A Short Review of Economic Growth: Theories and Policies

J. Bradford De Long

University of California at Berkeley, and National Bureau of Economic Research

November 1996

Preliminary Draft; Not Quite Complete

Executive Summary

This essay provides a short view of how different policies could affect economic growth—of what are reasonable and unreasonable estimates of the boost to economic growth that could follow from different policy options. The task is complicated because economists' views on the nature and causes of the wealth of nations are, today, more than usually divergent.

As a result of a line of thought and discussion sparked by Stanford economist Paul Romer in the mid-1980s, the theory of economic growth today is up for grabs. A substantial minority of economists still hold to the "baseline" vision of economic growth laid out by Robert Solow in the 1950s, which tends to lead to the conclusion that most growth is determined by extra-economic factors and does not depend strongly on economic policy, for

the progress of science and technology depends little on monetary or fiscal policy. The “vital center” of the American economics profession today holds to an extended and reformulated version of the Solow framework, best exemplified by Gregory Mankiw, David Romer, and David Weil’s “Contribution[s] to the Empirics of Economic Growth,” in which growth is more significantly affected by policies for two reasons: first, estimates of the social marginal product of physical investment are somewhat larger; second, because shifts in economic policy that boost production amplify themselves much more by inducing further investment in physical capital and, most important, in human capital via education.

A “dynamic fringe” of economists—a fringe that looked as if it might be on the verge of obtaining intellectual dominance five years ago, but that has lost some ground since—has become attached to the “endogenous growth” perspective attached to Paul Romer, and tends to reach conclusions that good and bad economic policies can have much more significant effects on growth. According to this perspective externalities—wedges between the social returns realized by the economy and the private returns realized by investors—are pervasive, and the advance of economically-useful knowledge and thus of total factor productivity depends urgently on the progress of other forms of investment. This “endogenous growth” perspective comes in a “narrow” flavor, which emphasizes returns to research and development, and a “broad” flavor, which stresses the many channels through which investment can influence the overall level of total factor productivity.

One's conclusions about the ability of economic policies to affect economic growth depend crucially on which vision of economic growth one adopts. So the latter stages of this paper carry all four perspectives along. Three conclusions, however, appear quite strong and robust:

- First, there is strong reason to believe that the American economy invests too little—that the persistent budget deficits (which threaten to explode again in the next decade) are damaging, and that especially in times of inflation the tax system is badly-tuned to provide incentives for investment and growth—even if one holds to the baseline Solow framework, in which the economic growth rate is hard to move and successful policies with high cost-benefit ratios have little visible impact on time series of economic growth.
- Second, as one moves away from the baseline Solow framework—first to the extended and augmented Solow model in which human capital plays an important role, and then to the externality-emphasizing "endogenous growth" perspectives—the case for tuning American economic policy in the direction of a budget surplus and low taxation on *prospective* investments becomes much stronger. The Mankiw-Romer-Weil model generates impacts of policy changes on economic growth twice as great as the Solow framework if one looks out at total cumulative effects twenty

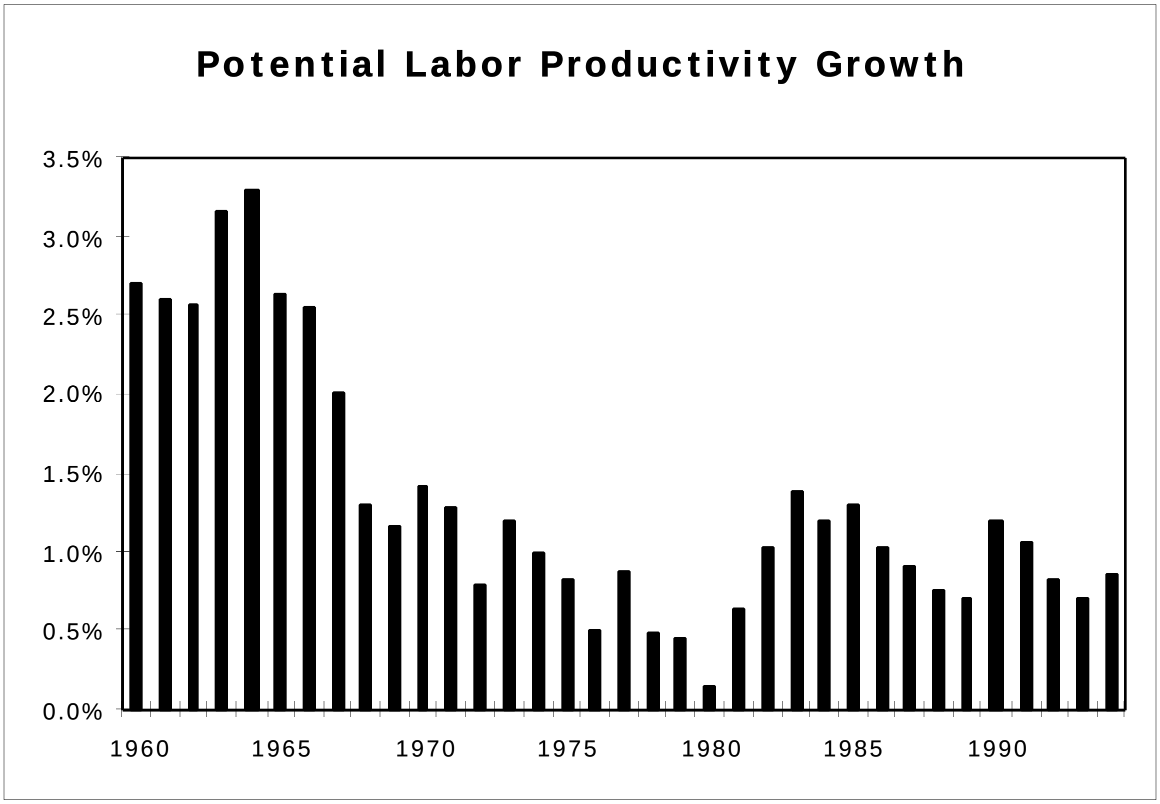
years in the future; the “endogenous growth” perspectives generate results that are greater still.

- Third, the stakes at risk in the task of finding policies to spur American economic growth are larger for the left than for the right half of the political spectrum. All have an interest in faster economic growth: faster growth empowers the American people to better achieve their ends—whether their ends are sitting on beaches sunning themselves, raising their children, protecting endangered species, or increasing their level of education. The left has an interest in the preservation of the twentieth century social insurance state—to which I am quite attached—that I at least think has done a good job at raising human welfare and making America a somewhat more egalitarian place. In the absence of faster economic growth than has been seen in the past two decades, the future of the social insurance state is easy to read: Medicare and Social Security devour the rest of the Great Society and the New Deal over the course of the next generation, and then two generations hence Medicare and Social Security run up against their own budget constraints and are transformed into something we cannot now forecast.

