RICHARD T. ELY LECTURE

ECONOMIC GROWTH AS AN OBJECTIVE OF GOVERNMENT POLICY*

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In recent years economic growth has come to occupy an exalted position in the hierarchy of goals of government policy, both in the United States and abroad, both in advanced and in less developed countries, both in centrally controlled and decentralized economies. National governments proclaim target growth rates for such diverse economies as the Soviet Union, Yugoslavia, India, Sweden, France, Japan—and even for the United Kingdom and the United States, where the targets indicate dissatisfaction with past performance. Growth is an international goal, too. The Organization for Economic Cooperation and Development aims at a 50 percent increase in the collective gross output of the Atlantic Community over the current decade.

Growth has become a good word. And the better a word becomes, the more it is invoked to bless a variety of causes and the more it loses specific meaning. At least in professional economic discussion, we need to give a definite and distinctive meaning to growth as a policy objective. Let it be neither a new synonym for good things in general nor a fashionable way to describe other economic objectives. Let growth be something it is possible to oppose as well as to favor, depending on judgments of social priorities and opportunities.

I

In essence the question of growth is nothing new, but a new disguise for an age-old issue, one which has always intrigued and preoccupied economists: the present versus the future. How should society divide its resources between current needs and pleasures and those of next year, next decade, next generation?

The choice can be formalized in a way that makes clear what is essentially at stake. A consumption path or program for an economy describes its rate of consumption at every time point beginning now and extending indefinitely into the future. Not all imaginable consumption paths are feasible. At any moment future possibilities are limited by

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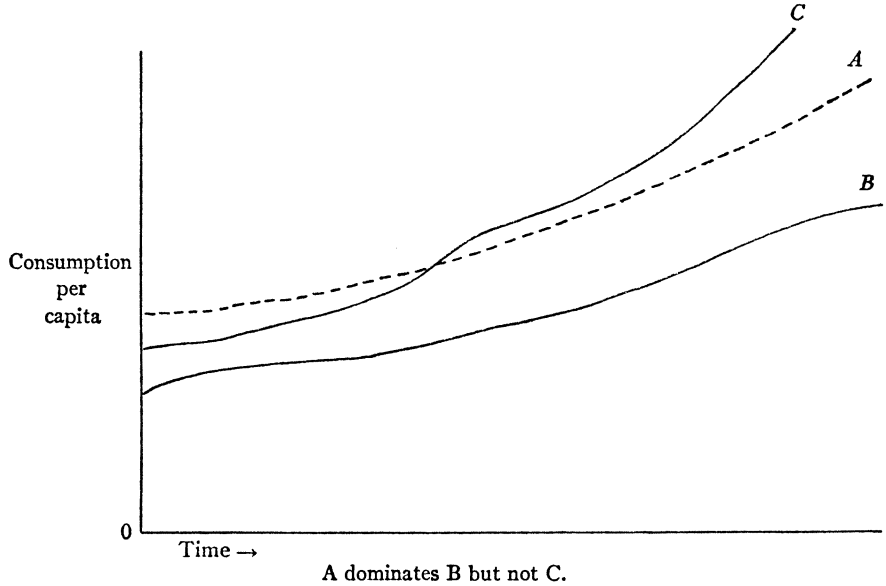
our inherited stocks of productive resources and technological knowledge and by our prospects for autonomous future increase in these stocks. Of feasible paths, some dominate others; i.e., path A dominates B if consumption along path A exceeds consumption along path B at every point of time. I hope I will incur no one's wrath by asserting that in almost everyone's value scheme more is better than less (or certainly not worse), at least if we are careful to specify more or less of

ALTERNATIVE CONSUMPTION PATHS



A dominates B but not C.

FIGURE 1

what. If this assertion is accepted, the interesting choices are between undominated or efficient feasible paths; e.g., between a pair A and C where A promises more consumption at some points in time but less at others. See Figure 1. In particular, I take growthmanship to be advocacy of paths that promise more consumption later in return for less earlier.

But growthmanship means more than that. Growthmen are usually willing to throw the weight of the government on to the scales in order to tip the balance in favor of the future. Here they fly in the face of a doctrinal tradition of considerable strength both in economics and in popular ideology. Does not the market so coordinate the free, decentralized decisions of individuals between present and future so as to reach an optimal social choice? Is not any government intervention in favor of growth, therefore, bound to tilt the scales toward the future to a degree that society does not "really" want?

The basic question raised by advocates of faster growth may be further formalized to emphasize this issue. Assuming that the economy is now on a feasible and undominated consumption path, the desirability of deviating from it can be expressed in the language of interest rates and present values. Any feasible and efficient path, including the prevailing path, implies two sets of interest rates. One, which we may call the time preference set, expresses the society's marginal rates of substitution as consumers between consumption at one date and consumption at another date. This set answers questions like the following: Given society's consumption prospect, how much increase in consumption five years or fifty years or t years from now is worth the loss of a dollar's worth of consumption today? The rates implied by the answers need not all be the same. The other set, which we may call the technological set, expresses the opportunities which present and prospective technology offers the society for marginal substitutions of consumption at one date for consumption at another. This set answers questions like the following: Given the consumption path, by how much could consumption be increased five years or fifty years or t years from now by the resources released from a dollar's worth of consumption today? Again, the rates can vary with time. A sacrifice in current consumption may yield, say, 10 percent per year if its fruits are taken five years from now, but 20 percent—or 2 percent—if they are taken fifty years from now.

