rates. For example, government consumption and investment spending, and proxies for economic freedom show up as suggested by the models. Also, the interplay among population growth, investment in human capital (school enrollment), and the initial level of per capita income confirm theoretical predictions about the tradeoff between the quantity and quality of children. I anticipate that additional results will emerge from my ongoing research in this area.

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Government policies have numerous effects on a country's economic performance. In this study I assess the effects of various kinds of public services and taxation on long-term rates of growth and saving. The focus of the research is an empirical investigation of the growth experiences of a large number of countries in the post-World War II period. The framework for this empirical work derives from some recent theories of endogenous economic growth. In part I, I sketch a model where public services and taxation affect an economy's long-term growth and saving. This model neglects population growth, allows no distinction between physical and human capital, and concentrates on steady-state results. Part II extends the theory to allow for choices of population growth, and for distinctions between physical and human capital. Part III brings in some transitional dynamics. In this extension, increases in per capita income go along with decreases in population growth and increases in the amount invested in each person's human capital. Part IV discusses the empirical findings. These results are preliminary, and amount to a progress report from an ongoing project on economic growth.

I. Effects of Government Policies on Long-Term Growth and Saving

In this section I discuss a theory of the long-term effects of government policies on saving and economic growth. The analysis is an exposition and extension of a model developed more fully in Barro (1988), which built on work by Romer (1989), Lucas (1988), and Rebelo (1987). The aspects of government policies considered are the effects of public services on private production and household utility, the influences of governmental activities on property rights, and the effects of taxation on private incentives to save and invest.

Assume that the representative household in a closed economy seeks to maximize

$$U = \int_0^{\infty} u(c)e^{-\rho t}dt, \tag{1}$$

where u is the momentary utility function, c is consumption per person, and $\rho > 0$ is the constant rate of time preference. The form of the utility function is

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}, \quad \sigma > 0 \tag{2}$$

so that marginal utility has a constant elasticity with respect to c. The case where $\sigma = 1$ corresponds to log utility. The infinite horizon in equation (1) applies naturally when parents are altruistic toward children, who are altruistic toward their children, and so on. Then the rate of time preference can be thought of as reflecting the degree of altruism toward children, rather than the influence of time, *per se*. I assume at this point that population (which equals the labor force) is constant, although later parts of the paper allow for population growth.

In the main analysis, the production function has the Cobb-Douglas form,

$$y = Ak^{1-\alpha}g^{\alpha}, \tag{3}$$

where $0 < \alpha < 1$, y is output per person (assumed to be net of depreciation of capital), k is capital per person, and g (representing public services) corresponds to real government purchases per person. Production could be carried out directly by households, or equivalently by competitive firms. I assume a one-sector production technology, so that (net) product, y, can be used either for consumption, c, (net) investment, $\dot{k}$, or government purchases, g.

I assume that the government buys only final product from the private sector, including bridge services, jet fighter services, etc. Alternatively, the government could buy labor services and capital goods or services from the private sector, and then use these inputs to carry out public production. If the technologies for the government and the private sector are the same, and if capital is mobile between the public and private sectors, the results would not change. At this point I assume that public services (provided free of charge to the users) enter into the production function, but not directly into the utility function.

The idea behind equation (3) is that some "infrastructure" activities of government are inputs to private production and also raise the marginal product of private capital. For the usual public-goods reasons, such as non-excludability and perhaps increasing returns to scale, the private market does not sustain the "appropriate" level of these services. These considerations apply especially to activities such as the enforcement of laws and contracts, national defense, and perhaps to highways, water systems, and so on. In equation (3), output per capita, y, depends on government purchases per capita, g. In some cases (where public services are truly public, in the sense of non-rival), it would be more accurate to relate y to the total of government purchases, rather than to the amount per capita.

Equation (3) assumes constant returns to scale in k and g. The variable k should be interpreted as a broad measure of private input, which is viewed as the service flow from a broad concept of private capital. Thus, k includes physical capital, human capital, and aspects of privately-owned knowledge. (My analysis does not consider the free-rider problems associated with general-purpose knowledge, as analyzed by Romer, 1986.) Then the idea is that constant returns apply to this broad measure of reproducible capital, as long as the public service input, g, changes in the same proportion as k.

In the initial setup the government is constrained to a balanced budget and a proportional income tax at rate τ. Hence

$$g = \tau y = \tau A k^{1-\alpha} g^{\alpha} \tag{4}$$

Using equation (3) to calculate the marginal product of capital, f_k (calculated when k changes with g held fixed), and substituting $g = \tau y$ leads to

$$f_k = (1-\alpha) \cdot A^{1/(1-\alpha)} \cdot \tau^{\alpha/(1-\alpha)} \tag{5}$$

Given the specification of the production function in equation (3), an increase in $\tau = g/y$ shifts upward the marginal product of private capital in equation (5).

Given the form of equation (1), the initial capital k(0), and a proportional income tax at rate τ, the first-order condition for each household's maximization of utility leads in the usual way to a condition for the growth rate of consumption per person,

$$(6) \qquad \gamma = \dot{c}/c = (1/\sigma)\cdot[(1-\alpha)\cdot A^{1/(1-\alpha)}\cdot(1-\tau)\cdot\tau^{\alpha/(1-\alpha)} - \rho]$$

where γ denotes a per capita growth rate. The expression within the brackets and to the left of the minus sign is $(1-\tau)\cdot f_k$, which is the private rate of return to investment (and saving). I assume parameter values for A, α, and ρ so that γ is positive for some values of τ (which means that sustained per capita growth is feasible in this model), and values for A, α, ρ, and σ so that the attained utility, U, is finite for all values of τ. (The latter condition holds for sure if $\sigma \geq 1$—for example, with log utility where σ=1.)

In this model the economy is always in a steady state where the variables c, k, and y all grow at the rate γ shown in equation (6). The levels for the paths of c, k, and y are determined by the initial quantity of capital, k(0). Using equation (3) and the condition, $g = \tau y$, the level of output can be written as

$$(7) \qquad y = A^{1/(1-\alpha)}\cdot\tau^{\alpha/(1-\alpha)}\cdot k$$

Therefore, k(0) determines y(0) from equation (7), given the value of τ. The initial level of consumption, c(0), equals y(0) less initial investment, $\dot{k}(0)$, and less initial government purchases, $\tau\cdot y(0)$. Using the fact that initial investment equals $\gamma\cdot k(0)$ (because the capital stock grows always at the proportionate rate γ), the initial level of consumption turns out to be

$$(8) \qquad c(0) = k(0)\cdot[(1-\tau)\cdot A^{1/(1-\alpha)}\cdot\tau^{\alpha/(1-\alpha)} - \gamma]$$

Figure 1 (which assumes particular parameter values for α, σ, A, and ρ, and is meant only to be illustrative) shows the relation between γ and τ. The growth rate γ rises initially with τ because of the effect of public services on private productivity. As τ increases, γ eventually reaches a peak and subsequently declines because of the reduction in the term, $1-\tau$, which is the fraction of income that an individual retains at the margin. The peak in the growth rate occurs when $\tau = \alpha$. Given the form of equation (3), this point corresponds to the natural efficiency condition, $f_g = 1$. (At this point, an increment in g by one unit generates just enough extra output to balance the resources used up by the government.) This result—that the productive efficiency condition for g holds despite the presence of a distorting income tax—depends on the Cobb-Douglas form of the production function. However, the general nature of the relation between γ and τ applies for other forms of production functions. The basic idea is that more government activity of the infrastructure type is good initially for growth and investment because anarchy is bad for private production. However, as the government expands, the rise in the tax rate, τ, deters private investment. This element dominates eventually, so that growth and the size of government are negatively related when the government is already very large.

The saving rate is given by

$$(9) \qquad s = \dot{k}/y = \gamma\cdot A^{-1/(1-\alpha)}\cdot\tau^{-\alpha/(1-\alpha)}$$

Substituting the result for γ from equation (6) leads to the relation between s and τ that is shown in Figure 2. The behavior is similar to that in Figure 1, but s must peak in the region where $\tau < \alpha$.

In this type of model, where steady-state per capita growth arises because of constant returns to a broad concept of capital, the growth and saving rates, γ and s, are intimately connected. The analysis predicts that various elements, including government policies, will affect growth and saving rates in the same direction. This result differs from the predictions of models of the Solow (1956)-Cass (1965)-Koopmans (1965) type, where the steady-state per capita growth rate (reflecting exogenous technological progress) is unrelated to the saving rate (or to parameters, such as the rate of time preference, that influence saving).

I show the following in Barro (1988):

(1) With a Cobb-Douglas production technology, the choice $\tau = \alpha$, which corresponds to $f_g = 1$, maximizes the utility attained by the representative household. That is, maximizing U corresponds to maximizing γ, even though a shift in τ has implications (of ambiguous sign) for the level of c, through the impact on c(0) in equation (8).

(2) A command optimum also entails $\tau = \alpha$ ($f_g = 1$), but has higher growth and saving rates than the decentralized solution. The deficiencies of growth and saving in the decentralized result reflect the distorting influence of the income tax.

(3) The decentralized equilibrium corresponds to the command optimum if taxes are lump sum and if the size of government is set optimally at $g/y = \alpha$. (In the present setting, with no labor-leisure choice, a

consumption tax is equivalent to a lump-sum tax.) However, if $g/y \neq \alpha$, the decentralized results with lump-sum taxes differ from the command optimum (conditioned on the specified value of g/y). The last result reflects external effects that involve the determination of aggregate government expenditures (given that the ratio, g/y, is set at a specified, non-optimal value).

(4) The results depend on how public services enter into the production function. The specification assumes that an individual producer cares about the quantity of government purchases per capita (and not—as with the space program, the Washington Monument, and not too many other governmental programs—on the aggregate of government purchases). The setup assumes also that the quantity of public services available to an individual does not depend on the amount of that individual's economic activity (represented by k and y). If an increase in an individual's production, y, leads automatically to an increase in that individual's public services (as with sewers and police services, and perhaps with national security), an income tax (or a user fee) can give better results than a lump-sum tax.

Thus far, the model views public services as entering directly into private production functions. This form applies to some aspects of highways, public transportation and communication, enforcement of contracts, and some other activities. Governments also expend resources on domestic law and order and national defense to sustain property rights. (Other governmental activities, such as regulations, expropriation, taxation, and military adventures—can reduce property rights.) Instead of entering directly into the production function, one can think of property rights as included in the

$(1-\tau)$ part of the private return to capital, $(1-\tau)\cdot f_k$. That is, greater property rights amount to a larger probability that an investor will receive the marginal product, f_k (and also retain ownership to the stock of capital). Therefore, more property rights works like a reduction in τ. If the government spends resources to enhance property rights, the effects of more spending on growth and saving rates look in a general way like those shown in Figures 1 and 2.

Consider now the model's predictions for the relations of the per capita growth rate, γ, and the saving (and investment) rate, s, to the government spending ratio, g/y. Here, I think of g as encompassing only those activities of government that can be modeled as influencing private production or as sustaining property rights. Thus, g would not include public services that enter directly into household utility (discussed below), or transfer payments, which are difficult to model in a representative-agent framework. In practice, this means that the concept of g considered here corresponds to a relatively small fraction of government expenditures.

If governments randomized their choices of spending, the model predicts that long-term per capita growth and saving rates, γ and s, would relate to g/y as shown in Figures 1 and 2. The relations would be non-monotonic, with γ and s increasing initially with g/y, but decreasing with g/y beyond some high values.

The conclusions are different if governments optimize, rather than behaving randomly. In the model the government optimizes by setting $g/y = \alpha$, which corresponds to the productive-efficiency condition, $f_g = 1$. (Since optimization corresponds to productive efficiency for government services, the results do not depend on public officials being benevolent. Productive efficiency can be desirable even for public officials that have little concern for their constituents.) In considering long-term behavior across countries, observed differences in spending ratios, g/y, would correspond in an optimizing framework to variations in α. That is, the sizes of governments would differ only because the relative productivities of public and private services are not the same in each place. (Perhaps the differences in α relate to geography, weather, natural resources, and so on?) Whatever the reason for variations in α across countries, the covariation between g/y and γ or s that is generated by these variations does not correspond to the relations shown in Figures 1 and 2.