I. Introduction

Economic growth—the *measured* rate of increase of real GDP per worker, and of labor productivity—has slowed markedly in the United States over the past generation. In the 1950s and 1960s measured real GDP per worker increased at roughly 2.5% per year; since 1970 it has averaged less than 1.0% per year.

It is possible to see this glass as half-full. Measured estimates of real GDP growth in all probability understate true improvements in productivity and standards of living . They fail to solve the unresolvable problems of valuing the invention of new goods and new types of goods. It has become standard to guess (but it is only a guess) that "true" growth is one percentage point per year greater than "measured" growth. If this is indeed the case, then "true" real GDP per worker growth has averaged not 1.0% per year but 2.0% per year. (Although the magnitude of the slowdown remains at least as large as, and possibly larger than, the standard measurements imply.) 2.0% per year real GDP per worker growth is very large by long run historical standards, relative to any period but the thirty-year post-World War II boom. It is significantly faster than nineteenth or early twentieth century standards, and vastly more rapid than the millennia of near-stagnation in living standards that preceded the industrial revolution.



But it is more likely that the glass is half empty. The slowdown in productivity growth has left us with a social insurance system and government spending commitments that make sense only if output per worker, and thus the tax base per worker, grows at a measured rate of 2.5% per year on average. Promises made by presidents and congressional leaders in the 1960s and 1970s—and 1980s—about future tax rates and benefit levels cannot be kept if measured output per worker growth remains at 1.0% per year. Politicians are not falling over themselves to deal with this long-run gap by raising taxes or by lowering social insurance benefits.

At a true rate of GDP per worker growth of 3.5% per year—a measured rate of 2.5% per year—America's real standard of living doubled every twenty years. At a true rate of 2.0%—a measured rate of 1.0%—such a doubling takes thirty-five years. The productivity slowdown makes America a poorer country than it might otherwise have been. The resulting gap between how people are living today and how generation ago they had believed that they would be living today makes voters cranky. It turns politics into a search for scapegoats: corporate welfare recipients, individual welfare recipients, Mexicans who stay in Mexico and produce goods for export to the United States, Mexicans who cross the border, bosses who downsize companies, teachers' unions.

Reversing even a part of the productivity growth slowdown would pay enormous benefits, both in higher living standards and greater welfare directly and in changing the political climate in a way that would make better choices easier.

So what might be done to reverse this slowdown? Can anything be done to reverse this slowdown?

Some think that nothing or next to nothing can be done to increase economic growth. Others think that reversing the productivity growth slowdown is trivially easy. Both are wrong—yet their incorrect arguments echo through our political system.

This essay provides a short view of how different policies could affect economic growth—of what are reasonable and unreasonable estimates of the boost to economic growth that could follow from different policy options. The task is complicated because economists' views on the nature and causes of the wealth of nations are, today, more than usually divergent.

As a result of a line of thought and discussion sparked by Stanford economist Paul Romer in the mid-1980s, the theory of economic growth today is up for grabs. A substantial minority of economists still hold to the "baseline" vision of economic growth laid out by Robert Solow in the 1950s, which tends to lead to the conclusion that most growth is determined by extra-economic factors and does not depend strongly on economic policy, for the progress of science and technology depends little on monetary or fiscal policy. The "vital center" of the American economics profession today holds to an extended and reformulated version of the Solow framework, best exemplified by Gregory Mankiw, David Romer, and David Weil's "Contribution[s] to the Empirics of Economic Growth," in which growth is more significantly affected by policies for two reasons: first, estimates of the social marginal product of physical investment are somewhat larger; second, because shifts in economic policy that boost production amplify themselves much more by inducing further investment in physical capital and, most important, in human capital via education.

A "dynamic fringe" of economists—a fringe that looked as if it might be on the verge of obtaining intellectual dominance five years ago, but that has lost some ground since—has become attached to the "endogenous growth" perspective attached to Paul Romer, and tends to reach conclusions that good and bad economic policies can have much more significant effects on growth. According to this perspective externalities—wedges between the social returns realized by the economy and the private returns realized by investors—are pervasive, and the advance of economically-useful knowledge and thus of total factor productivity depends urgently on the progress of other forms of investment. This “endogenous growth” perspective comes in a “narrow” flavor, which emphasizes returns to research and development, and a “broad” flavor, which stresses the many channels through which investment can influence the overall level of total factor productivity.

One’s conclusions about the ability of economic policies to affect economic growth depend crucially on which vision of economic growth one adopts. So the latter stages of this paper carry all four perspectives along. Three conclusions, however, appear quite strong and robust:

- First, there is strong reason to believe that the American economy invests too little—that the persistent budget deficits (which threaten to explode again in the next decade) are damaging, and that especially in times of inflation the tax system is badly-tuned to provide incentives for investment and growth—even if one holds to the baseline Solow framework, in which the economic growth rate is hard to move and successful policies with high cost-benefit ratios have little visible impact on time series of economic growth.