A small proposed feasible deviation from the existing path can in principle be tested as follows: Calculate the present values of the proposed deviations in consumption, negative and positive, discounting them by the time preference set of interest rates. If the sum is positive, the proposed deviation is worth while. If it is zero or negative, it is not worth while. We know that this sum will not be positive if it happens that the time preference and technological interest rates are identical.

Evidently growthmen believe that the two sets diverge in such a way that society would give a positive present value to feasible increases in future consumption purchased at the expense of current and near future consumption. Their opponents think the contrary. Many of them have faith in the capital markets and believe there is a presumption that these markets make the two sets of rates equal.

II

This is the heart of the issue, I believe, and I shall return to it later in this lecture. First, however, I must discuss some questions raised by the formulation of the growth issue which I have just tried to sketch. What is the relationship between growth and other objectives of economic policy, in particular full employment of resources? Are there some noneconomic reasons for accelerating growth—reasons which this

formulation excludes or evades? Exactly what is the "consumption" whose path is to be chosen? Finally, can government successfully influence the growth path?

1. *Growth Versus Full Employment.* To accelerate growth is not the same thing as to increase the utilization of existing resources, manpower, and capital capacity. In the formulation sketched above, a consumption path with underutilization is dominated or inefficient. By putting the idle resources to work, consumption can be increased both now and in future. The same is true of other measures to improve the efficiency of allocation of resources. We can all agree, I presume, on the desirability of growth measures free of any cost. If that is the meaning of growth policy, there is no issue.

For short periods of time, stepping up the utilization of capacity can increase the recorded rate of growth of output and consumption. But over the decades fluctuations in the utilization of capacity will have a minor influence compared to the growth of capacity itself. To express the same point somewhat differently, the subject of economic growth refers mainly to supply, or capacity to produce, rather than to demand. In the short run, accelerating the growth of demand for goods and services can, by increasing the rate of utilization of capacity, speed the growth of output. But in the long run, output and real demand cannot grow faster than capacity. If monetary demand is made to set a faster pace, it will be frustrated by a rate of inflation that cuts real demand down to size.

Public policy affecting aggregate demand should be aimed at maintaining a desired rate of utilization of capacity. Economists and other citizens will differ on how high this rate should be, because they differ in the weights they attach to additional employment and output, on the one hand, and to the risks of faster price inflation, on the other. But however this balance is struck, monetary and fiscal policies can in principle hit the target utilization rate just as well whether the economy's capacity is growing at 5 percent or 3 percent or zero percent.

Full employment is, therefore, not a reason for faster economic growth; each is an objective in its own right. In an economy suffering from low rates of utilization of manpower and capital resources, accelerating the growth of aggregate demand may well be the need of the hour. But this ought not be considered growth policy in the more fundamental sense. Tax reduction today has sufficient justification as a means of expanding demand and raising the rate of utilization. It is probably an unfortunate confusion to bill it as a growth measure, too.

I do not mean, of course, that the rate of growth of the economy's capacity is in practice wholly independent of its rate of utilization. In principle they may be independent. Demand can be expanded in ways

that do not accelerate, indeed may even retard, the growth in capacity itself. But as a rule some of the output resulting from an increase in utilization will be used in ways that expand future capacity. Thus the Great Depression deprived the nation and the world of investment as well as consumption; we, as well as our fathers, bear the cost. The proposed tax reduction, even though its major impact is to stimulate consumption, will nonetheless increase the share of national capacity devoted to capital accumulation. It is in this sense that it can be called a growth measure. But there may be ways to expand demand and utilization to the same degree while at the same time providing both more stimulus for and more economic room for capacity-building uses of resources now idle.

2. *Noneconomic Reasons for Growth.* Economic growth may be a national objective for noneconomic reasons, for national prestige or national strength or national purpose.

No doubt much of the recent dissatisfaction with U.S. growth is motivated by unfavorable comparisons with other countries, especially the Soviet Union. If current rates are mechanically extrapolated, it is easy to calculate that the U.S. will not be first in international statistical comparisons in our great grandchildren's textbooks. Presumably the American nation could somehow stand and even rationalize this blow to our national pride, even as we survive quadrennial defeats by Russian hordes in the Olympics. At any rate, it is not for professional economists to advise the country to act differently just to win a race in statistical yearbooks. The cold war will not be so easily won, or lost, or ended.

International competition in growth may, however, be of importance in the battle for prestige and allegiance among the "uncommitted" and less developed countries. These nations place a high premium on rapid economic progress. They will not—so the argument runs—choose the democratic way in preference to communism, or market economies in preference to centrally directed economies, unless our institutions show by example that they can outperform rival systems. A political psychologist rather than an economist should evaluate this claim. But it has several apparent weaknesses: (*a*) Rate of growth is not the only dimension of economic performance by which our society will be judged by outside observers. Equality of opportunity and of condition, humanity, understanding, and generosity in relation to less privileged people in our own society and abroad—these are perhaps more important dimensions. (*b*) The U.S. is not the only noncommunist economy. The examples of Western Europe (in particular the contrast of Western to Eastern Germany) and Japan are more relevant to the rest of the world, and they give convincing evidence of the economic vitality of free societies. (*c*) What is much more important is a demonstration that

an underdeveloped country can progress rapidly under democratic auspices. Without this kind of demonstration, faster growth of affluence in already affluent societies may cause more disaffection than admiration.