Equation (7) shows that, for a given τ, the level of productivity, y/k, depends on the parameter, $A^{1/(1-\alpha)}$. Suppose that this parameter is held constant while α varies across countries (that is, the variations in relative productivity of public and private services are assumed to be independent of this concept of the level of productivity). Then it can be shown from equations (6) and (9) that an increase in α—which implies an increase in g/y—goes along with decreases in γ and s. For a given level of productivity, the economy does better (and has a higher growth rate) if the relative productivity of private services is higher—that is, if α is lower. The reason is that public services require public expenditures, which have to be financed by a distorting income tax. It is only because of this effect that the model predicts a nonzero correlation between α and γ. The more general point is that, if governments optimize, they go to the point where the marginal effect of more government on growth is nil. Therefore, there would not be much cross-country relation between growth rates and the size of government if governments optimize (if we include in government spending only the activities that relate to private production).

Governments also carry out consumption expenditures, g^c, which do not affect private production functions, but do have a direct impact on the representative household's utility. With an income tax, a higher level of g^c/y implies a lower value of $1-\tau$, but no change in the private marginal product, f_k. Therefore, an increase in g^c/y (which may be warranted in terms of maximizing the representative person's utility) leads to lower values for growth and saving rates. (In an example considered in Barro, 1988, I showed that government consumption spending would not affect the optimal share in GNP of the government's productive expenditure—this share remained at α in the case considered.)

Unlike for productive government spending, the predictions for government consumption are straightforward. In the case of consumption activities (that is, public services that affect utility but not production), a larger share of government spending would correlate negatively with growth and saving rates.

The main difficulty of interpretation is the possibility of reverse causation from the level of income to the choice of government consumption spending as a share of GNP, g^c/y. Suppose, for example, that this spending is a luxury good in the sense that a higher level of income leads to an increase in g^c/y. (Empirically, I find that this "Wagner's Law" effect applies to transfers, but not to other types of government spending that I classify below as consumption.) Given the initial level of income, y(0), a higher growth rate γ means a higher average level of income over the sample, and hence, a higher sample average for g^c/y. (If the growth rate γ were anticipated, even the initial value of g^c/y would be positively correlated with the sample average of γ.) Thus, this reverse effect could generate a positive association between g^c/y and γ. In the empirical work I argue that this effect is important for transfer payments, but not for other categories of government spending.

II. Population Growth and Human Capital in the Model of Steady-State Growth

The model described above did not allow for population growth, and it also did not allow for distinctions between physical and human capital. Empirically, population growth appears to interact closely with the level and growth rate of income, as well as with investment in human capital. In order to incoporate these elements into the model, I use some results from the existing literature.

Becker and Barro (1988) and Barro and Becker (1989) consider the determination of population growth in a model where altruistic parents choose own consumption, the number of children, and the bequests left to children. However, these models do not allow for endogenous per capita growth. Becker and Murphy (1988) and Tamura (1988) have extended the model to analyze the joint determination of population growth and per capita growth. The important consideration—which makes it worthwhile to study population growth jointly with per capita growth—is that population growth influences investment, especially in human capital, and thereby affects per capita growth rates. In effect, population growth is a form of saving and investment (in numbers of children) that is an alternative to investment in human capital (the quality of children). Therefore, factors that lead to higher population growth—such as a decrease in the cost of raising children—tend to reduce the growth rate of output per capita.

Building on Becker and Barro (1988), Lucas (1988), Rebelo (1987), and especially Becker and Murphy (1988), I have been working on the following model:

$$U = \int_0^{\infty} u(c)e^{-\rho t}[N(t)]^{1-\epsilon}dt \qquad (10)$$

$$y = c + \dot{k} + nk = A[(1-\eta-\nu)h]^{\beta}k^{1-\beta} \qquad (11)$$

$$\dot{h} + nh = B\nu h - \delta h \qquad (12)$$

$$n = \dot{N}/N = \theta\eta - \delta \qquad (13)$$

For the new variables, N is the level of population, n is the growth rate of population, h is human capital per person, η is time spent raising children, ν is time spent investing in human capital, $1-\eta-\nu$ is time spent producing goods (used either for consumables or new physical capital), B is a parameter for productivity in generating new human capital, θ is a parameter for productivity in raising children, δ is the mortality rate, and ϵ $(0 < \epsilon < 1)$ is a parameter that measures diminishing marginal utility of children. Time spent at leisure is ignored (that is, is regarded as fixed). Government services and taxation can be thought of as effects on the parameters A and B. For convenience, I depart from Becker and Murphy in setting up the model in continuous time. The main abstraction here is that the family size, N(t), has to be thought of as evolving continuously over time. For purposes of aggregate analysis, I believe that this abstraction is no problem.

This model can be used to analyze steady-state per capita growth, populaton growth, and saving/investment rates. The effects associated with population growth involve two main channels. First, higher population growth corresponds to a higher effective rate of time preference (through the effect of N with $0 < \epsilon < 1$ in equation (10)). Second, given the mortality rate δ, higher population growth goes along with more time spent raising children (η), which implies a lower rate of return on human capital. (This result assumes that human capital is productive in producing goods or new human capital, but not in producing new persons.) Through both channels, forces that lead to a higher rate of population growth tend to go along with a lower rate of per capita growth and a lower rate of investment, especially in human capital.

The model can be used (as in Lucas, 1988) to assess some effects from an international capital market. A perfectly functioning world credit market ensures equal rates of return on capital in all countries. (Given differences in production functions across countries, wages on human capital would not be equated in the absence of labor mobility.) Countries may differ in terms of productivity parameters, A and B, partly because of the effects of government policies on these coefficients. But countries may be similar in their productivity for raising children, θ. Investments in physical and human capital would tend to occur in the places with high values of A and B. (In this constant-returns model, these forces are not offset by diminishing marginal producitivty of capital.) In effect, countries with low values of A and B have a comparative advantage in producing bodies, and would concentrate on this activity. The existence of the international credit market means that countries with low values of A and B end up with lower values of k and h than otherwise. Hence wage rates per person tend to be even lower than otherwise in these poor countries.

Countries may differ more in the parameter A (productivity in market goods) than in B (productivity in creating human capital). Then, without an international credit market, all countries would have similar rates of return (determined mainly by the similar values of B), but wage rates per unit of human capital would be increasing in A. In this case the introduction of a world credit market has little impact on the results. The more significant element would be mobility of human capital—people would like to migrate with their human capital toward the countries with high values of A.

I hope to go further with this analysis to distinguish effects on national saving from those on domestic investment. Empirically, as observed by Feldstein and Horioka (1980), these two variables move closely together. In effect, national saving equals domestic investment plus noise, where the noise corresponds to the current-account balance, which is unrelated (over samples of 15 to 25 years) to variables that I have examined. With a well-functioning global capital market, this behavior is puzzling.

III. Transitional Dynamics Associated with Population Growth

One well-known empirical regularity is that population growth declines with the level of real per capita income over a broad range of incomes, both across countries and over time for a single country. This property does not emerge from the steady-state analysis considered above. Becker and Murphy (1988) introduced two sources of transitional dynamics, which can account for this behavior of population growth. (In the model outlined in Part II, the only transitional dynamics involves the relative amounts of k and h. This element seems important in recoveries from wars or other emergencies, but not in the pattern of long-term economic development.)

Becker and Murphy's first element that creates dynamics is the treatment of human capital as the sum of raw labor (which comes with all bodies) and accumulated human capital. At high levels of development, the raw component is unimportant, but at low levels, this component is significant for investment and growth. In particular, the fixed component of human capital implies that the rate of return on investment in human capital is low initially, but increases with the amount of investment over some range. Therefore, if the amount of human capital per person is low, the low rate of return tends to discourage investment, and thereby makes it difficult to escape from underdevelopment. Becker and Murphy's second dynamic element is that the cost of raising children (inversely related to θ) includes goods as well as time. As wage rates become high, the time cost dominates the goods cost. Therefore, at higher levels of per capita income it is more likely that an increase in income will lead to lower population growth (because the substitution effect from higher value of time is more important relative to the income effect). At low levels of development, it is likely that an increase in income leads (along Malthusian lines) to higher population growth, which makes it difficult for a country to escape from underdevelopment.

The presence of these dynamic elements in Becker and Murphy's model leads to two types of steady states. Aside from the steady-state growth equilibrium (as in the model discussed before), there is a low-level underdevelopment trap. If an economy starts with low values of human capital, it may not pay to invest. Such an economy has high population growth, low investment, and low (or zero) per capita growth. If an economy starts with sufficiently high values of human capital, it tends to grow over time toward a steady state with constant per capita growth. During the transition, expansions of per capita income are accompanied by decreases in population growth and increases in each person's human capital. Over some range, the rate of investment in physical capital, and the rate of per capita growth also tend to increase.

IV. Empirical Findings for a Cross Section of Countries

My empirical analysis uses data across countries from 1960 to 1985 to analyze the joint determination of the growth rate of real per capita GDP, the ratio of physical investment expenditure (private plus public) to GDP, a proxy for investment in human capital (the secondary school enrollment rate), and the growth rate of population. Thus far, I find that national saving rates behave similarly to the rates for domestic investment—the present results refer only to domestic investment.

I began with data from Summers and Heston (1988), and supplemented their cross-country data set with measures of government activity and other variables from various sources (see the data appendix). These additional variables, such as the breakdown of government expenditure into various components, and spending figures at the level of consolidated general government, necessitated the reduction in the sample size from about 120 countries from Summers and Heston to 72 countries. (In a few cases where the central government was known to account for the bulk of government spending—primarily African countries—the figures refer to central government.) After considerable effort, with the help of David Renelt, I have assembled a usable data set for the 72 countries. (See the data appendix for a list of the countries included.) The data include total government expenditures for overall consumption purposes, for investment purposes, and for education, defense, and transfer payments. The data I use are, in most cases, averages over 15 to 25-year periods for the variables considered. For a few countries, the averages cover less than 15 years. This averaging over time seems appropriate for a study of long-term effects on growth and investment.

The sample excludes the major oil-exporting countries. These countries tend to have high values of real GDP per capita, but—especially with respect to population growth and education—act more like countries will lower values of income. This behavior can probably be explained by thinking of these countries as receiving large amounts of income from natural resources, but otherwise not being advanced in terms of technology, human capital, and so on. Hence, high income does not necessarily go along with high real wage rates and correspondingly high real value of time. I plan eventually to extend the theory to incorporate these countries into the analysis.

The variables that I use are the following:

$y(0)$: Real per capita GDP for 1960 in 1980 prices (using the Summers and Heston data, which are designed to allow a comparison of levels of GDP across countries).

Δy: Average annual growth rate of per capita GDP from 1960 to 1985.

i/y: Ratio of real investment expenditures (private plus public) to real GDP. Although this variable is available from Summers and Heston from 1960 for most countries, I have the breakdown between public and private components typically only since 1970. I measured the variable i/y as an average from 1970 to 1985.

school: Fraction of relevant age group in the 1970s enrolled in secondary schools. This variable (from the World Bank) is a proxy for investment in human capital.