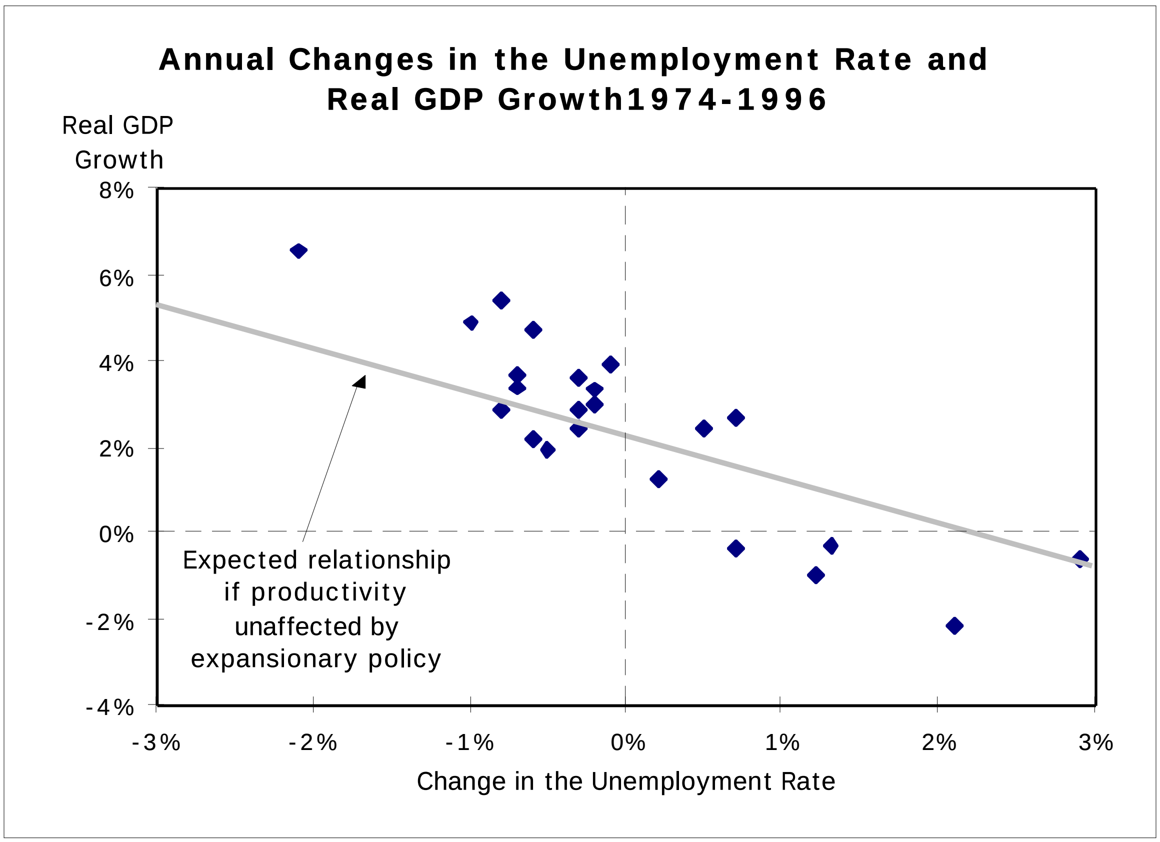
- Second, as one moves away from the baseline Solow framework—first to the extended and augmented Solow model in which human capital plays an important role, and then to the externality-emphasizing "endogenous growth" perspectives—the case for tuning American economic policy in the direction of a budget surplus and low taxation on *prospective* investments becomes much much stronger. The Mankiw-Romer-Weil model generates impacts of policy changes on economic growth twice as great as the Solow framework if one looks out at total cumulative effects twenty years in the future; the "endogenous growth" perspectives generate results that are greater still.
- Third, the stakes at risk in the task of finding policies to spur American economic growth are larger for the left than for the right half of the political spectrum. All have an interest in faster economic growth: faster growth empowers the American people to better achieve their ends—whether their ends are sitting on beaches sunning themselves, raising their children, protecting endangered species, or increasing their level of education. The left has an interest in the preservation of the twentieth century social insurance state—to which I am quite attached—that I at least think has done a good job at raising human welfare and making America a somewhat more egalitarian place. In the absence of faster economic growth than has been seen in the past two decades, the future of the social insurance state is easy to read: Medicare and Social Security

devour the rest of the Great Society and the New Deal over the course of the next generation, and then two generations hence Medicare and Social Security run up against their own budget constraints and are transformed into something we cannot now forecast.

II. Wrong Answers

Look first at the wrong answers to the question of what might be done to spur economic growth. As examples of the first wrong answer—that it is easy—consider the views of those like the near-nominee for Federal Reserve Vice Chair, Felix Rohatyn, on the one hand; and the views implicit in the arguments of Stanford’s John Taylor, point man on economic issues for the recent Republican presidential campaign on the other. In the views of those like Felix Rohatyn, the only thing keeping the U.S. economy from growing at 4% or 5% per year is the Federal Reserve: let the Federal Reserve ease up on interest rates, and the U.S. economy will leap forward rapidly. In the view of those like John Taylor, marginal changes in tax policies could easily boost the rate of economic growth by a full one percentage point per year or more.

As an example of the second wrong answer—that is impossible—consider the views of Harvard economist Robert Barro. Barro holds that rates of growth are ultimately determined by (a) an economy’s technology gap vis-a-vis the world’s “best practice” frontier, and (b) its politico-economic institutions: “maintenance of the rule of law and property rights... market distortions, the extent of political freedom and monetary/inflation policy." Because the U.S. economy is at the world's technology frontier and possesses relatively good institutions, annual growth in the low two percents "is as good as it gets."



The Felix Rohatyn view is wrong because there is no evidence that looser monetary policy leads to significantly faster real GDP growth. Over the twenty-three years since the 1973 "oil shock" that tripled world energy prices and began our current regime of relatively slow economic growth, some eighty percent of the variation in year-to-year real GDP growth rates is accounted for by changes in the unemployment rate and changes in the rate of labor force growth: holding the unemployment rate constant, a one percentage-point increase in labor force growth over a year increases real GDP by an estimated 0.54 percent; holding the labor force constant, a one percentage-point decrease in the unemployment rate over a year increases real GDP by 1.67 percent. “Background” growth in real output holding both the labor force and the unemployment rate fixed has averaged 1.57 percent per year.

(1)	Real GDP Growth =	1.57%	-1.676(Unemp. Ch.)	+0.538(LF Growth)	R^2=.79	SEE=.010
		(0.58%)	(0.206)	(0.308)		

With the labor force growing at its current pace of approximately 1.0 percent per year, real GDP growth averages some 2.1% per year holding the unemployment rate constant. Looser monetary policy would accelerate economic growth, and labor productivity would increase: a one percentage point extra reduction in the unemployment rate boosts output not just by the 0.54 percent that is the marginal product of an extra worker, but by an extra 1.34 percent—some coming because lower unemployment means a higher average workweek, and some coming because more expansionary monetary policy is genuinely accompanied by higher productivity.

But the magnitude of the productivity boost from looser monetary policy is limited. 4% per year growth would—with the labor force expanding as current demographics allow—lower unemployment by 1.1% per year; 5% per year growth would lower unemployment by 1.7% per year. Three years at 4% growth or two years at 5% growth would lower unemployment to levels not seen since 1943-1945 that have always been associated with double-digit inflation.

Thus claims that looser monetary policy could boost growth to 4% or 5% a year over the medium term assume a major break in the structure economy: a large and unprecedented shift in the relationship between productivity growth and employment that there is no reason to anticipate.

Similarly improbable is the Dole-Kemp-Taylor hope, expressed vociferously in the recent presidential campaign, that relatively small changes in the tax code could trigger large increases in economic growth through improvements in productive efficiency. The tax law changes in 1981's *ERTA* , the flagship initiative of the Reagan administration, were designed to have as large a positive supply-side impact as possible: every dollar of notional revenue loss was spent reducing marginal tax rates for someone, and the reductions in marginal tax rates were larger the higher was the initial marginal rate of the taxpayer.