On the score of national strength, there is a case for growth. But it is more subtle than the facile association of military power with generalized civilian economic capacity. Nuclear technology has made this connection looser than ever. A country is not necessarily stronger than another just because it has a higher GNP. Great productive capacity may have been the decisive reserve of military strength in the last two World Wars, but nowadays it is useless if it remains unmobilized until the cataclysmic buttons are pushed. A country with smaller GNP can be as strong or even stronger if it persistently allocates enough of its GNP to military purposes. And in the age of overkill, apparently there can be a point of saturation.

Should we grow faster to be better prepared to meet possible future needs for output for military purposes—or for other uses connected with national foreign policy? If we do not, we will have to meet such needs when they arise by depriving other claimants on national production, principally consumption, at the time. But in order to grow faster, we have to deprive these claimants now. Hence the national power argument seems to boil down to the economist's calculation after all; i.e., to the terms of trade between current and future consumption.

But there is an important exception. Some hazards are great enough to bias our choice to favor the future over the present, to accept less favorable payoffs than we otherwise would. We might conceivably be challenged one day to a duel of overriding priority, involving all-out commitment of resources to military uses, foreign aid, space adventures, or all of these together. A high GNP might be the difference between victory and defeat rather than the difference between more or less consumption. In other words, this contingency is one that could be met only by sacrifices of consumption in advance, not by sacrifices at the time.

As for national purpose, it is surely conceivable that a growth target could inspire, galvanize, and unite the nation. But it is not the only objective that could serve this purpose, nor is it necessarily the best candidate.

3. *Growth in What?* The formulation of the growth issue sketched above presents it as a choice among available consumption paths. The concentration on consumption deserves some elaboration and explanation—especially because growth performance and aspiration are popularly expressed in terms of gross or net national product.

Some of the noneconomic reasons for favoring faster growth also sug-

gest that GNP is the relevant measure, especially if it is the most usual and visible measure. But as economists we would make welfare or utility depend on consumption. We would require the investment part of GNP to derive its value from the future consumption it supports. After all, a future in which the rate of growth of GNP reaches fantastic heights has no appeal if the fruits of the achievement are never consumed. We must heed the "golden rule" of capital accumulation: there is a saving ratio and a corresponding capital intensity that maximize consumption. Persistent saving in excess of the rule makes GNP higher but consumption lower. (See Phelps [5].)

Neither GNP nor consumption, as ordinarily measured, counts leisure. Yet I do not understand advocates of faster growth to be taking a stand in favor of goods and services priced in the market and against leisure. Should the trend toward shorter hours, longer vacations, and earlier retirements accelerate, the rate of growth of consumption as measured in the national accounts might decline. But a decline for this reason should not bother a growth-oriented economist. The *Affluent Society* to the contrary notwithstanding, the conventional wisdom of economics was long since liberated from the fallacy that only produced goods and services yield utility and welfare. Economists do have prejudices against biasing the price system in favor of leisure and against forcing the leisure of involuntary unemployment on anyone. But those are other matters. The consumption whose growth path concerns us should include leisure valued at the real wage. Needless to say, it should also allow for consumption goods and services provided by government.

Finally, is the relevant measure aggregate consumption or consumption per capita? Later in the lecture I shall be concerned with social indifference curves between consumption at one date and at a later date. An example is pictured in Figure 2. What measure of consumption should the axes of such a diagram represent? The answer depends on questions like the following: Do we discharge our obligation to the next generation if we enable them to enjoy the same aggregate consumption even though there will be more of them to share it? Should we, on the other hand, sacrifice today in order to raise per capita consumption half a century from now just because there will then be more consumers? Or should generations count in some sense equally regardless of size?

These are not easy questions for the social philosopher, but revealed social preferences lean towards per capita consumption. Presumably we do not value increase in population for its own sake. We might if sheer numbers were important for national power. But in general we are content to leave population trends to free choice; indeed, we seek to enlarge parents' ability to limit births at their discretion. Neither immigration

nor subsidies for childbearing are advanced as growth proposals. In the world at large, certainly, the commonly accepted aim is to retard the growth of population, not to accelerate it. (For discussion of some aspects of this problem, see Koopmans [3].)

4. *Government's Power to Influence Growth.* I come now to the question whether the government can influence growth, even if we wish it to. The growth objective is commonly framed in terms of an exponential growth rate. Those who advocate measures to promote growth frequently are expressing a preference for a higher per annum rate of growth, for 4 percent or 5 percent instead of 3 percent or $3\frac{1}{2}$ percent. But the thrust of much recent theorizing and model building is that in the really long run we have no choice about the growth rate. (See, for example, Phelps [6].) The long-run growth rates of GNP and aggregate consumption are exogenously determined by the growth of the labor force and the progress of technology. Or, to express the same conclusion somewhat differently, the rates of growth of productivity per man and