ΔN: Average annual growth rate of population from 1960 to 1985 (from Summers and Heston).

g^c/y: Ratio to real GDP of real purchases of goods and services for consumption purposes by consolidated general government. The idea here is to obtain a proxy for the types of government spending that enter directly into household utility, rather than firms' production functions. I began with Summers and Heston's numbers for government general consumption expenditures. These figures include substantial components for spending on national defense and education, which I would model more like productive government spending (and which are more like public investment than public consumption). Thus, I subtracted the ratios to GDP for expenditures on defense and education from the Summers-Heston ratios for general government consumption. (However, unlike the values from Summers and Heston, the defense and education variables are ratios of nominal spending to nominal GDP, rather than real spending to real GDP.) Summers and Heston's numbers are available since 1960 for most countries, but I have the data on defense and education mainly since 1970. The variable g^c/y is, in most cases, an average from 1970 to 1985. (Fewer years are included for countries with missing data on defense or education.)

g^i/y: Ratio to real GDP of real investment expenditures by consolidated general government. I think of public investment as a proxy for the type of infrastructure activities that influence private production in the theoretical model. (It is not inevitable that public investment corresponds to spending that affects production, whereas public consumption corresponds to spending that affects utility. But, in practice, the breakdown of government spending into categories may work this way.) The variable g^i/y is, in most cases, an average from 1970 to 1985. (Fewer years are available for some countries.) I used the Summers-Heston deflators for total investment and GDP to adjust the data, which were obtained as ratios of nominal spending to nominal GDP. That is, I assumed that the deflator for total investment was appropriate for public investment.

g^d/y: Government spending for national defense as a ratio to GDP. The data are ratios of nominal spending to nominal GDP, and are in most cases averages of values from 1970 to 1985. Holding fixed a country's external threat, an increase in g^d may mean more national security and hence, more property rights. Then the effects on growth and investment are as worked out for productive government spending in the theory. However, defense outlays are highly responsive to external threats (or to domestic desires for military adventures), in which case g^d may proxy negatively for national security. Thus, it is difficult to predict the relation of defense spending to growth and investment.

g^e/y: Government expenditures for education as a ratio to GDP. The values are ratios of nominal spending to nominal GDP, and are, in most cases, averages of figures from 1970 to 1985. I anticipate that this variable would work similarly to the public investment variable.

g^s/y: Government transfers for social insurance and welfare as a ratio to GDP. The variable is, in most cases, an average of values from 1970 to 1985. At present, I have data on this variable for only 66 of the 72 countries that are in the main sample. I anticipate that this variable would work similarly to g^c/y—that is, associate with lower rates of per capita growth and investment.

pol. rights: Ordinal index, running from 1 to 7, of political rights from Gastil (1987). (This type of variable has been used in previous studies of economic growth by Kormendi and Meguire, 1985, and Scully, 1988.) Figures are averages of data from 1973 to 1985, with higher values signifying fewer rights. My intention is to use this variable as a proxy for property rights; thus, a higher value of the index should be associated with lower rates of investment and growth. (One shortcoming of this variable is that, aside from its subjective nature, it pertains to political rights, rather than to economic rights, per se. Although countries like Chile, Korea, and Singapore are exceptions, my conjecture is that economic and political rights are strongly positively correlated across countries.)

Soc: Dummy variable taking the value 1 for economic system primarily socialistic, and 0 otherwise. The underlying data are from Gastil (1987).

Mixed: Dummy variable taking the value 1 for economic system mixed between free enterprise and socialism, and 0 otherwise. These data are also from Gastil (1987). Countries not classified as either socialistic or mixed were in the category, free enterprise.

War: Dummy variable equal to 1 for countries that experienced violent war or revolution since 1960. (See the appendix for sources.) The expectation is that war and related aspects of political instability compromise property rights and lead thereby to less investment and economic growth. Refining the variable to measure number of years of war or revolution did not add to the explanatory value.

Africa: Dummy variable equal to 1 for countries in Africa, and 0 otherwise.

Lat. Amer.: Dummy variable equal to 1 for countries in Latin America (including Central America and Mexico), and 0 otherwise.

My general strategy is to consider a system of equations in which four key variables are simultaneously determined: the per capita growth rate, Δy, the physical investment ratio, i/y, the amount of investment in human capital (proxied by the variable school), and population growth, ΔN. I treat the measures of government expenditures and the other variables mentioned above as explanatory variables. The endogeneity of these variables affects the interpretation of the results. Some of these effects—such as the consequences of government optimization with respect to choices of productive spending and the response of defense spending to external threats—have already been mentioned. I will consider here some issues concerning the endogeneity of initial real per capita GDP, y(0), and the responsiveness of government consumption spending (g^c/y and g^s/y above) to changes in income.

I want to think of cross-country differences in y(0) in terms of the transitional changes in the level of income as an economy moves from a starting point of low income toward a position of steady-state per capita growth. Then, in accordance with Becker and Murphy's (1988) analysis, the prediction is that higher y(0) goes along with lower population growth and a greater share of national product devoted to investment in human capital. As y(0) rises, the extent of these responses diminishes, and eventually vanishes when the economy reaches the steady-state growth position. There are also weaker effects on per capita growth and the physical investment ratio—but, over some range, the effect of y(0) on these variables would also be positive. For countries where income levels are too low to escape the trap of underdevelopment, the predictions are reversed. That is, in this range, population growth would rise with y(0), while human capital investment and the other variables would decline.

One problem is that y(0) may be influenced by temporary measurement error or by temporary business fluctuations. These factors tend to generate a negative association between y(0) and subsequent rates of growth per capita. For growth rates averaged over 25 years, the business-cycle effect would tend to be minor. However, measurement error for GDP can be extreme for the low-income countries. To assess this effect, I looked at an interaction between y(0) and the quality of the data (as reported subjectively by Summers and Heston). The results suggested no effect from data quality, which may indicate that this type of measurement error is not important.

A different effect is that y(0) would be positively correlated with per capita growth in the past. To the extent that the factors that create growth are persisting (and are not separately held constant), this relation tends to generate a positive association of y(0) to per capita growth and the investment variables. At this point I do not see how to gauge the magnitude of this effect.

I mentioned before that the ratios of various components of government spending to GDP could be related to the level of income, and therefore to the per capita growth rate, γ. If the response is positive (negative), this element generates a positive (negative) correlation between the expenditure ratio and the growth rate.

Table 1 shows Wagner's Law type regressions for various categories of government spending. The table shows the regression coefficient on log[y(0)] (where y(0) is per capita GDP in 1960) for the ratio of each type of spending to GDP (averaged typically from 1970 to 1985). The results show that in two areas—education and transfers for social insurance and welfare—the ratio of spending to GDP tends to rise with the level of per capita income. Quantitatively, the effect is particularly important for transfers, g^s/y, where an increase in y(0) by 10% corresponds to a rise by 1/2 percentage point in the spending ratio. In the case of government general consumption (exclusive of defense and education), the spending ratio tends to decline with the level of income. In two other areas—public investment and defense—the spending ratios bear no significant relation to the level of income. Overall, in only one of the five spending categories—transfers for social insurance and welfare—does the level of income account for a substantial fraction of the cross-country variation in the spending ratio. The R^2 here is about .6, as compared to values less than .2 in the other cases. Therefore, except for the transfers category, the bulk of the variations across countries in the spending ratios would be predominantly unrelated to differences in income. Thus, when looking at the relation with economic growth, the area of transfers is the one case where important reverse causation (the positive effect of the growth rate on the expenditure ratio) is likely to be important.

The main regression results appear in Table 2. Regressions 1, 3, 5, 7 exclude dummies for Africa and Latin America, whereas regressions 2, 4, 6, 8 include these dummies.

Consider first the coefficients on the starting (1960) level of income, y(0), which appears linearly and also as a squared term. (The quadratic form is intended as an approximation, which appears satisfactory over the sample, but could not be extrapolated to very high levels of income.) The linear terms show a pronounced negative relation with population growth (regressions 7 and 8 of Table 2) and a strong positive relation with schooling (regressions 5 and 6). (The simple correlation between y(0) and ΔN is -.71, while that between y(0) and schooling is .80—see Figures 3 and 4 for scatter plots.) The opposing signs on $[y(0)]^2$ indicate that the effects of income on population growth and schooling attenuate as income rises. At the sample mean for y(0) of $2200, the coefficients in regression 7 imply that an additional $1000 of per capita income is associated with a decline in population growth by .35 percentage points per year. This negative effect of income on population growth vanishes when income reaches $5600 per capita. (The highest level of y(0) in the sample is $7380 for the United States.) For schooling in regression 5, the positive effect of income is gone when income reaches $6200. (However, the use of the secondary school enrollment rate as a measure of schooling automatically tends to truncate the sample at the highest income levels.)

The results accord with the model of Becker and Murphy (1988), in the sense of suggesting an important tradeoff between quality and quantity of children as the level of per capita income rises. That is, the transition from low to high per capita income involves lower population growth and more investment in each person's human capital. I did not, however, find any indication that the signs of the income coefficients were different for the countries with the lowest per capita incomes (say less that $500). That is, I did not see evidence of the particular kind of low-level trap of underdevelopment that Becker and Murphy discussed.

The relation of y(0) to per capita growth, Δy, is less pronounced, although regressions 1 and 2 of Table 2 show significantly negative effects. At the sample mean of y(0), an increase in per capita income by $1000 is associated (according to regression 1) with a decline in the per capita growth rate of .60 percentage points per year. As discussed by Romer (1989), this type of inverse relation between the per capita growth rate and the level of per capita income is present in models that predict convergence of levels of per capita income across countries (although the inverse relation is not itself sufficient to guarantee full convergence). The convergence property tends to arise when there are diminishing returns to capital, but not in the sort of constant-returns models that I discussed earlier. As Romer noted, the simple correlation between per capita growth and the starting level of per capita income is, in fact, close to zero in the kind of cross-country sample that I am using. For my sample, the simple correlation is .05—see the scatter plot in Figure 5. Therefore, the negative coefficient on y(0) in regressions 1 and 2 depends on holding constant the other variables in the equations.

For the investment ratio, i/y, the simple correlation with y(0) is positive (.43—see the scatter plot in Figure 6). The coefficients on y(0) in regressions 3 and 4 of Table 2 are positive, but insignificantly different from zero.

I regard the variable g^c/y (where g^c refers to government general consumption spending aside from defense and education) as a proxy for government expenditures that do not directly affect private sector productivity. It it a robust finding that g^c/y is negatively related to per capita growth[1] (regressions 1 and 2 of Table 2) and the investment ratio, i/y (regressions 3 and 4). Figure 7 shows a scatter plot of per capita growth against g^c/y. In the sample, g^c/y has a mean of .107 with a standard deviation of .054. Regressions 1 and 3 imply that an increase in g^c/y by one standard deviation above its mean is associated with a decline by 0.8 percentage points in the annual per capita growth rate, and a decrease by 2.2 percentage points in the investment ratio. (Recall that investment includes private and public components.) The estimated effects of g^c/y on schooling and population growth (regressions 5-8) are insignificantly different from zero.

Conceptually, I would expect government transfers to interact with growth and investment in a manner similar to government consumption purchases. I added the variable g^s/y to the regressions (where g^s is transfer payments for social insurance and welfare), although this addition necessitated a drop in the sample size from 72 to 66 countries. The variable g^s/y had a significantly negative coefficient for population growth, but the other estimated coefficients were insignificant (and the results for the other explanatory variables did not change much). For example, for per capita growth (with continent dummies excluded), the estimated coefficient on g^s/y

[1]Landau (1983) reports analogous results using the Summers-Heston measure of government consumption. Landau's results hold constant a measure of investment in human capital (school enrollment), but not investment in physical capital. Kormendi and Meguire (1985) report no correlation between per capita growth and the average growth of a measure of g^c/y. However, the type of growth model developed in part I above (based on constant returns to a broad concept of capital) suggests that per capita growth would depend on the average level of g^c/y, rather than on the growth of g^c/y.

was .046, s.e. = .051, whereas that for the investment ratio was -.33, s.e. = .19. It is puzzling that the transfers variables would show up with a negative coefficient for investment, but a positive point estimate for per capita growth. My conjecture is that this positive coefficient reflects reverse causation from growth to the spending ratio, g^s/y. Recall from Table 1 that the transfers ratio is, in fact, closely related to the level of income, so this type of reverse effect is likely to be important here. I plan to investigate these possibilities further.