Yet even the largest serious estimates of the supply-side benefits from *ERTA's* tax reductions—the estimates produced by Lawrence Lindsay and presented in his book, *The Growth Experiment*—find that each dollar's worth of tax cut (defined in terms of the notional static revenue loss) triggered at most a dollar's worth of additional real GDP, some uncertain amount of which was not a true addition to production but a shift from unrecorded and untaxed to recorded and taxed economic activity. Thus the (notional) one and a half percentage points of GDP reduction in income taxes triggered, on Lindsay's estimates, a one-time one and a half percent boost to real GDP—an increase in the real GDP growth rate of 0.3% per year over the five years after implementation.

Other estimates than Lindsay's tend to be smaller.

The tax law changes proposed by Dole-Kemp were not carefully tuned to ensure that every dollar's worth of notional static revenue loss reduced someone's marginal tax rate, were not designed to have as large a positive supply-side effect as possible, and were much smaller than *ERTA's* tax reductions relative to the size of the economy: perhaps one-third as large.

It might be that we would have been extremely lucky: that the proportional boost to productivity from tax rate reductions would truly be as large as Lindsay has estimated, and that the diversion of attention from reducing marginal tax rates to other goals (like providing family-friendly child credits) would not significantly attenuate the benefits. But even then the boost to growth from a tax rate reduction one-third as large as *ERTA* would be on the order of 0.1 percentage point per year—less than one-twelfth of the boost needed to achieve the Dole-Kemp campaign's predicted growth rate of 3.5% per year. The likely effects on growth are at least an order of magnitude smaller than the effects claimed even if you grant that *ERTA's* tax reductions produced supply-side output gains at the upper end of the estimated range.

But just because neither Felix Rohatyn's nor the Dole-Kemp-Taylor policies promise any significant boost to economic growth doesn't mean that the economic growth rate is set in stone.

One economist who does believe that the U.S. growth rate cannot be increased is Harvard's Robert Barro. In Barro's view, growth is determined by (a) the economic institutions that govern the incentives to invest and innovate, (b) demography, and (c) the potential for technology transfer: the gap between the average level of installed productive technology and the world's best practice level of technology. The United States today is still the world's industrial leader: there is no possibility of boosting growth by closing the technology and productivity gap because there is no gap to close. The United States has completed its demographic transition to low fertility, so there is no prospect of changing demography boosting capital per worker.

The United States has what Barro considers to be good economic institutions: a relatively small share of output diverted to "consumption" by the government, free trade, a market economy, and a stable political order based on classical liberal principles.

This is "as good as it gets in the long run for a country that is already rich," in Barro's view. Barro's conclusion is that our political and economic institutions have been such as to guide us into collective policy choices that have delivered 2.5% per year real GDP growth over the past generation. That does not mean that we as a nation lack the capability to make better choices that lead to faster growth and higher economic welfare. We may fail to make better choices—Barro may be correct in his implicit forecast that the U.S. economy will not grow faster in the future. But it is unhelpful to confuse a failure to exercise the capability to grow faster with the lack of any capability for faster economic growth.

III. Theories of Economic Growth

Grant that boosting American economic growth is neither trivially easy (as it is in the Rohatyn or the Dole-Kemp-Taylor view of the world), nor next to impossible (as it is in the Barro view of the world). What policies might boost economic growth? And by how much might they boost it?

What the answers are to these questions depends on what the underlying determinants of economic growth are: different visions of growth produce different conclusions about which policies can boost growth, and by how much.

The baseline vision of economic growth is that set out by Robert Solow in the 1950s. Solow's vision can be summarized in the statement:

(2) $$y/l = \alpha\left(\frac{Y}{K}I - \delta - l\right) + \tau$$

The rate of growth of GDP per worker (**y/l**) is (a) increased by a higher share of GDP devoted to *investment* (**I**), (b) decreased by a higher rate at which the physical capital stock *depreciates* (δ), (c) decreased by a faster *labor force growth rate* (**l**), and (d) increased by faster growth in *technology* or *total factor productivity* (τ). An increase in the rate of growth of the *technology* or *total factor productivity* of the economy translates one-for-one into an increase in output per worker growth.

The strength of the other of these effects—the amount by which an increase or decrease affects GDP per worker growth—depends on a parameter α, which is best interpreted as the "share" of national product that is earned by owners of capital (rather than suppliers of labor), and on the economy's *output-to-capital* ratio (**Y/K**). If you multiply the capital share α by the *output-to-capital* ratio, you obtain the (gross of depreciation) *marginal product of capital:* the extra boost to GDP next year produced by a $1 boost to this year's investment. For the United States today, more-or-less typical estimates of the aggregate output-to-capital ratio and the capital share are one-third and 0.3, respectively. Together these imply a (gross of depreciation) marginal product of capital of roughly ten percent per year.

This "Solow model" tends to produce pessimistic conclusions about the ability of *anything* except for raw improvements in "technology" broadly understood to boost economic growth. Because the capital share parameter α is relatively small, boosts to investment are not that effective at boosting GDP per worker growth in the short run. Because increases in investment decrease the output-to-capital ratio, in the long run such increases have even smaller effects on economic growth.

For example, consider a shift in the government budget deficit that boosts national savings and investment by an amount equal to some three percent of GDP each year. In the Solow model such an increase boosts growth in the first year after the policy shift by roughly 0.28%: at current levels, a shift of some $210 billion a year away from public and private consumption has produced a boost to the level of GDP of $21 billion in the first year. But by the tenth year the shift to a more investment- and capital-intensive economy has lowered the returns to capital and increased the investment effort necessary to keep the proportionately higher capital stock from depreciating, so the benefit to growth is only .17%; and by the twentieth year the increase in economic growth is only .11%. The economy in the twentieth year is some 3.5% more productive than in the absence of the policy shift, and the policy shift surely has a very high cost-benefit ratio at our current real interest rates of 3% per year or so. But a reduction in the government's deficit that shifts some three percentage points of national product out of consumption and into saving is a major shift. And the benefit in faster growth—an average increase of .17% per year in annual economic growth—is visible but not overwhelmingly large.