SUGGESTED CRITERION OF INTERTEMPORAL IMPARTIALITY

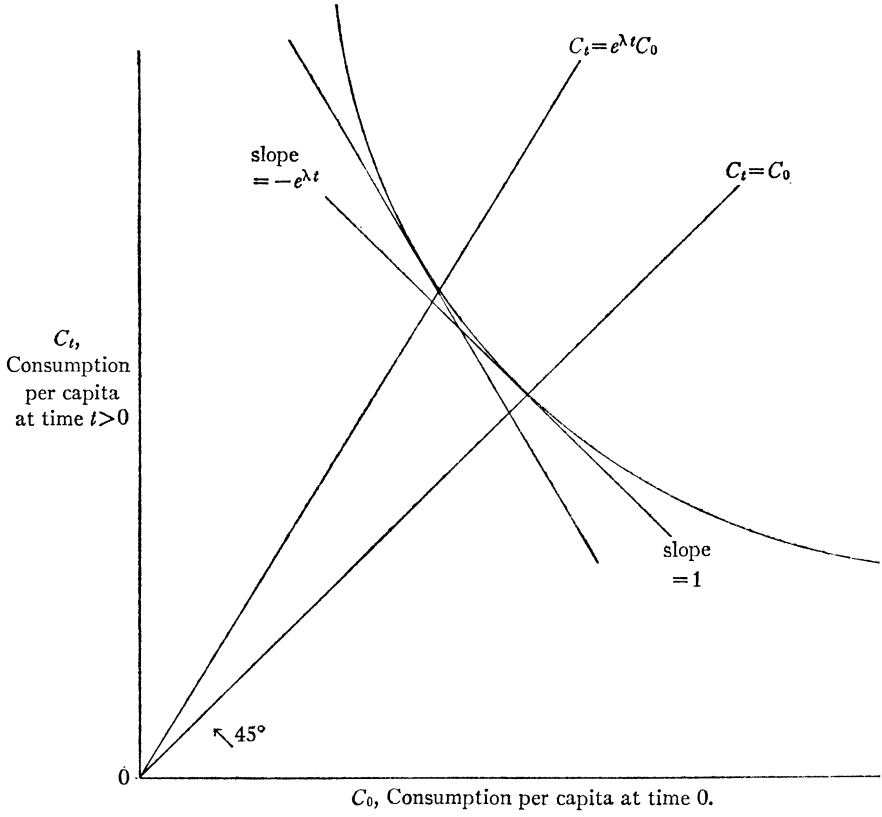


FIGURE 2

of consumption per capita are in the long run controlled by the rate of advance of technology.

According to these models, there are various hypothetical paths which share the exogenously determined rate. These paths differ in level. On a higher path, consumption per capita is always larger than on a lower one. A higher path represents a higher capital intensity (so long as capital intensity does not exceed its golden rule value), and a correspondingly higher propensity to save is required to maintain it.

An economy moving along one of these paths may "decide" to move to a higher one, by lowering its propensity to consume. For a while, its growth rate will be higher, as the effects of increasing capital intensity and modernization are added to those of the underlying progress of technology. Eventually, however, capital intensity will cease to increase and the growth rate will converge to its natural value. The process can be repeated by further increases in the saving ratio, but the golden rule argument cited above sets a limit long before the propensity to consume reaches zero—indeed, when the propensity to save is equal to the elasticity of output with respect to capital accumulation. This is the highest path for consumption per capita.

Asymptotically, then, it appears that we have no choice about our rate of growth, but can choose only between parallel paths of different levels. But asymptotically is a very long time. The period of transition from one path to another, short from the perspective of the model builder, may be measured in decades or generations. It is therefore not wholly misleading to regard society as choosing among growth rates.

Models of this kind take the rate of technological progress as exogenous. In fact, it is probably subject to improvement, like the degree of capital intensity, by expenditure of current resources. We still know very little about the technology that governs the production of applicable technological knowledge. What is required to keep the index of technology, which determines the productivity of labor and capital, growing at a constant exponential rate? Does it take simply a constant absolute amount of labor and capital? Does it take a constant fraction of the resources devoted to production? Does it take an input of resources growing at the same rate as the technology index itself? Only when we can answer such questions can we know whether and how the pace of economic growth is ultimately limited by the natural increase of the labor force.

A second reason for doubting that government measures can affect the intertemporal choices of society is the possibility that the private decisions of individuals can and will offset these measures. Suppose, for example, that the government levies new taxes and uses the proceeds for saving and investment, either through public expenditure or through public lending to private investors or through retirement of public debt.

The government's purpose is to increase later consumption at the expense of earlier. But if this purpose is perfectly well understood, will not the public reduce its private saving in the knowledge that its collective saving is now doing part of the job?

I have two comments regarding this possibility. First, it may be that the government's saving corrects a situation of underinvestment, where public or private projects that would pay for themselves in social benefits (discounted at the time preference set of interest rates) were not being undertaken. In this case, the government's twist of the path will not be undone even if perfectly understood because the new path corresponds better to public preferences. Second, the assumption that the public correctly foresees all the consequences of government policy is farfetched. In the example above, economists would usually expect the new taxes to be paid in large part out of private consumption. Disposable income is reduced; and so, gradually, is the public's net financial claim on the government—a more tangible element in private balance sheets than the present value of future tax liabilities or of free services from government.

I conclude, therefore, that at least for the medium run, government can affect the growth of the economy; and I turn to the question whether it should.

III

In this section I propose to argue: (1) that government might legitimately have a growth policy, and indeed could scarcely avoid having one, even if private capital markets were perfect; (2) that capital markets are far from perfect and that private saving decisions are therefore based on an overconservative estimate of the social return to saving; and (3) that the terms on which even so advanced an economy as our own can trade present for future consumption seem to be very attractive.