I thought of the public investment ratio, g^i/y, as a proxy for government infrastructure type spending, which affects private sector productivity. The estimated coefficient of this variable in the growth equation (regressions 1 and 2 of Table 2) is significantly positive. See Figure 8 for a scatter plot of per capita growth versus g^s/y. (Aschauer, 1989, gets analogous results from the U.S. time series.) Abstracting from the possibility of reverse causation from growth to the public-investment variable, the results would indicate that the typical government was operating where the marginal effect of public investment spending on the per capita growth rate was positive. As indicated in the theory, this type of result is inconsistent with public-sector optimization (which dictated the choice of public spending to maximize the per capita growth rate).

The estimated coefficients on g^i/y are also positive in the equations for the investment ratio, i/y (regressions 3 and 4 of Table 2). Recall that investment, i, includes public, as well as private, spending—that is, g^i is a component of i. Therefore, if taken literally, the coefficient of 2.2 in the regressions for i/y means that an extra unit of public investment induces about a one-for-one *increase* in private investment.

One problem is that the flow of public investment spending does not coincide with the flow of services from public capital, which is the concept that corresponds to the public service input, g, in the theoretical analysis. If k^g is the stock of public capital per person, and if this stock grows at the per capita growth rate γ, the flow of gross public investment as a ratio to GNP is given by

$$g^i/y = (\gamma + n + \delta^g) \cdot k^g/y \tag{14}$$

where n is the population growth rate and δ^g is the depreciation rate for public capital. Suppose that the flow of public services is proportional to k^g, and that the quantity of these services as a ratio to GNP is determined exogenously. Then the variable g^i/y, used in the previous regressions, would vary automatically with the per capita growth rate, γ. This relation could explain the positive coefficients on g^i/y in regressions 1 and 2 of Table 2, and the coefficients in excess of unity on g^i/y in regressions 3 and 4.

Table 3 shows regressions where k^g/y replaces g^i/y. Since data on public capital stocks are unavailable for most countries, I estimated k^g/y from division of g^i/y by the term, $\gamma+n+\delta^g$, with δ^g set (as a rough approximation) to equal 0.1. The coefficient on k^g/y is positive (regression 1 of Table 3), but no longer significantly different from zero. On the other hand, the presence of γ in the denominator of the calculated value of k^g/y means that the estimated coefficient could have a serious downward bias if g^i/y is not measured very accurately (as is doubtless the case for many countries). I plan to think further about how to assess the effect of public investment on growth and total investment.

I looked also at government spending for education, g^e/y. My expectation was that this investment in human capital would operate in a manner similar to other types of public investment. The estimated coefficients on g^e/y turn out to be insignificant for per capita growth and the investment ratio. If added to regressions 1 and 3 of Table 2, the estimated coefficients are .12, s.e. = .56 for Δy, and .31, s.e. = 1.53 for i/y.

The defense spending variable, g^d/y, is insignificant in the equations for growth and investment (regressions 1-4 of Table 2). There is some indication of a negative effect on schooling (regression 5 and 6) and a positive effect on population growth (regressions 7 and 8).

The variable war enters negatively for growth and investment (regressions 1-4), as would be expected if the variable proxies for political instability. This variable is insignificant for schooling or population growth (regressions 5-8).

The political rights variable indicates that fewer rights associate with lower per capita growth (regression 1 of Table 2), lower investment in physical and human capital (regressions 3 and 5), and higher population growth (regression 7). These effects are attenuated with the inclusion of dummies for Africa and Latin America (regressions 2, 4, 6, and 8). (That is, the African and Latin American countries tend to have fewer political rights, although the data prefer the continent dummies to the particular measure of these rights.)

There is some indication that socialistic countries have lower per capita growth rates, although the small number of these countries in the sample makes the results unreliable. Countries with mixed economic systems have slightly higher per capita growth than the free enterprise economies, but the difference is not statistically significant.

Even with the other explanatory variables held fixed, the dummy for Africa is significantly negative for per capita growth, investment, and schooling. The dummy for Latin America is significantly negative for growth and schooling, and significantly positive for population growth. (The last effect does not represent the influence of the Catholic religion. A dummy variable for Catholism as the majority religion is insignificant in the equations for population growth or the other variables.) I think that the continent dummies are proxying for aspects of political instability (especially in Latin America) and governmental restrictions on trade (especially in Africa), which are not captured well by the other variables. Better measures of political instability and governmental restrictions, which I am presently constructing, may make the continent dummies unnecessary—that is, these other variables may explain why it matters for growth, etc. that a country is located in Africa or Latin America.

Table 4 shows correlation matrices for the residuals from the equations estimated in Table 2. One matrix applies to the regressions that omit the continent dummies, and the other to the regressions that include these dummies. Although the magnitude of the correlations tends to be weaker in the latter case, the general pattern of results is similar.

The results show that the residual for per capita growth is positively related to that for physical investment (correlation in the equations without continent dummies of .52) and schooling (.41), and negatively related to the residual for population growth (-.35). These results accord with the theory discussed before where the determination of per capita growth is directly connected to the determination of investment rates. The other striking finding is the negative relation between the residuals for schooling and population growth (correlation = -.50). This result again suggests the importance of the tradeoff between the quality and qnantity of children.

Another way to look at the interaction among the dependent variables is to consider regressions where the other dependent variables appear as regressors. With per capita growth as the dependent variable, regressions 9 and 10 of Table 2 show that the estimated coefficient on the investment ratio, i/y, is significantly positive, while that on population growth is significantly negative. (See Figure 9 and 10 for scatter plots of per capita growth against i/y and population growth.) One interesting finding from the regressions is that the coefficient on the public investment ratio, g^i/y, is insignificant (with negative point estimates) when the total investment ratio, i/y, is included as a regressor. This result suggests a close linkage between growth and investment, but not a special role for the public component of investment. In any event, it would be inappropriate to argue that regressions 9 and 10 isolate a positive effect from an exogenous increase in the investment rate (or a negative effect from an exogenous increase in population growth) on per capita growth. At this point, one can just as well tell stories about causation in opposing directions—for example, Modigliani (1970) argues that the positive relation between per capita growth and the saving rate reflects the effect of growth on an economy's aggregate propensity to save.

Regressions 11 and 12 of Table 2 use population growth as the dependent variable. The coefficients on per capita growth are significantly negative, but the most striking results are the significantly negative coefficients on the schooling variable. The scatter plot in Figure 11 shows the strong negative correlation between population growth and school enrollment.

V. Concluding observations

I regard the empirical findings as preliminary, but suggestive. Some aspects of government services (and, implicitly, of the taxes that finance these services) affect growth and investment as predicted by the theoretical models. Notably, public consumption spending is systematically inversely related to growth and investment Public investment tends to be positively correlated with growth and private investment, and these results are interpretable within the models. There is also an indication that property rights affect growth and investment in ways that the theories predict.

The results bring out a strong negative interaction between population growth and investment in human capital (that is, the tradeoff between the quantity and quality of children). This relation appears partly as responses to differences in the initial level of income, and partly from the residual correlation between population growth and schooling.

I am planning a good deal of additional research on theories of economic growth and of empirical analysis related to these theories. Many other researchers have recently become interested (once again) in economic growth, and a lot of promising work is presently under way. I am optimistic that this research will result in greater understanding about the factors that influence long-term economic growth, and especially about the role of government in this process.

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Table 1

Regressions of Government Spending Ratios on the Level of Income

Category of Spending [mean]	No. Obs.	Constant	Log[y(0)]	R^2	$\hat{\sigma}$
g^c/y [.105]	74	.115 (.006)	-.027 (.006)	.19	.050
g^i/y [.033]	73	.032 (.002)	.002 (.002)	.01	.016
g^d/y [.032]	74	.031 (.005)	.001 (.005)	.00	.040
g^e/y [.042]	75	.040 (.002)	.007 (.002)	.15	.014
g^s/y [.057]	68	.038 (.005)	.047 (.005)	.58	.038

Note: The table shows a regression of each expenditure ratio (calculated as an average from 1970 to 1985) on the logarithm of y(0), which is the 1960 value of real per capita GDP. Standard errors are shown in parentheses and $\hat{\sigma}$ is the standard error of estimate. g^c refers to government general consumption spending (excluding defense and education), g^i to public investment, g^d to defense spending, g^e to educational expenditures, and g^s to transfers for social insurance and welfare.

Table 2: Basic Regressions for 72 Countries

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	Δy [.024]		i/y [.21]		school [.41]	
constant	.059 (.010)	.063 (.009)	.203 (.038)	.215 (.038)	.246 (.104)	.253 (.099)
y(0) [2.2]	-.0084 (.0041)	-.0107 (.0043)	.018 (.016)	.009 (.018)	.165 (.043)	.181 (.047)
$[y(0)]^2$	.0005 (.0006)	.0007 (.0006)	-.0026 (.0022)	-.0017 (.0024)	-.0133 (.0059)	-.0165 (.0064)
g^c/y [.108]	-.154 (.034)	-.132 (.032)	-.41 (.13)	-.35 (.13)	-.27 (.37)	-.12 (.35)
g^i/y [.033]	.262 (.099)	.255 (.091)	2.22 (.39)	2.21 (.38)	1.55 (1.06)	1.31 (.99)
g^d/y [.030]	.005 (.046)	-.004 (.044)	.17 (.18)	.16 (.18)	-.70 (.49)	-1.00 (.48)
war [.35]	-.0098 (.0037)	-.0122 (.0036)	-.037 (.014)	-.045 (.015)	.015 (.040)	.013 (.039)
pol. rights [3.2]	-.0038 (.0013)	-.0020 (.0013)	-.0112 (.0050)	-.0065 (.0052)	-.041 (.014)	-.025 (.014)
soc [.04]	-.0095 (.0088)	-.0141 (.0082)	.047 (.034)	.033 (.034)	.150 (.093)	.136 (.089)
mixed [.47]	.0061 (.0034)	.0046 (.0031)	.006 (.013)	.002 (.013)	.071 (.036)	.056 (.034)
africa [.22]	--	-.0178 (.0053)	--	-.049 (.022)	--	-.109 (.057)
lat. amer. [.25]	--	-.0117 (.0041)	--	-.027 (.017)	--	-.145 (.044)
R^2	.45	.56	.62	.66	.75	.79
$\hat{\sigma}$	.0131	.0119	.051	.049	.139	.129

Note: Standard errors of coefficients shown in parentheses, means of variables shown in brackets. $\hat{\sigma}$ is the standard error of estimate. See text for definitions of variables.