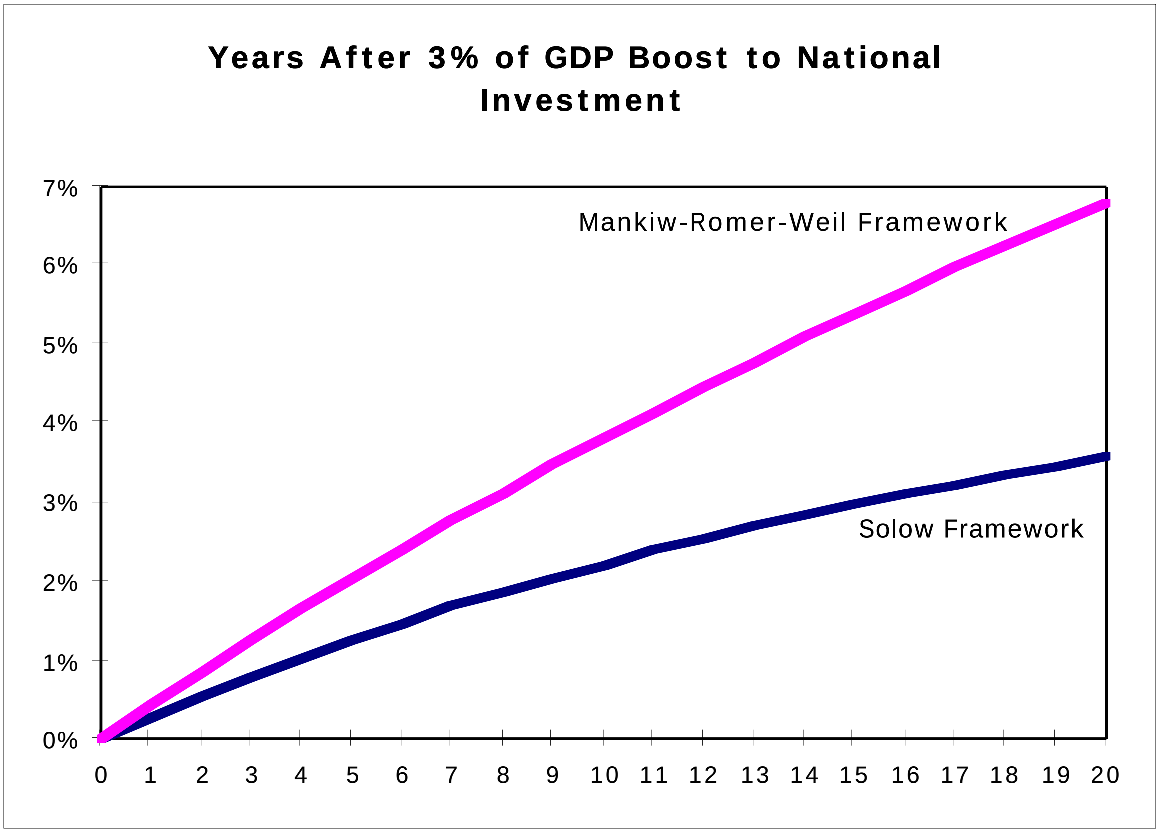
Economists have no consensus view of economic growth. The modal view—the view that most economists who have thought long about the issue would hold—is most likely the view set out by Gregory Mankiw, David

Romer, and David Weil. Mankiw, Romer, and Weil's vision is an extended version of Solow's:

$$(3)\quad y/l = \alpha\left(\frac{Y}{K}I - \delta_k - l\right) + \beta\left(\frac{H}{K}E - \delta_h - l\right) + \tau$$

It is extended in two ways. First, it allots a powerful role to "human" capital (**H**)—and to the share of national product devoted to investment in education (**E**). Investments in human capital through education are treated symmetrically with investments in physical capital through investment. Second, the Mankiw-Romer-Weil vision has higher values for the parameters α and β that govern the returns on investments in physical and human capital: α in the range of 0.45 or so (as opposed to 0.3 in the Solow model), and β in the range of 0.25 or so.

These differences combine to give shifts in policy significantly larger effects on growth than in the Solow framework. The same shift in the deficit analyzed above would boost first-year growth by 0.43% in the Mankiw-Romer-Weil framework (as opposed to 0.28% in the Solow framework), and is still boosting growth by 0.27% (as opposed to 0.11%) by the twentieth year, for a total twenty-year increase in GDP per worker of .34% per year—fully twice as large.



The differences spring from two sources. The first is that the addition of "education capital" increases the importance of accumulation in economic growth and slows down the approach of diminishing returns. The second is that Mankiw, Romer, and Weil's estimates of the parameters of the production function come from an examination of cross-country economic growth, and suggest a considerably larger return to even investment in physical capital than did the Solow framework.

The most optimistic vision of the potential impact of policy on growth of all—the vision that I am attached to for most of the time—goes several steps beyond Mankiw-Romer-Weil in playing up the pervasiveness of economic “externalities,” and their role in economic growth. The most powerful exponent of this view is Paul Romer, who has been advocating this view of the sources of economic growth for more than a decade. It goes under such names as “new growth” or “endogenous growth,” and is made up of a number of different and inconsistent strands. It is not yet fully sorted out.

The optimistic vision begins by noting that the main engine of economic growth is and has been, as Solow and Abramovitz demonstrated in the 1950s, the advance of economically-useful knowledge: better ways of using machines, better ways of organizing production and communications, and better ways of using natural resources. But no one imagines that these increases in economically-useful knowledge have simply dropped from the sky. No one imagines that the improvements in knowledge and technology of which we are the beneficiaries have been produced by processes unrelated to what has been going on in the rest of the economy. The applied science and organizational changes that have greatly multiplied our productivity over the past generations have always been very closely tied to economic life.

So there is no reason to think that the rate of “technology” or “total factor productivity” growth—the extra τ term at the end of equations (2) and (3)—is in any sense a fixed constant.

For example, after World War II continental Europe grew rapidly, as it built its capital stock and worker skills back to pre-World War II levels. But continental Europe did much better than simply return to its pre-World War

II growth trend: today it has output per capita levels more than forty percent above what you would have expected from simple extrapolations of pre-World War II or pre-World War I long-run economic growth trends.

Or consider that on the eve of World War II Argentina was a wealthy nation, an effective member of the “first world.” It ranked fourth or fifth in the world among nations in automobile ownership per capita, with more than one automobile for every fifty people. It ranked higher in estimated GDP per capita than any of Germany, Italy, or France. It ranked among the top ten countries in the world in telephones per capita. Yet Argentina has gone from 100% of western Europe’s estimated GDP per capita in 1950 to less than 50% of western Europe’s estimated GDP per capita today.

Thus the magnitudes of differences across eras for the same country and across countries in the same era cannot but make any observer extremely skeptical of any claim that countries must “learn to live with” their long run growth trends. Instead, there is every reason to think that pro-growth policies can nurture—and anti-growth policies destroy—long-term economic growth.