1. *Government Neutrality in Intertemporal Choice.* Many economists and many other citizens will argue that the government should be neutral as between present and future. In their view the capital markets produce an optimal result, balancing the time preferences of individuals, freely expressed through their consumption and saving behavior, against the technological opportunities for substituting consumption tomorrow for consumption today. Let us assume for the moment that government can be neutral in some meaningful sense and that the capital markets perform their assigned function. Even so, I believe government should have a growth policy, and only by accident a neutral one.

I fail to see why economists should advise the public that it is wrong for them collectively to supplement (or diminish) the provisions for the future they are making individually. I agree to the desirability of satis-

fying human preferences—that is what our kind of society and economy is all about. But I have never been able to understand why the preferences of individuals are worthy of respect only when they are expressed in the market, why the preferences of the very same individuals expressed politically should be regarded as distortions. Sometimes economists come close to rationalizing all market results and private institutions by the argument that they would not occur and survive if they were not otpimally satisfying individuals' preferences. But political results and public institutions are not granted the benefit of presumptive justification-through-existence.

In both arenas preferences certainly need to be guided by full and accurate information. In the arena of government policy, it is the business of economists to help the society know what it is doing, to understand the choices, benefits, costs, and risks it confronts, not simply to repeat *ad nauseum* that the best thing to do is nothing.

The case for explicit government policy in intertemporal social choice is especially strong. More than any other social institution, government represents the permanence and continuity of the society. And in a democracy one way in which each generation uses government is to protect the interests of unborn generations against its own shortsighted and selfish instincts.

We cannot be sure that lineal family ties will give individuals sufficient motivation to provide for society's future. Suppose the individuals of a whole generation, deciding that their children and grandchildren might better start from scratch, were to proceed to consume their capital. Good capital markets might reflect this epidemic of acute time preference in a perfectly Pareto-optimal way. But would we as a nation feel that we were collectively discharging our obligations to our successors?

Through many activities of government, including conservation and public education, we have recognized a generalized obligation to equip the next generation—an obligation wholly distinct from our individual provisions for our own children. This generalized obligation acquires special force if we take seriously our ideals of equality of opportunity. We like to think that our society gives the members of each generation an equal chance in the race, or at least that their chances are not predetermined by family backgrounds. Besides requiring investment in human beings on a basis other than ability to pay, this ideal suggests redistributive taxation of estates. And if estate taxation dulls incentives to save for specific heirs, the government needs to replenish saving collectively.

But what is growth-neutral government finance anyway? I have already dismissed as farfetched one answer; namely, that any government finance is growth neutral when it is fully and accurately foreseen,

and accordingly offset, by taxpayers and by the beneficiaries of government services. Often a balanced budget is considered a growth-neutral fiscal policy. The budget in this rule is not, of course, the conventional U.S. administrative budget. Rather the rule suggests that (*a*) net government investment should be covered by borrowing, with the Treasury competing in the capital markets with private investors for private saving, and that (*b*) other government expenditure, including allowance for consumption of public capital, should be covered by current taxes or fees.

The rule is clear cut and has intuitive appeal. But it seems to bias social choice against the future when there is simply a shift in public preference from private consumption, present and future, to collective consumption, present and future. The rule would levy only enough new taxes to cover the additional collective consumption. But the evidence is that taxpayers would pay some of these new taxes from saving (especially if the collective consumption the taxes finance were of regrettable necessities like national defense rather than of services that clearly yield utility now and in future). Interest rates would rise and investment would be curtailed, even though no shift in social time preference has occurred. Clearly the 10 percent of GNP which the cold war has forced us to devote persistently to national defense has not come wholly from private or public consumption. True neutrality evidently would require a tighter fiscal policy the bigger the government's budget for current consumption.

But in any case, the quest for neutrality is probably a search for a will-of-the-wisp. For it is not only the overall budget position of government but also the specifics of taxation and expenditure which affect intertemporal choices. We have not yet learned how to implement the welfare economist's lump-sum taxes. I have already given one example of a tax which is desirable in view of other social objectives but is bound to affect incentives for private accumulation of wealth. It will suffice to remind you also that our methods of taxation necessarily favor one kind of current consumption, leisure, both as against other current consumption and as against future consumption of products and leisure.

The major policy proposals of growthmen boil down to the suggestion that government should save—or save more—by making investments on its own account, subsidizing the investments of others, or by channeling tax money through the capital markets into private investment. This last item is the major purpose of the full employment budget surplus for which Councils of Economic Advisers longed under both Presidents Eisenhower and Kennedy.

It is now widely recognized that in principle the government can match aggregate demand to the economy's capacity in a variety of ways. Its various instruments for regulating or stabilizing demand affect con-

sumption and investment differently. A strong pro-growth policy would restrict consumption by taxation or by economy in government's current expenditure while stepping up public investment and encouraging private investment through tax incentives or low interest rates and high liquidity. The government cannot avoid choosing some combination of its demand-regulating instruments. Therefore government is bound to affect the composition of current output and society's provision for the future. Let us debate this choice of policy mixtures on its merits, weighing growth against its costs and against other objectives of policy, without encumbering the debate with a search for that combination which meets some elusive criterion of neutrality.

2. *Imperfections in Private Capital Markets.* I turn now to the second subject: the efficiency of the capital markets. Do private saving decisions reflect the real payoffs which nature and technology offer the economy? There are several reasons to believe that the answer is negative.