Table 2, continued

	(7)	(8)	(9)	(10)	(11)	(12)
Dep. Var.	ΔN [.018]		Δy		ΔN	
constant	.0246 (.0041)	.0254 (.0039)	.045 (.012)	.052 (.012)	.0308 (.0046)	.0316 (.0049)
y(0)	-.0062 (.0017)	-.0080 (.0019)	-.0166 (.0037)	-.0183 (.0044)	-.0048 (.0018)	-.0068 (.0021)
$[y(0)]^2$	.00055 (.00023)	.00083 (.00025)	.00135 (.00047)	.00157 (.00055)	.00045 (.00022)	.00071 (.00025)
g^c/y	.008 (.015)	.005 (.014)	-.096 (.030)	-.090 (.029)	-.005 (.014)	-.004 (.014)
g^i/y	-.068 (.042)	-.054 (.039)	-.068 (.100)	-.026 (.099)	-.065 (.044)	-.057 (.044)
g^d/y	.062 (.019)	.078 (.019)	.032 (.040)	.035 (.043)	.046 (.017)	.058 (.018)
war	-.0002 (.0016)	-.0009 (.0016)	-.0057 (.0032)	-.0081 (.0033)	-.0002 (.0015)	-.0011 (.0016)
pol. rights	.0012 (.0005)	.0008 (.0005)	-.0011 (.0011)	-.0006 (.0011)	.0003 (.0005)	.0003 (.0005)
soc	-.0084 (.0037)	-.0089 (.0036)	-.0224 (.0074)	-.0243 (.0074)	-.0081 (.0034)	-.0094 (.0034)
mixed	-.0033 (.0014)	-.0029 (.0014)	.0023 (.0029)	.0020 (.0028)	-.0015 (.0013)	-.0015 (.0013)
africa	--	.0013 (.0023)	--	-.0106 (.0048)	--	-.0013 (.0022)
lat. amer.	--	.0056 (.0018)	--	-.0039 (.0039)	--	.0027 (.0017)
Δy	--	--	--	--	-.120 (.056)	-.120 (.058)
i/y	--	--	.120 (.027)	.106 (.027)	.026 (.014)	.024 (.014)
school	--	--	.015 (.012)	.011 (.012)	-.0176 (.0047)	-.0152 (.0048)
ΔN	--	--	-.59 (.28)	-.59 (.28)	--	--
R^2	.70	.74	.67	.69	.79	.81
$\hat{\sigma}$	.0055	.0052	.0104	.0102	.0047	.0046

Table 3

Regressions for 72 Countries, Using Estimate of Public Capital Stock

Dep. Var.	(1) Δy	(2) i/y	(3) school	(4) ΔN
constant	.064 (.010)	.235 (.039)	.270 (.102)	.0238 (.0040)
y(0)	-.0082 (.0043)	.011 (.017)	.161 (.045)	-.0059 (.0018)
$[y(0)]^2$	.0005 (.0006)	-.0022 (.0023)	-.0132 (.0060)	.00053 (.00024)
g^c/y	-.154 (.036)	-.45 (.14)	-.29 (.37)	.010 (.015)
k^g/y [.23]	.020 (.015)	.275 (.059)	.17 (.15)	-.0096 (.0060)
g^d/y	.017 (.047)	.24 (.19)	-.65 (.49)	.060 (.019)
war	-.0104 (.0039)	-.043 (.015)	.011 (.040)	.0000 (.0016)
pol. rights	-.0040 (.0013)	-.0129 (.0053)	-.042 (.014)	.0013 (.0005)
soc	-.0104 (.0092)	.028 (.037)	.139 (.095)	-.0077 (.0038)
mixed	.0053 (.0035)	.004 (.014)	.068 (.036)	-.0033 (.0014)
R^2	.40	.57	.75	.70
$\hat{\sigma}$	.0136	.054	.140	.0055

Table 4

Correlation Matrix for Residuals

	Δy	i/y	school	ΔN
Δy		.52 [.46]	.41 [.31]	-.35 [-.29]
i/y			.28 [.21]	-.04 [.03]
school				-.50 [-.42]

Note: The entries give the correlation of the residuals from regressions with the indicated dependent variables. The upper figure in each cell refers to regressions 1, 3, 5 and 7 from Table 2. The lower number (in brackets) refers to regressions 2, 4, 6 and 8, which include dummies for Africa and Latin America.

Data Appendix

List of 72 Countries Included in Main Sample

Botswana
Cameroon
Egypt
Ghana
Kenya
Liberia
Malawi
Mauritius
Morocco
Senegal
Sierra Leone
Swaziland
Tunisia
Uganda (X)
Zaire
Zambia
Burma
India
Israel
Japan (X)
Jordan
Korea (South)
Malaysia
Pakistan
Philippines
Singapore
Sri Lanka
Thailand
Austria
Belgium
Cyprus
Denmark
Finland
France
Germany (West)
Greece
Iceland
Ireland
Italy
Luxembourg
Malta
Netherlands
Norway
Spain
Sweden
Switzerland
Turkey (X)
United Kingdom
Barbados

Canada
Costa Rica
Dominican Republic
El Salvador
Guatemala
Mexico
Nicaragua
Panama
United States
Argentina
Bolivia
Brazil
Chile
Colombia (X)
Ecuador (X)
Guyana
Paraguay (X)
Peru
Uruguay
Australia
Fiji
New Zealand
Papua New Guinea

(X) indicates missing data on transfers for social insurance and welfare.

Sources of Data

I plan to prepare a detailed data appendix, giving detailed sources and the values of variables, especially on the various components of government expenditures. However, at this point, additional data are still being assembled.

Aside from Summers and Heston (1988), the sources for data on government expenditures were International Monetary Fund, *Government Finance Statistics Yearbook*, 1987, 1983, 1978, and *International Financial Statistics, Supplement on Government Finance*, 1986; OECD, *National Accounts*, various years; United Nations, *Yearbook of National Accounts Statistics*, various years; World Bank, *World Tables*, 1st and 2nd editions; and UNESCO, *Yearbook*, 1987. The series on secondary school enrollment rates was from World Bank, *World Tables*. The data on war and revolution were from R.E. Dupuy and T.N. Dupuy, *Encyclopedia of Military History*, Harper and Row, New York, 1986; G.D. Kaye, D.A. Grant, and E.J. Emond, *Major Armed Conflict: a Compendium of Interstate and Intrastate Conflit, 1720 to 1985*, Orbita Consultants, Ltd., Ottawa, 1985; and M. Small and J.D. Singer, *Resort to Arms: International and Civil Wars, 1816-1980*, Sage Publications, Beverly Hills, 1982.

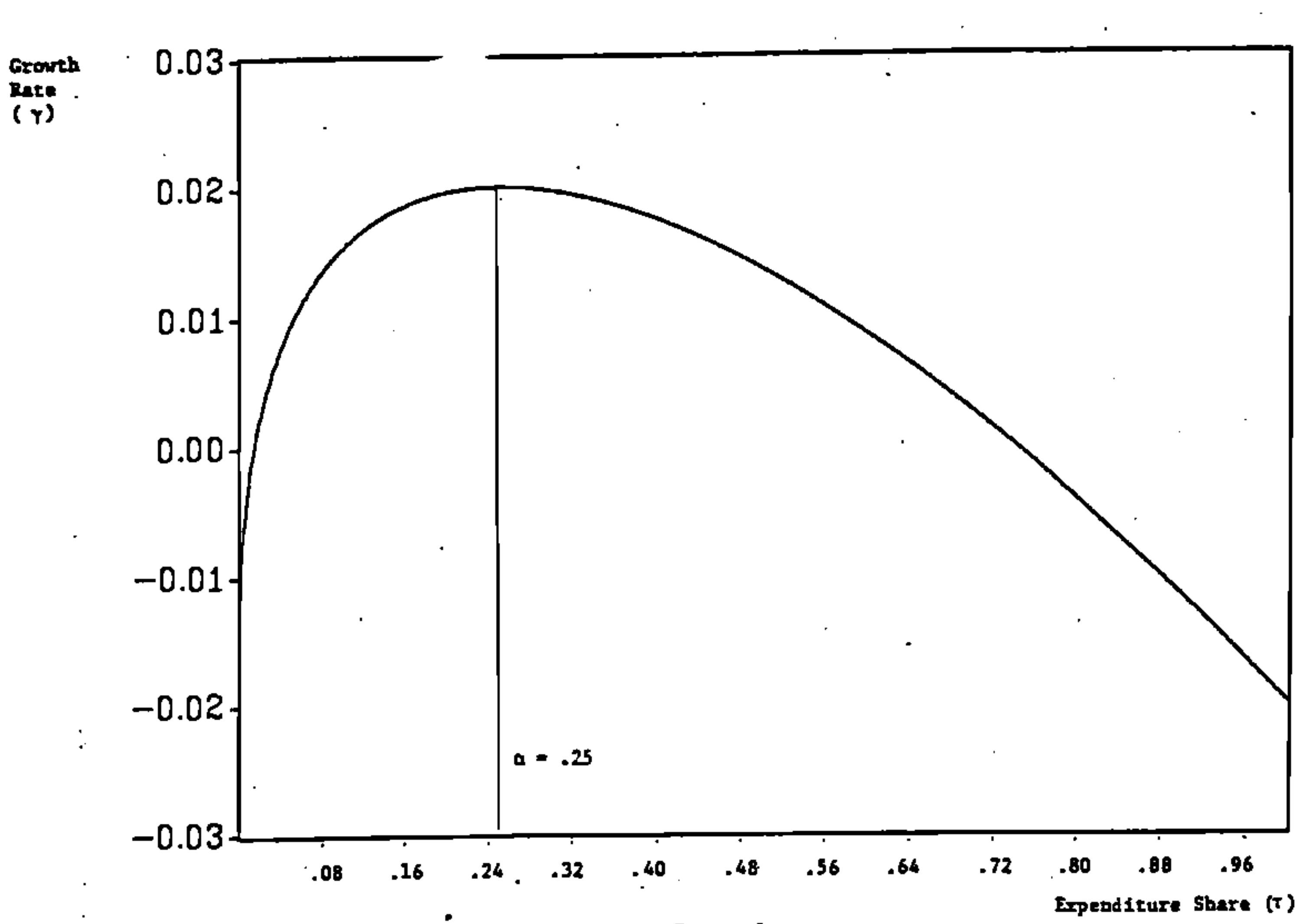

Figure 1

The Growth Rate and the Size of Government

NOTE: The curve shows the growth rate, γ, from equation (6). The parameter values are $\sigma = 1$, $\alpha = .25$, ... .02, $^{1/\alpha}$ = .113. These values imply that the maximum value of γ is .02.

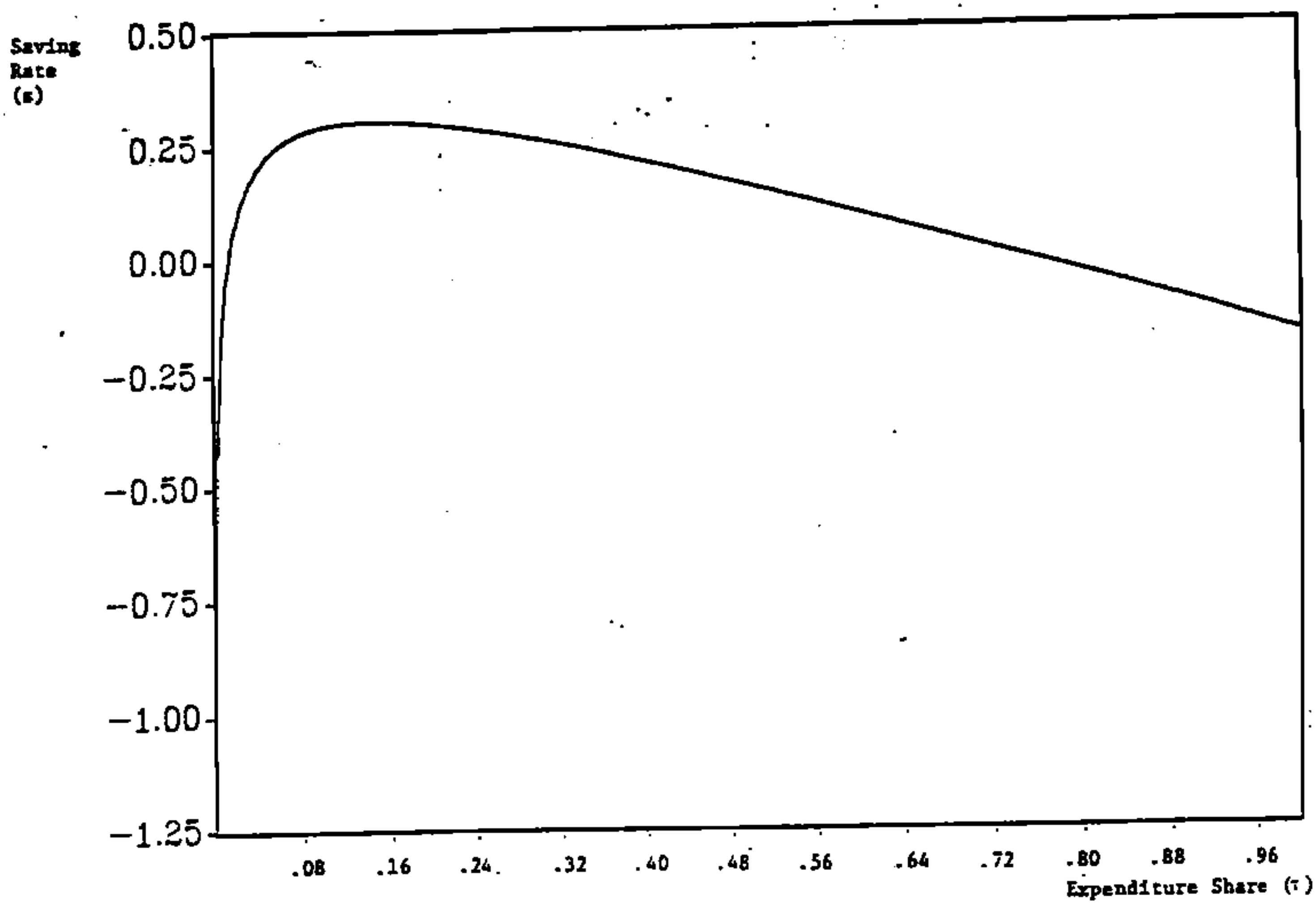

Figure 2
The Saving Rate and the Size of Government

NOTE: The curve shows the saving rate, s, from equation (9). Parameter values are indicated in Figure 1.