What, according to this optimistic vision of growth, would a productive set of pro-growth policies would be? How much extra economic growth would they generate? And how about the argument that the market system will take care of it all anyway—won’t market forces generate the “right” amount of economic growth, and won’t any additional growth come at much too high a price in terms of reduced standards of living for those who make increased investments in the future?

After all, we let market forces decide the number of books relative to CD's to produce, and even to switch from analog LP to digital CD systems. Why not let market forces decide how much of society's collective work time and effort to devote to pursuing advances in economically-useful knowledge?

The answer is that there is good reason to think that the Invisible Hand will do a bad job at allocating resources between current consumption and future growth when external effects—boosts to my productivity that come about as a result of your actions—are pervasive.

The Invisible Hand is very good at directing economic activity when resources are scarce, and property rights are straightforward. But economically-useful knowledge is not scarce in this sense: just because I am making use of it doesn't mean that you cannot use the same piece of knowledge. And it is very, very hard to keep people from making full use of whatever they know, no matter who holds formal title to the piece of "intellectual property." The nature of knowledge-as-commodity guarantees that it is a broad and important area of the economy where public involvement is needed, and where reliance on the market alone will not produce good outcomes.

It would be overselling the state of knowledge to claim that the "endogenous growth theories" of economists are anything more than questions: signposts that point to problems and unresolved issues. They do provide a few principles for how to think about the relationship between public policy, the advance of knowledge, and economic growth. They do not provide settled directives.

There are two major strands of thought in the “endogenous growth” tradition about what is the right way to think about the links between the macroeconomic variables in the current economy and the growth of total factor productivity or of “technology.” The first is that the principal benefits to productivity come from investments in research and development—that an additional dollar spent by the private sector on research and development boosts GDP by between fifty cents and a dollar. Investments in research and development have enormous social returns to the economy. And private industry tends to significantly underinvest in research and development because the firms that undertake the research do not reap the lion’s share of the social benefits.

For example, consider current computer software human interface technology: the windows-icons-mouse paradigm for presenting organized information to knowledge workers that makes managing computer data much easier than under the old disk-operating-system paradigm of scrolling lists of directories and text files. The work that led to this technological breakthrough and improvement in productivity was almost all undertaken by the Xerox Corporation, at their Palo Alto Research Center, in the 1970s.

Xerox has not made a cent off of this advance in technology.

Apple has made a good deal of money off of this advance in technology. *Microsoft* is making an enormous amount of money off of this advance in technology. (And *Intel* is making an enormous amount of money as a result of the derived demand for its microprocessors generated by the increase in computer usability.) But the ideas and approaches pioneered by Xerox soon became part of the common stock of knowledge of the software industry, Apple's implementation of these ideas proved much more marketable and effective than Xerox's attempts to implement these ideas had proved in the late 1970s. And now to Apple's dismay Microsoft's implementation is selling much, much better than Apple's.

The net result? Extraordinarily large benefits to the economy and the society in terms of expanded productivity growth from the work carried on at Xerox's Palo Alto Research Center in the 1970s. But barely a cent returned in revenues to Xerox from this particular drain on its cash flow.

And companies that are in business to make money will not spend a great deal of time and effort on such research projects that do not boost their productivity and revenues, even if they boost industry productivity and revenues manyfold.

Thus there is every reason to believe that the private sector significantly underinvests, from the point of view of the economy as a whole, in research and development. And there is every reason to believe that policies that boost research and development by a dollar promise fifty cent or one dollar increases in annual real GDP. This is the "narrow" flavor of endogenous growth theory: that if we could channel an additional 0.1% of GDP into private-sector investment in research and development, we would find that GDP per capita growth would be higher by, at a rough mid-range estimate, some 0.075% percent per year.

The second strand in the “endogenous growth” literature argues that the relationship between technology improvement and economic activity overall is more indirect than simply very large social benefits from investments in research and development. A large share of advances in technology have to come from “learning-by-doing”: from attempting to utilize new types and new generations of capital equipment, and figuring out in the process of implementation how the production process needs to be reorganized and how the capital goods need to be redesigned to produce maximum productivity. Still further increases in productivity have to come with the increases in workers’ “human capital” from on-the-job training: the best way to become skilled and productive at handling modern machine technologies is to work at applying them, and improvements in workers’ skills and capabilities are social benefits to the economy’s productivity that are usually not included in businesses’ calculations of their returns on investment.

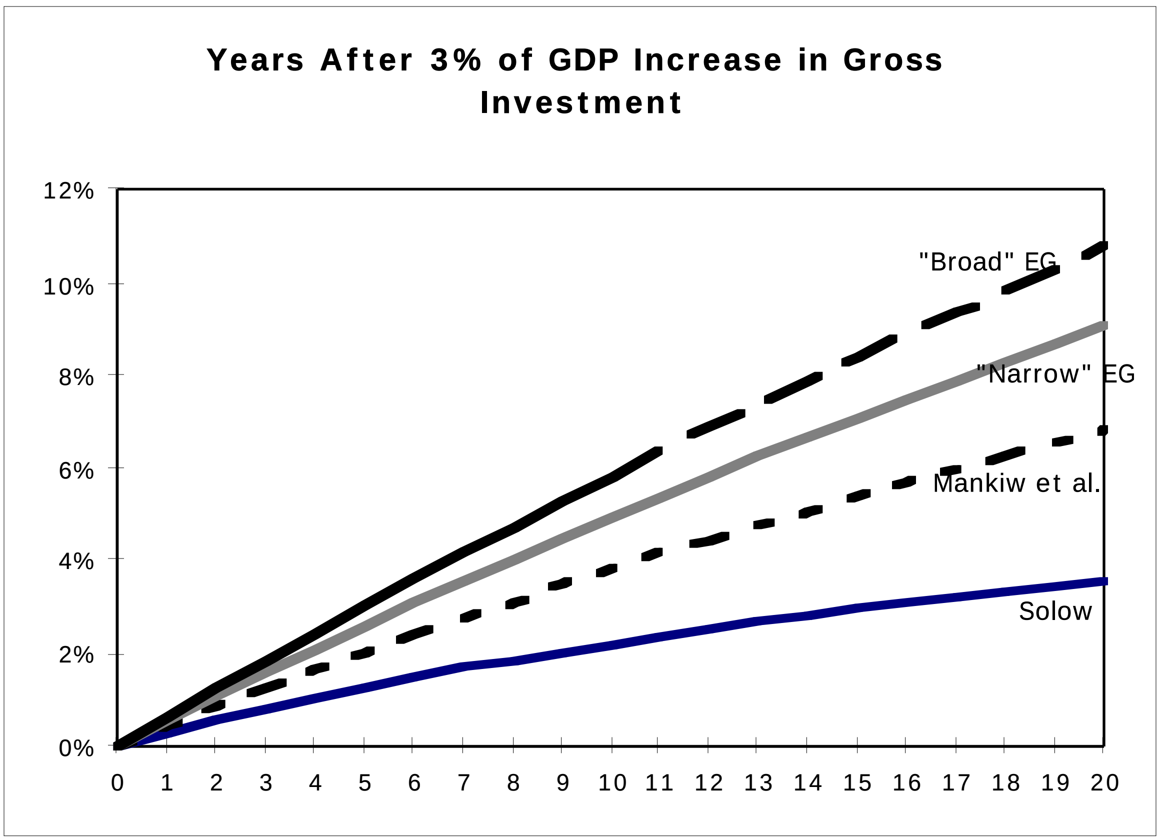
It is still an open question exactly what kinds of investment and economic activity produce very large benefits in terms of faster economic growth. I have always been very impressed with my own work along these lines: a series of articles I have written with Lawrence Summers that make what I at least see as a very, very powerful case that simply generic investments in machinery and equipment carry social rates of return of thirty percent or so: boost spending on equipment by one dollar, and find that next year's GDP is higher by thirty cents.