Monopoly and Restrictions of Entry. The evidence is that the rates of return required of real investment projects by U.S. business corporations are very high—typically more than 10 percent after allowance for depreciation, obsolescence, and taxes. Rates of this magnitude are not only required *ex ante* but realized *ex post.* Why do these rates so greatly exceed the cost of borrowed funds, the earnings-to-price ratio of equity issues, and in general the rates of return available to savers?

One reason clearly is that the relevant markets are not purely competitive. A monopolistic or oligopolistic firm limits its expansion in product markets, its purchases in factor markets, and its calls on capital markets, because the firm takes into account that prices and rates in these markets will turn against it. The managers seek to maintain a market valuation of the firm in excess of the replacement cost of its assets, the difference representing the capitalized value of its monopoly power, often euphemistically called good will. Restrictions and costs of entry prevent other firms from competing this difference away. Foresighted and lucky investors receive the increases in the firm's market value in the form of capital gains. But the willingness of savers to value the assets of the firm above their cost, i.e., to supply capital at a lower rate of return than the firm earns internally, is not translated into investment either by this firm or by others. One effect is to depress rates of return in more competitive sectors of the economy. But another result is to restrict total saving and investment.

Risks, Private and Social. Risks provide a second reason for the observed divergence between the rates of return satisfactory to savers and those typically required of real investment projects. Some of these are risks to the economy as well as to the owners of the business: technological hazards, uncertainties about consumer acceptance of new products, or uncertainties about the future availability and social opportunity

cost of needed factors of production. Even though these are social as well as private risks, it is not clear that society should take a risk-averse position towards them and charge a risk premium against those projects entailing more uncertainties than others. Presumably society can pool such risks and realize with a very small margin of uncertainty the actuarial return on investments.

Moreover, some of the private risks are not social risks at all. Consider, for example, uncertainties about competition and market shares; if several rivals are introducing a new process or new product, the main uncertainties in the investment calculation of each are the future actions of the others. Consider, further, the high and sometimes prohibitive cost which many firms impute to external funds—apparently as insurance against loss of control to new shareowners, or, with extremely bad luck, to bondholders. If savers were offered the rates of return asked of and earned by business investments, in the form of assets that impose no more risk on the holder than is commensurate to the social risks involved, presumably they would choose to save more.

It is true, on the other hand, that some net saving is now motivated by personal contingencies that are likewise social risks of a much smaller order. But our society has created insuring institutions, both private and public, to reduce the need for oversaving to meet such contingencies. Except in the field of residential construction, it has created few similar institutions to prevent private risk-aversion from leading to underinvestment.

External Returns to Investment. Some investments yield benefits which cannot be captured by the individual or firm making the initial outlay. Research and development expenditures and outlays for training of personnel are obvious cases in point. Government policy has already recognized this fact both in tax law and in government expenditures, and it is difficult to judge whether this recognition is sufficient. Kenneth Arrow [1] has pointed out that not only R and D but all forms of investment activity share in some degree the property that B may learn from A's doing. The support which this observation gives to a general policy of encouraging investment is somewhat tempered by reflecting that the same social process of "learning by doing" can occur in production of goods and services for current consumption. However, experience is most important as a teacher in new situations, and innovations are likely to require investment.

In regard to investment in human capacities and talents, it is by no means clear that public outlays are yet sufficient to reap the external benefits involved, or even that the relevant capital markets are sufficiently developed to permit individuals to earn the private benefits. I recognize that calculations of the rate of return to educational outlays depend critically on how much of these outlays are charged to current

consumption. As an educator and ex-student I am inclined to rate high the immediate utility-producing powers of education.

3. *The Payoff to Social Saving.* The burden of my remarks so far is that we cannot escape considering growth or, more precisely, intertemporal choice as an issue of public economic policy. We cannot assume, either, that the market settles the issue optimally or that government can be guided by some simple rules of neutrality. We—and here I mean the economics profession and the country and not the three of us speaking tonight—must confront head-on the question whether the social payoff of faster growth in higher future consumption validates its cost in consumption foregone today. The issue that needs to be joined is typified by the contrast between Denison [2], who estimates a very high investment requirement for a one point increase in the medium-term growth rate (a ten point increase in the ratio of current gross investment to GNP) and Solow [8], who calculates a marginal investment requirement only about one-fifth as high.

Fortunately the profession has now begun the task of computing rates of return on various kinds of investment, tangible and intangible. Thanks to theoretical advances in growth models and in handling the knotty problems of technological progress, vintage capital, and obsolescence, we have a better conceptual foundation for these tasks than we did only a few years ago. Phelps [6], using the same conceptual approach as Solow [7], has estimated the overall rate of return on tangible investment in the U.S. to be about 14 percent in 1954. And even this figure seems conservative in relation to some target rates of return of large industrial corporations reported by Lanzillotti [4].

But whatever the true rates are, they must be compared with appropriate social rates of time preference.

Consider a family of exponential balanced-growth paths sharing a common growth rate; each member of the family has a constant saving ratio, and this ratio differs from path to path. It is also true that each path is characterized by a single technological interest rate, the same for all intervals of time. The theory of the golden rule tells us that the path of highest consumption per capita at every point in time is characterized by a gross saving ratio s equal to the elasticity of output with respect to capital α (this is also the share of nonlabor income in GNP if income distribution is governed by marginal productivity). Along the golden rule path the social rate of interest is constant and equal to the rate of increase of the "effective" labor force. This in turn is equal to the natural rate of increase in the labor force plus the annual rate of improvement in labor quality due to technical progress.