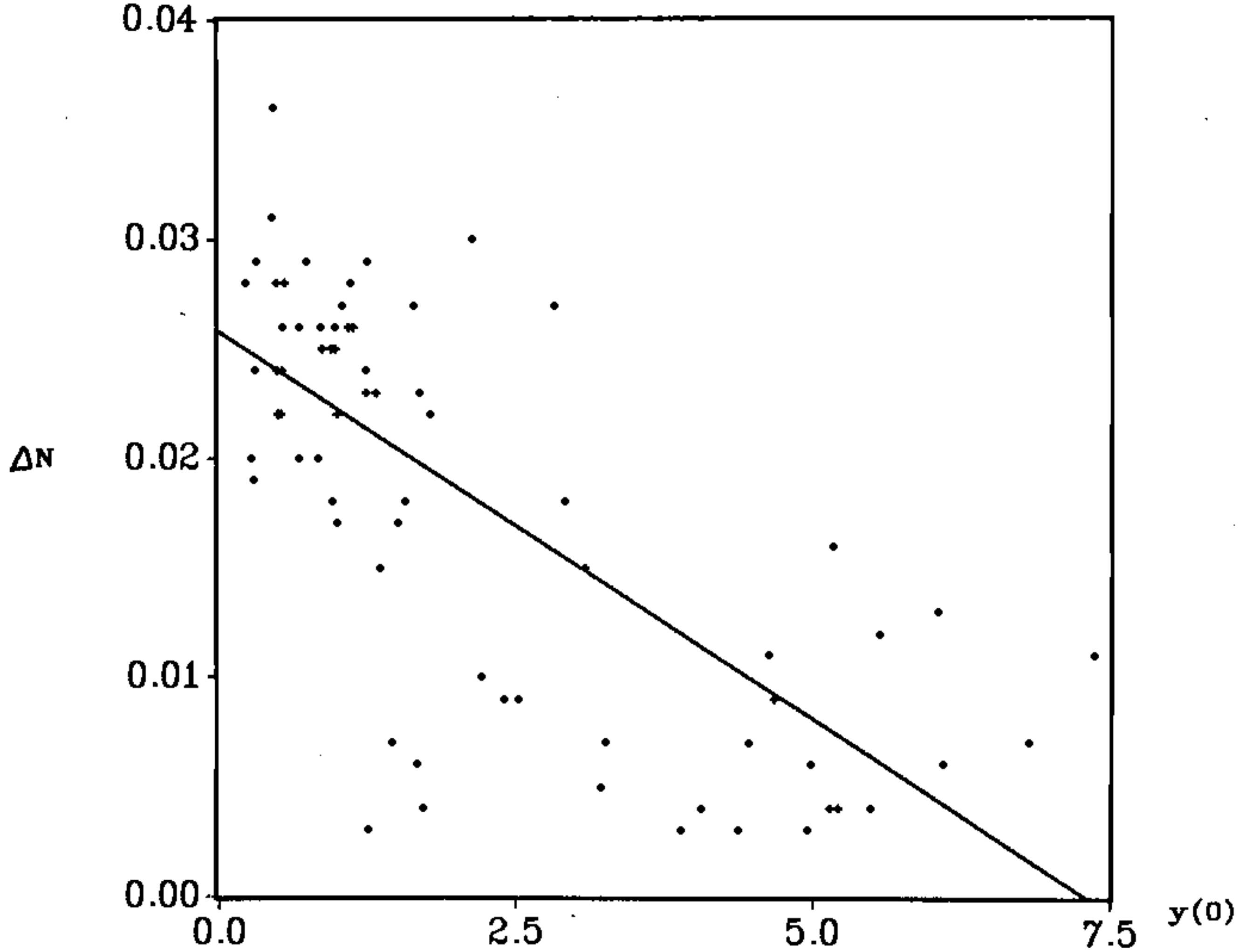

Figure 3 Population Growth versus the Initial Level of Per Capita GDP for 72 Countries

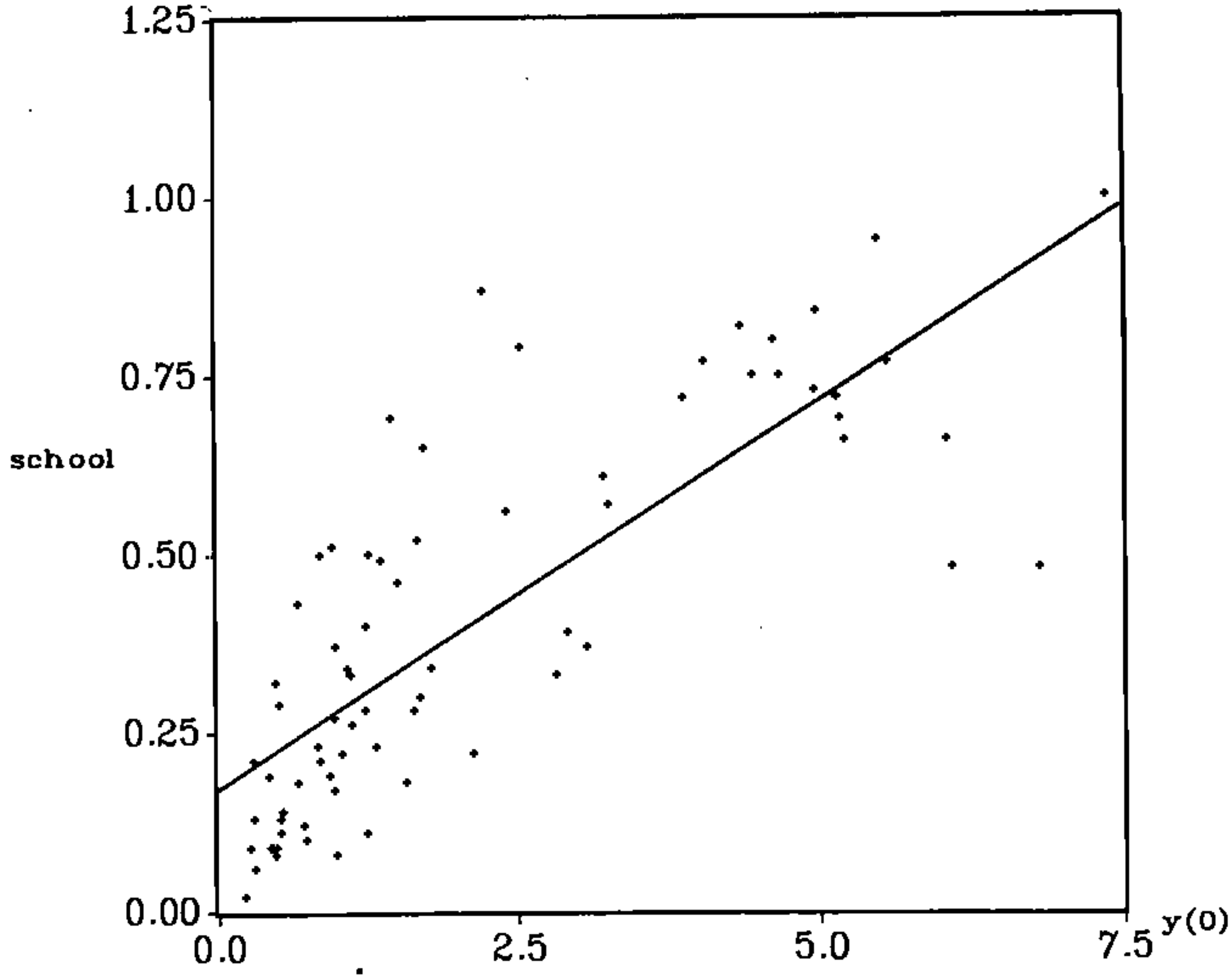

Figure 4 The Secondary School Enrollment Rate (school) versus the Starting Level of Per Capita GDP for 72 Countries

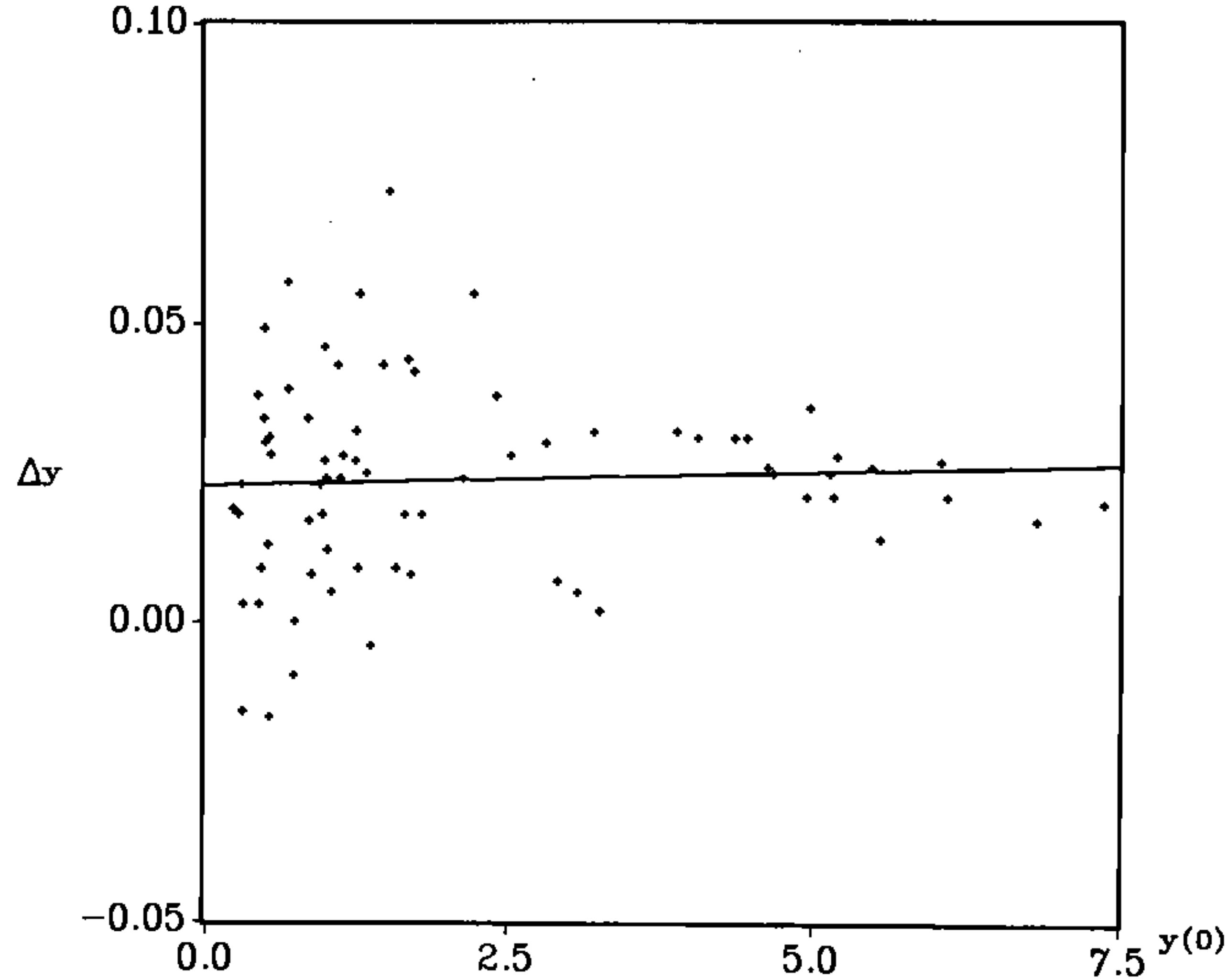

Figure 5 Per Capita Growth versus the Initial Level of Per Capita GDP for 72 Countries