But it is a real possibility that such high boosts from equipment investment are to be found only in developing countries, where the acquisition of new machinery and equipment carries with it the acquisition of perhaps a century's worth of technological development and improvement. Perhaps in advanced industrial economies the social returns to equipment investment are merely "normal": the data make it hard to tell.

But there are other channels as well through which increases in investment show up as increases in total factor productivity. There remains the open possibility that the United States has been remiss in investing in its infrastructure over the past generation, and that investments in infrastructure yield supernormal returns. There is the possibility that all forms of investment are more or less equally effective as carriers of total factor productivity growth, in which case that government subsidies to all forms of investment are worth undertaking.

What is clear is that the bulk of increases in productivity and living standards come and always have come from advances in knowledge and improvements in the application of knowledge, and that it is simplistic to think that these advances in knowledge and improvements in the application of knowledge are generated by processes unconnected with the rest of the economy. The "endogenous growth" theories have a different lesson: boost whatever economic activities are the carriers of advances in the application of knowledge, and find economic growth gains from increases in investment two or more times as large as even those estimated in the Mankiw, Romer, and Weil framework.

The view to which I am most attached is not surprisingly that outlined in De Long and Summers' studies of "Equipment Investment and Economic Growth," in which each one percentage point boost in the share of GDP devoted to equipment investment boosts economic growth by perhaps 0.25 percent per year.



The figure above gives an indication (assuming that boosts to investment are spread proportionately across all categories of investment: research and development, equipment, and other) of the relative magnitudes of the effects that the “narrow” and “broad” endogenous growth perspectives suggest, applied to the same deficit reduction policy shift used above to illustrate the difference between the Solow baseline and the human capital-based extension that is closest to the consensus of economists today.

It makes three conclusions obvious:

- First, that for all of the difference in presentation, philosophy, and rhetoric between the “endogenous growth” perspective on the one hand and the Solow model baseline and its revisions on the other, the perspectives do blend into each other, and do lie on a continuum as far as the predicted effects over reasonably long time spans of growth-promoting economic policies are concerned.
- The extensions of and augmentations to the Solow baseline by Mankiw, Romer, and Weil, for example, carry the predicted boost to growth at a twenty-year horizon from investment increases more than halfway from the Solow baseline to the outer envelope provided by the “broad” endogenous growth theories.
- Third, that the cumulative effects of policies—like a shift in the federal deficit to balance from its 1980s average value—that does promise a three percentage point of GDP increase in investment *are* large enough to be

visible in economic time series (although not large enough to fulfill the hopes of campaign strategists).

IV. Policies and Growth

What view you take of the likely effectiveness of budget and tax policies, or of subsidy and regulatory policies, at boosting growth depends on which vision of economic growth you adopt—the standard Solow baseline; the Mankiw-Romer-Weil extensions that attribute a larger role to investment, especially in human capital through education; the “narrow” version of endogenous growth theory that places great stress on the high benefits from investments in research and development; or the “broad” version of endogenous growth theory that places stress on the overall productivity benefits from broad categories of investment—whether equipment investment, infrastructure investment, or investment in general.

So carry all four of these approaches with us for the remainder of this essay. What are the benefits from various growth-promoting economic policies under each of these four theories?

Budget Policy

The first point to make is that balancing the budget would be a good idea even if one stuck completely to the Solow baseline view of economic growth. The table below reports the estimated gains if a policy of movement toward fiscal balance could boost investment in America by some three percentage points of GDP or so—an amount not out of line, given the failure of domestic private saving to offset the fall in government saving in the 1980s, and given the limited ability of capital inflows from abroad to compensate for the shortfall in domestic saving.

Potential Economic Growth Benefits from Deficit Reduction that Boosts Investment by Three Percent of GDP: One-Year, Five-Year, and Twenty-Year Increases in GDP

Model	1-Year	5-Year	20-Year
Solow Baseline	0.28%	1.21%	3.51%
Extended MRW	0.43%	1.98%	6.74%
Narrow EG	0.68%	2.82%	9.24%
Broad EG	0.74%	3.05%	10.46%

The benefits in terms of higher GDP in the Solow baseline vision of economic growth are present, but are relatively small when viewed against the background of trends and fluctuations in economic time series. Nevertheless deficit reduction is well worth doing even in the Solow baseline framework: each dollar of private investment crowded out by the deficit has a lost social rate of return of ten percent per year in real terms; it is impossible to believe that the marginal government expenditure is worth such a foregone investment opportunity.

The benefits in terms of faster growth in the “extended” version of growth theory—the version that takes account of investments in education and allows for a somewhat higher return to capital—are half again as large.