If there is no technical improvement, consumption per capita remains constant over time; and along the golden rule path a dollar of per capita consumption saved today will produce a dollar, no more and no less, in

per capita consumption tomorrow. The return on aggregate saving is just enough to keep up with population growth.

This rate of return represents impartiality between generations in this sense: When consumption per capita is the same tomorrow as today, there is no time preference; a dollar of consumption per capita is valued the same whenever it occurs. (See Koopmans [3].)

When there is technical progress, both the real wage and consumption per capita will advance at the annual rate at which labor quality improves, say λ. And along the golden rule path λ will also be the per annum rate of return, in future per capita consumption, on saving today. (A dollar of saving will yield in addition enough new capital to provide for the increment of population.) That is, an increase in per capita consumption of \$1.00 at time t requires sacrifice of only $\$e^{-\lambda t}$ at time zero.

It is reasonable to regard this rate of discount, too, as intertemporally impartial. Absence of time preference means that at equal consumption levels society values equally a dollar of future consumption and a dollar of present consumption. But on a path of growing per capita consumption, it is natural that a dollar of future consumption should no longer trade for current consumption at par. To take the rate of improvement in labor quality and in the real wage, λ, as the rate of time preference is to say in effect: saving is justified if and only if it earns more than future consumers will gain anyway through the inexorable progress of technology. Thus if the rate of technical progress is correctly foreseen, this principle meets a common criticism of growth; namely, that there is no reason to save for future generations when technological progress will make them better off anyway. Figure 2 illustrates a social indifference curve between present and future per capita consumption such that there is no time preference when the two are equal, but elsewhere a marginal rate of substitution that exceeds one in the same proportion that future consumption exceeds current consumption.

An economy saving at a constant rate s lower than α, the share of capital income in GNP, will be below its golden rule path. Its rate of return on saving will be accordingly higher than the golden rule rate. Indeed the present value of the stream of returns from a dollar of investment, computed at the golden rule rate on the theory that this is an appropriate impartial discount factor free of the taint of time preference, is equal to α/s. In the United States today the ratio α/s must exceed 1.5 and may be as high as 2.

For some models it is possible to compute the technological interest rate characteristic of a path with α/s greater than one; i.e., of a path below the golden rule path. This is, in effect, what Phelps did to arrive at his estimates of the return on investment in the United States, cited above. Consider a model based on a Cobb-Douglas production function

with variable factor proportions both *ex ante* and *ex post*. Let capital elasticity be α and labor elasticity $1-\alpha$; the natural rate of increase in labor force n; constant technical progress expressed as improvement in the quality of labor at rate λ; a gross saving ratio s; depreciation of capital at a constant rate δ. The members of this family of growth paths share a rate of growth $n+\lambda$ in aggregate output, investment, and consumption, and a rate of growth λ in the real wage and in per capita consumption. The rate of interest characteristic of a path is different depending whether technical progress is assumed to be (*a*) disembodied and affecting all capital old or new, or (*b*) embodied in new vintage capital only. The expressions for the rate of interest in the two cases are as follows (for their derivation see Appendix):

(*a*) disembodied technical progress

$$r = \frac{\alpha}{s}(n + \lambda + \delta) - \delta$$

(*b*) embodied technical progress

$$r = \frac{\alpha}{s}(n + \lambda + \delta) - \delta + \frac{\lambda(1-\alpha)}{s} - \frac{\lambda(1-\alpha)}{\alpha}$$

If, for example, $n=.015$, $\lambda=.03$, $\delta=.03$, and $s=.20$, then $r=.095$ in case (*a*) and $r=.135$ in case (*b*). The difference reflects the fact, originally emphasized by Solow [7], that additional saving moves the economy toward a higher path faster in the vintage-capital model and therefore is rewarded sooner with higher consumption.

The evidence is uncertain, and there is a clear need for more refined and reliable estimates of the parameters on which the issue turns. I believe the evidence suggests that policy to accelerate growth, to move the economy to a higher path, would pay. That is, the returns to a higher saving and investment ratio would be positive, if evaluated by a reasonable set of social time preference interest rates. This seems to me the strongest reason for advocating growth policy.

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APPENDIX

1. Let $I(v)$ be gross investment at time (vintage) v, and let $\rho(v, t)$ be its marginal productivity at time t. Then the present value of the stream of returns from investment of one dollar at time v is

$$\int_v^\infty e^{v^{-\int_v^t r(u)\,du}} \rho(v, t)dt.$$

Setting this present value equal to 1 for all v defines the series $r(u)$ of instantaneous technological interest rates.

In the models under discussion in the text calendar time does not affect $\rho(v, t)$, which can therefore be written as $\rho(t-v)$. It follows that $r(u)$ is a constant, and we may find it from:

$$\int_0^\infty e^{-r(t-v)}\rho(t-v)\,d(t-v) = 1 \tag{1}$$

The gross income to capital at time t, if capital of each vintage is paid its marginal product, is

$$\alpha Q(t) = \int_{-\infty}^{t} I(v)\,\rho(v, t)\,dv = \int_0^\infty I(t-v)\,\rho(t-v)\,d(t-v)$$

where $Q(t)$ is gross output summed over all vintages, and α is capital's share. Now if investment is growing exponentially at rate g—the rate of growth of output—then $I(t-v) = I(t)e^{-g(t-v)}$. Therefore

$$\frac{\alpha Q(t)}{I(t)} = \frac{\alpha}{s} = \int_o^\infty e^{-g(t-v)}\rho(t-v)\,d(t-v) \tag{2}$$

where s is the saving ratio, constant along the path. The right-hand side will be recognized at the present value of the stream of returns from investment when the discount factor is g rather than r. This present value exceeds 1 whenever α/s exceeds one.