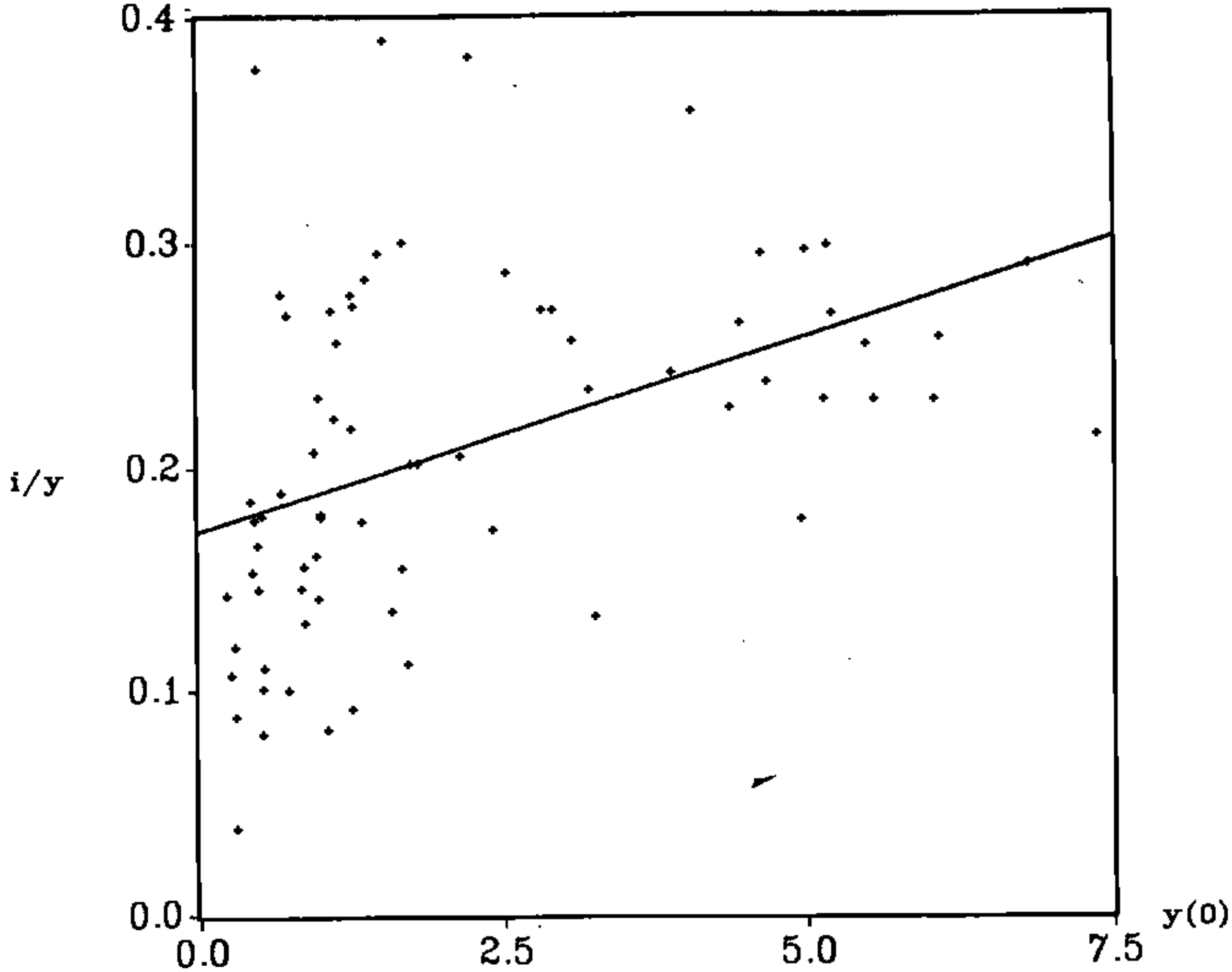

Figure 6 The Investment Ratio (i/y) versus the Initial Level of Per Capita GDP for 72 Countries

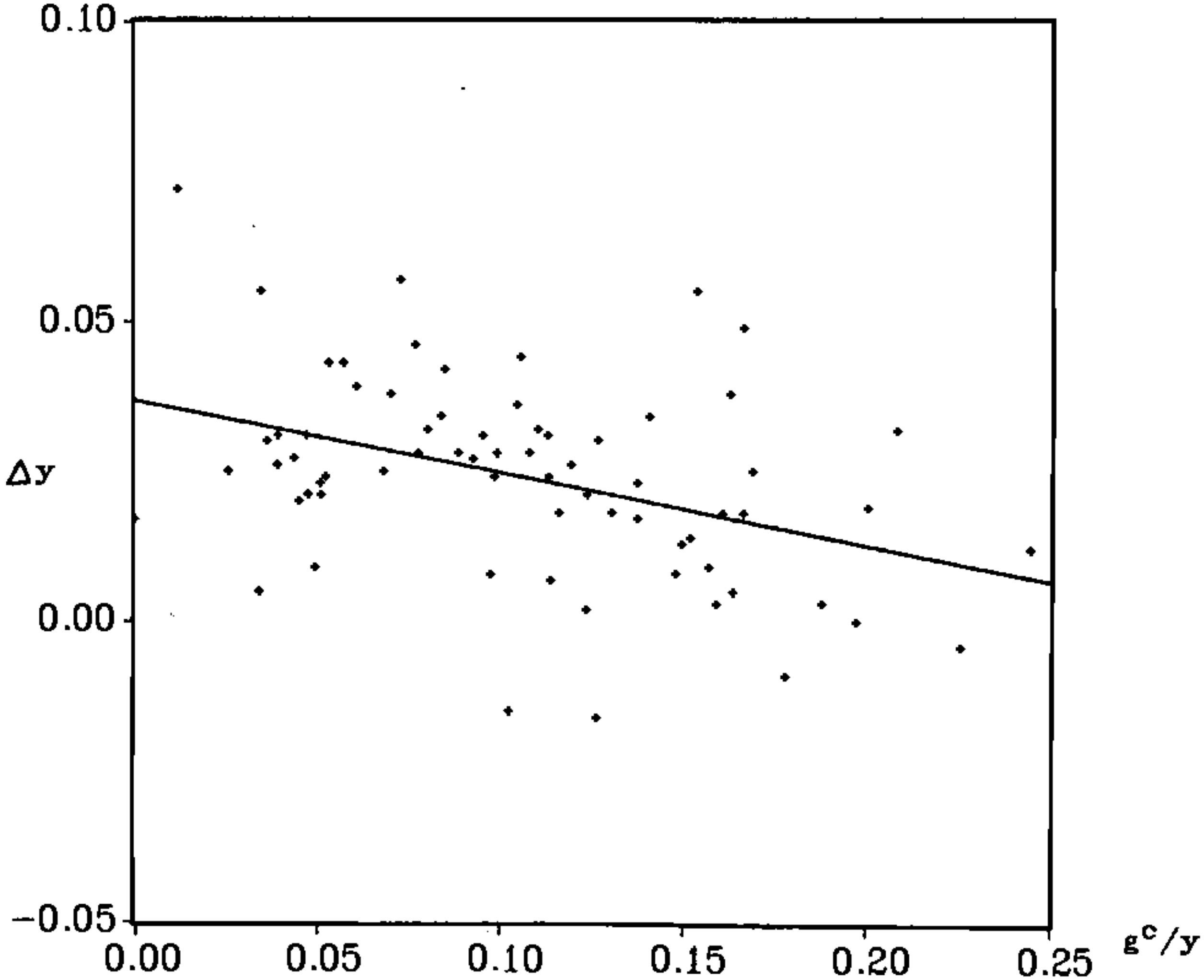

Figure 7 Per Capita Growth versus g^c/y for 72 Countries

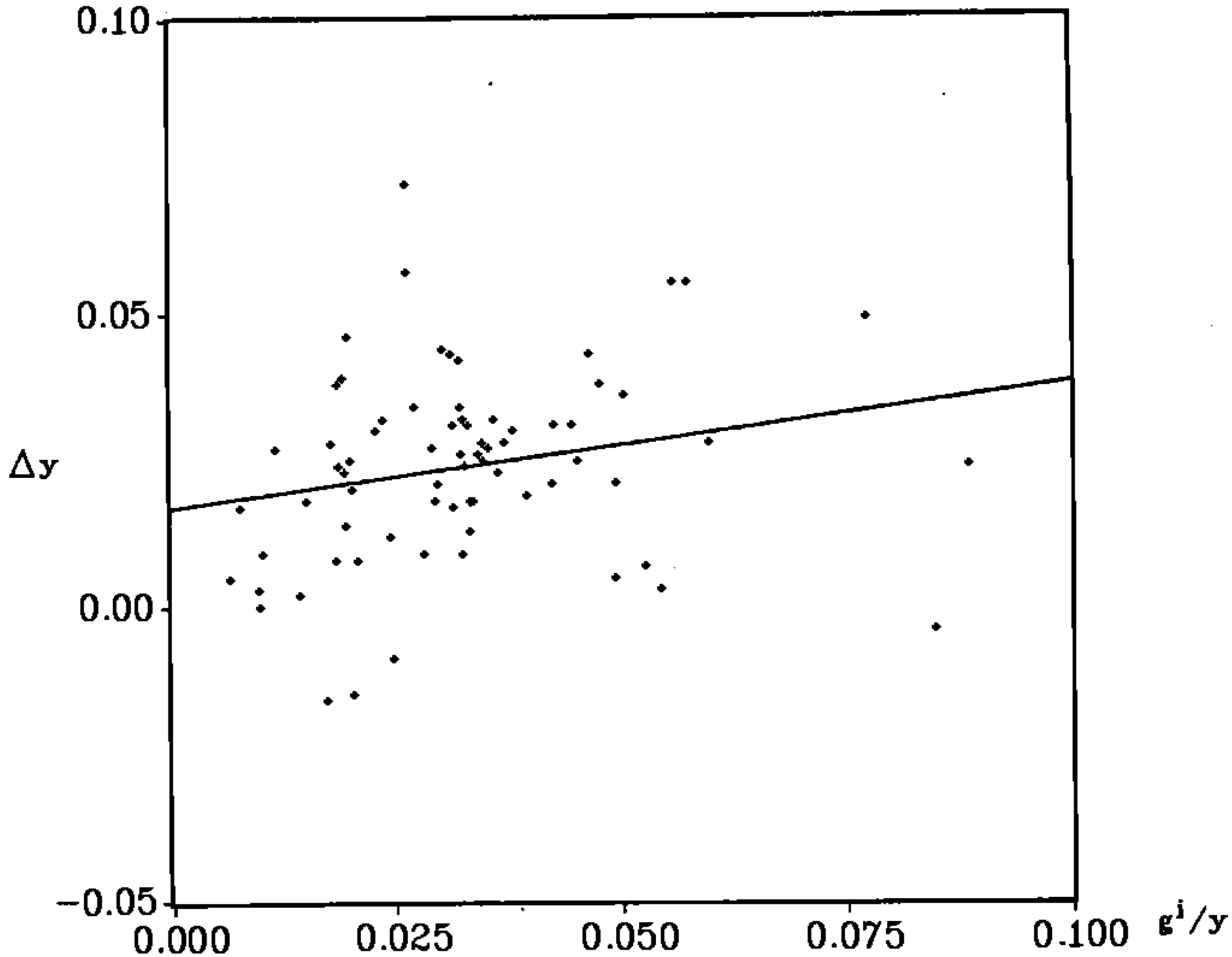

Figure 8 Per Capita Growth versus g^i/y for 72 Countries

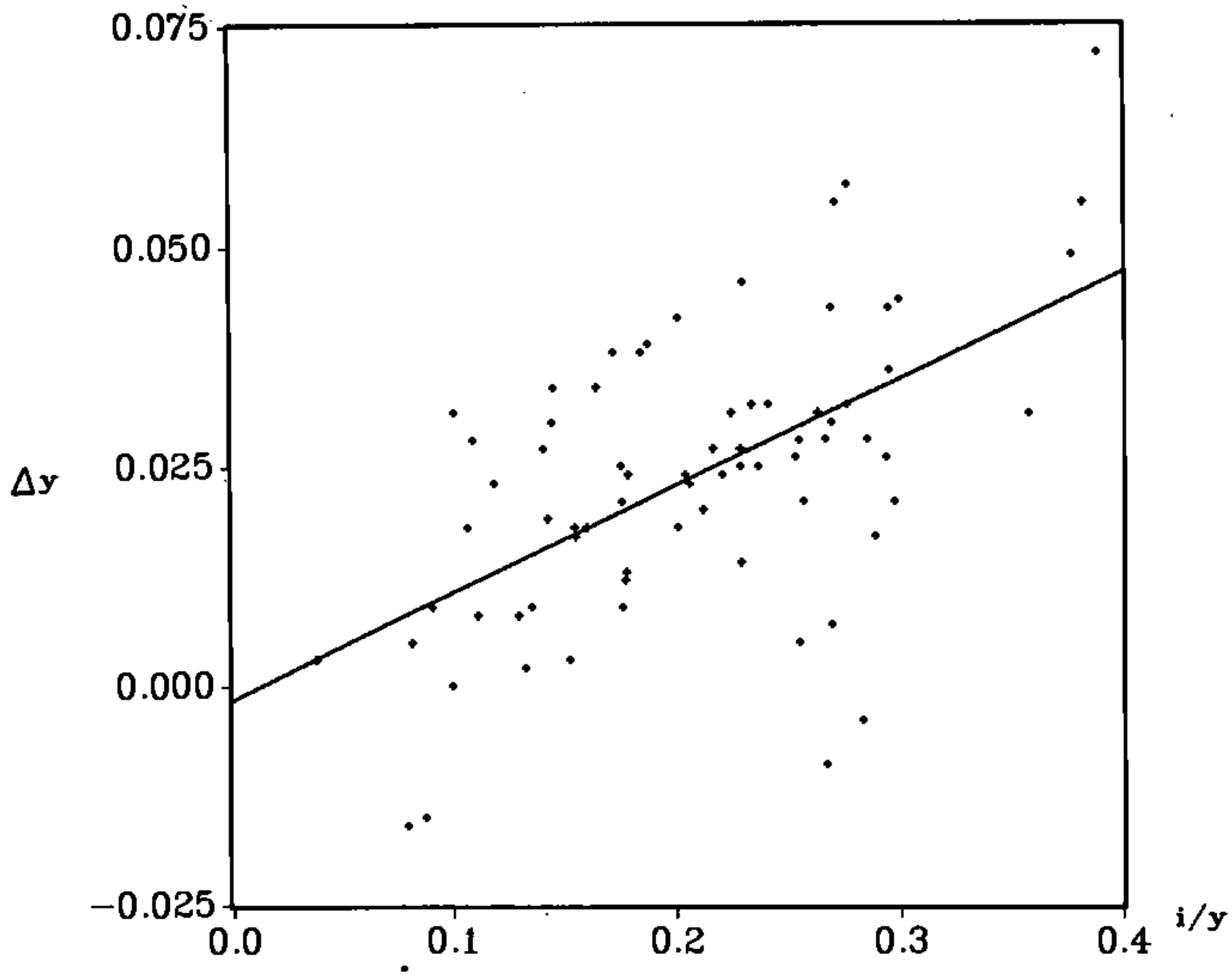

Figure 9 Per Capita Growth versus the Investment Ratio (i/y) for 72 Countries

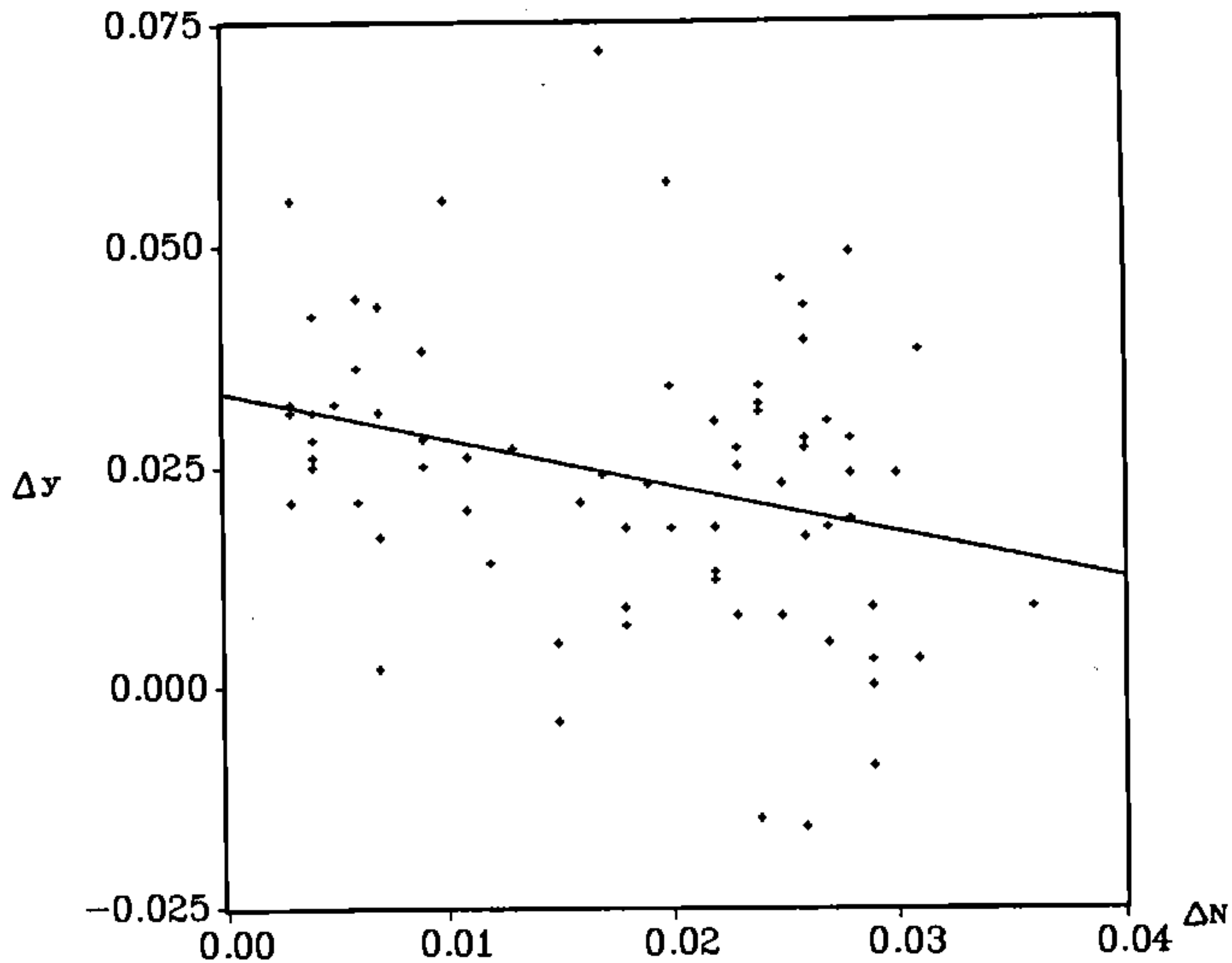

Figure 10 Per Capita Growth versus Population Growth for 72 Countries

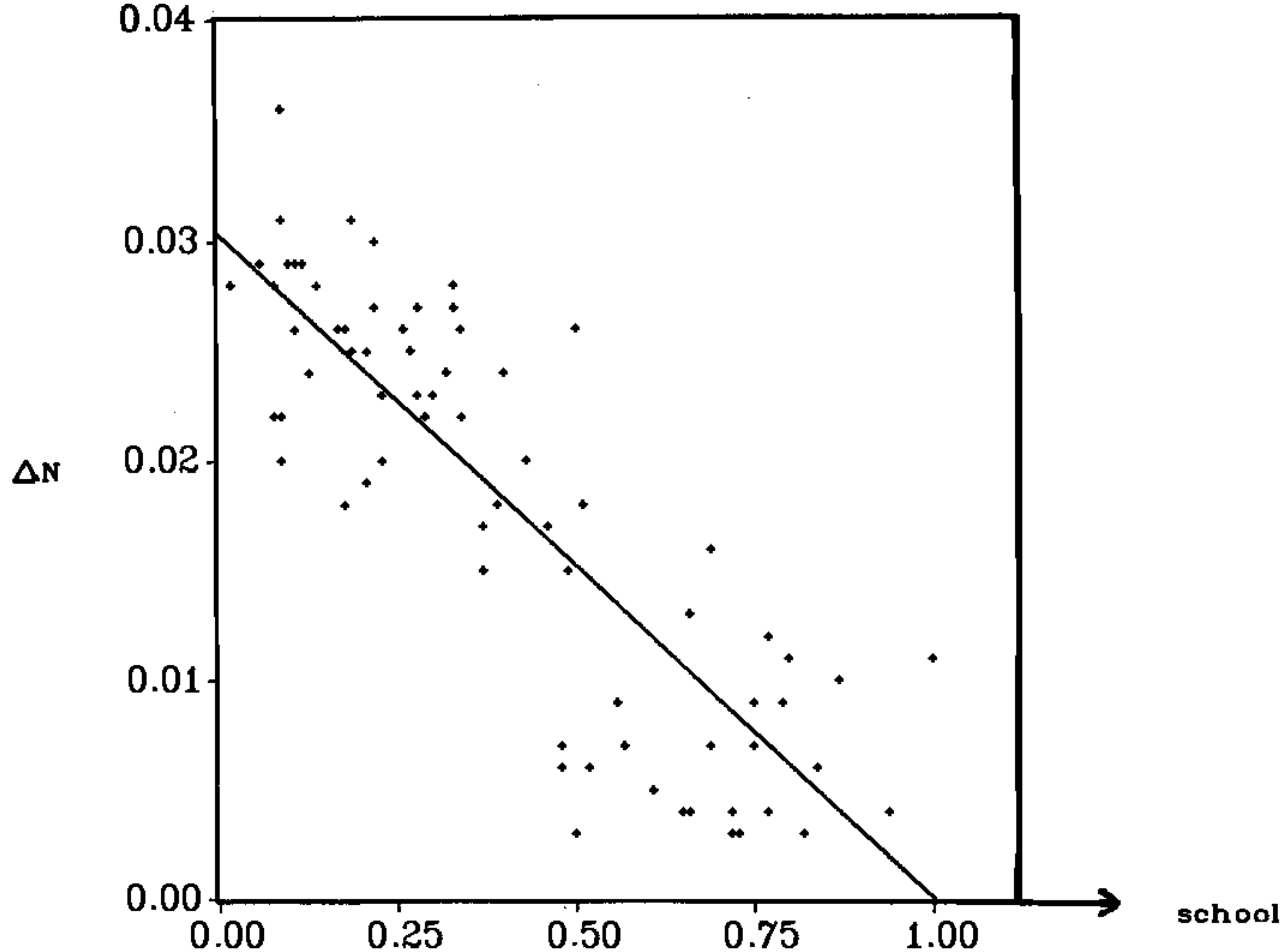

Figure 11 Population Growth versus the Secondary School Enrollment Rate (school) for 72 Countries