2. The above argument shows that $r \gtreqless g$ as $\alpha \gtreqless s$. It remains to derive the explicit expressions for r given in the text.

(*a*) Disembodied progress:

Let $Q(v, t)$ be the output and $L(v, t)$ the labor input associated with capital made at time v.

$$Q(v, t) = A(I(v)e^{-\delta(t-v)})^\alpha(L(v, t)e^{\lambda t})^{1-\alpha} \tag{3}$$

The marginal product of capital:

$$\rho(v, t) = \alpha\frac{Q(v, t)}{I(v)} = A\alpha e^{-\alpha\delta(t-v)}e^{\lambda(1-\alpha)t}\left(\frac{L(v, t)}{I(v)}\right)^{1-\alpha} \tag{4}$$

The marginal product of labor:

$$(5) \qquad w(t) = (1-\alpha)\frac{Q(v,t)}{L(v,t)} = A(1-\alpha)e^{-\alpha\delta(t-v)}e^{\lambda(1-\alpha)t}\left(\frac{L(v,t)}{I(v)}\right)^{-\alpha}$$

$$w(t)^{-(1-\alpha)/\alpha} = A^{-(1-\alpha)/\alpha}(1-\alpha)^{-(1-\alpha)/\alpha}e^{(1-\alpha)\delta(t-v)}e^{-\lambda((1-\alpha)^2/\alpha)t}\left(\frac{L(v,t)}{I(v)}\right)^{1-\alpha}$$

$$\rho(v,t) = A^{1/\alpha}\alpha(1-\alpha)^{+(1-\alpha)/\alpha}e^{-\delta(t-v)}e^{((1-\alpha)/\alpha)\lambda t}w(t)_{-((1-\alpha)/\alpha)}$$

Since the real wage w grows at rate λ,

$$\rho(v,t) = A^{1/\alpha}\alpha(1-\alpha)^{(1-\alpha)/\alpha}e^{-\delta(t-v)}e^{(1-\alpha)/\alpha\lambda t}(w(o)e^{\lambda t})^{-((1-\alpha)\lambda\alpha)}$$

$$\rho(v,t) = A^{1/\alpha}\alpha(1-\alpha)^{(1-\alpha)/\alpha}e^{-\delta(t-v)}w(o)^{-((1-\alpha)/\alpha)}$$

Thus $\rho(v,t)$ can be written as $\rho(t-v)$ and indeed

$$(6) \qquad \rho(v,t) = \rho(t-v) = \rho(v,v)e^{-\delta(t-v)} = \rho(o)e^{-\delta(t-v)}$$

To find r we set $\int_o^\infty e^{-r(t-v)}\rho(t-v)\,d(t-v)=1$

Therefore

$$(7) \qquad \rho(o)\int_o^\infty e^{-r(t-v)}e^{-\delta(t-v)}d(t-v) = 1$$

and $r=\rho(o)-\delta$. From section 1 we know

$$\rho(o)\int_0^\infty e^{-g(t-v)}e^{-\delta(t-v)}d(t-v) = \frac{\alpha}{s}$$

$$(8) \qquad \text{Therefore } \rho(o) = \frac{\alpha}{s}(g+\delta)$$

Since $g=n+\lambda$ we have

$$(9) \qquad r = \frac{\alpha}{s}(n+\lambda+\delta) - \delta$$

(*b*) Embodied progress:

In this case:

$$(10) \qquad Q(v,t) = A(I(v)e^{-\delta(t-v)})^{\alpha}(L(v,t)e^{\lambda v})^{1-\alpha}$$

By reasoning similar to (*a*) we obtain

$$(11) \qquad \rho(v,t) = A^{1/\alpha}\alpha(1-\alpha)^{(1-\alpha)/\alpha}e^{-\delta(t-v)}e^{((1-\alpha)/\alpha)\lambda v}w(t)^{-(1-\alpha)/\alpha}$$

$$\rho(v,t) = A^{1/\alpha}\alpha(1-\alpha)^{(1-\alpha)/\alpha}e^{(-\delta-(1-\alpha)\lambda/\alpha)(t-v)}w(o)^{-((1-\alpha)/\alpha)}$$

Once again $\rho(v,t)$ can be written as $\rho(t-v)$, and

$$\rho(t-v) = \rho(o)e^{-(\delta+(1-\alpha)\lambda/\alpha)(t-v)}$$

The same procedure used in (*a*) gives:

$$r = \rho(o) - \delta - \frac{(1-\alpha)\lambda}{\alpha} \tag{12}$$

and

$$\begin{aligned}\rho(o) &= \frac{\alpha}{s}\left(g + \delta + \frac{(1-\alpha)}{\alpha}\lambda\right) \\ &= \frac{\alpha}{s}(n + \lambda + \delta) + \frac{(1-\alpha)}{s}\lambda\end{aligned} \tag{13}$$

Therefore

$$r = \frac{\alpha}{s}(n + \lambda + \delta) - \delta + \left(\frac{1-\alpha}{s}\right)\lambda - \left(\frac{1-\alpha}{\alpha}\right)\lambda. \tag{14}$$