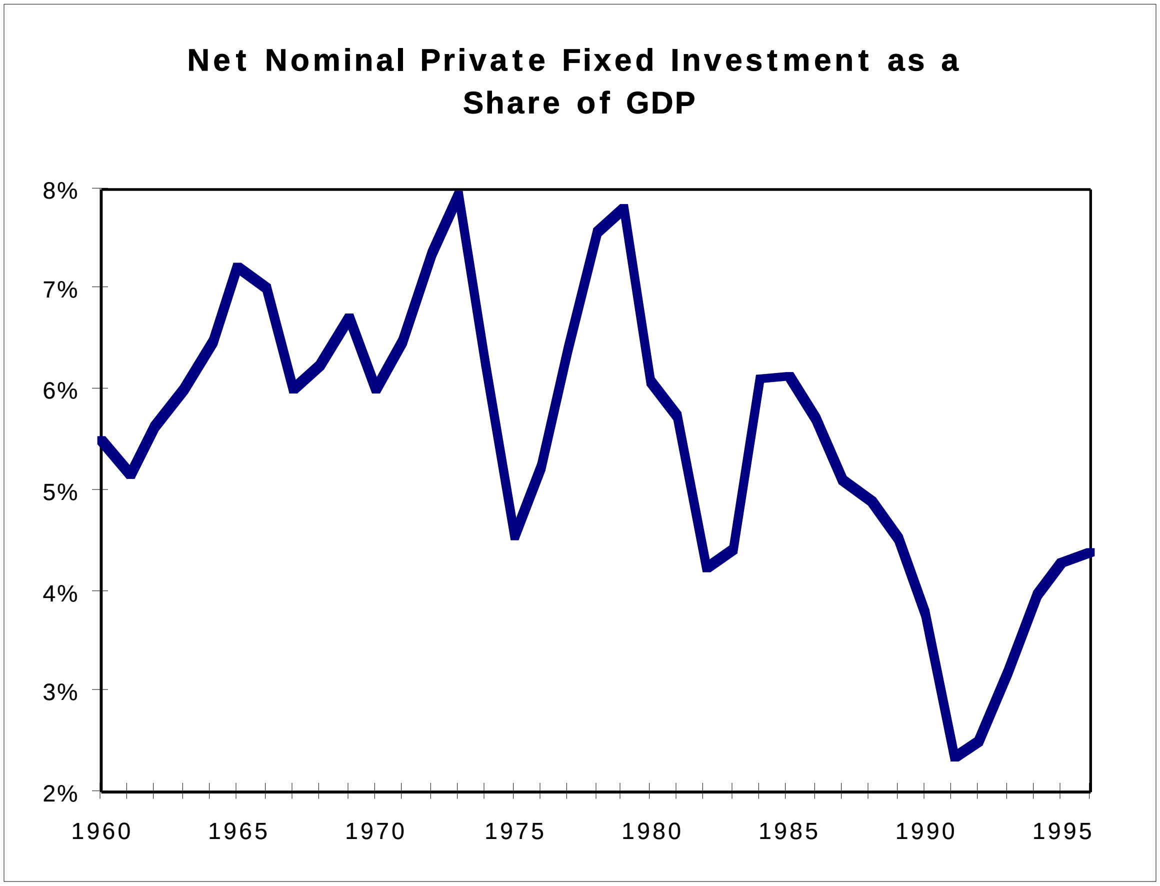
The benefits according to the endogenous growth vision would be larger still: boosts to national product on the order of 0.5 or 0.6 percent of GDP in the initial years after the shift in policy, and that translate into a near-permanent increase in economic growth of between 0.4 and 0.5 percent per year over the longer term.

Perhaps the best way to think about the interaction of broad visions of economic growth and budget policy is that broader visions of growth raise the stakes at risk with respect to policies that either shrink or expand the deficit. The consequences of federal deficits that boost interest rates and crowd out investment in America are much worse when the investments being crowded out are investments in research and development (that not only boost the productivity of the company undertaking them, but also boost the productivity of other firms as well).

The stakes are similarly increased for policy shifts that are not deficit neutral or deficit reducing—investment incentives that come at the expense of additional deficit reduction, for example. The potential benefits (should such policies truly increase investment) are larger; the potential costs (in terms of the social value of the private investment crowded out) are larger as well.

<u>Tax Policy</u>

Even in the standard Solow baseline there is a strong case for reducing taxation on capital. Even when inflation is not a factor, the chain of taxes—individual, corporate, and then individual again—imposed on a potential investor who decides to (a) earn money, (b) postpone consuming it, and (c) consume an appreciated sum in the future is quite high, and (in economic theory at least) ought to act as a significant deterrent to saving and investment.



Statistical work has at some times found significant impact of taxes on capital on individuals' saving and investment decisions. I tend to find myself at the "smaller effects" end of the spectrum of economists; but I am not completely comfortable with the proposition that taxes on capital income incur no cost in terms of discouraged saving and investment.

Moreover, over the past three decades the failure to make the tax system neutral with respect to inflation has resulted in extremely high effective tax rates on a very large category of real investments in some decades. Investors are not stupid: the fact that the inflation of the 1970s came once means that something like it may well come again; if such an inflation does come again, then tax rates on capital gains appear not low but high because investors pay tax on a large, fictitious, inflation component of any realized gain.

Private saving and investment as shares of national product have been falling in nominal terms (albeit rising in real terms, as continued technical progress lowers the price of capital goods) for some decades. It is hard not to be suspicious that potential investors "learned" from the 1970s that in times of inflation taxes on capital income become very heavy indeed, and that some of the decline in net investment as nominal share of GDP in the 1990s may be due to that recognition. The current recovery is a "high investment recovery" only if one focuses attention on gross rather than net investment.

As one moves away from the Solow baseline through the “extended” version to the narrow and broad “endogenous growth” theories, the rationale for reducing taxation on capital becomes much stronger: the wedge between the after-tax return to the investor and the social return is higher, and reducing this wedge promises correspondingly greater benefits.

As Alan Auerbach has frequently pointed out, however, a belief in externalities from capital investment strengthens the case for only certain particular kinds of tax law changes to promote investment. To the extent that the case for tax incentives rests on external benefits, they are external benefits from *investment*, not from *saving*. Expanding the range of tax-preferred savings vehicles is beside the point, as is lowering even prospective capital gains taxes—save for the important fact that international capital while mobile is not perfectly mobile, and that a significant (albeit shrinking) share of increases in domestic U.S. saving flow through to increases in U.S. investment.

Thus any shift from the Solow baseline in a direction of more optimistic visions of economic growth would tend to lead one to support tax law changes that would boost corporate investment. Yet the complexity of our tax system remains impressive and daunting. For example, would integrating the corporate and individual income tax—and thus removing the double taxation of dividends—have a significant impact on the cost of capital to firms? The odds are good that it would, in my view at least. But the answer is not completely clear. Is corporate debt a tax-favored (by escaping the corporate tax layer) or a tax-disfavored (because investors lack the ability to "time" the realization of their income as they do with capital gains) financing vehicle? Probably, but it is not completely clear.

Moreover, economists traditionally estimate the effects of tax-law changes assuming that the change in the tax law (i) is permanent, and (ii) is the only change that the tax law will see. How do you design a good tax policy that you hope will be a permanent change, but that very well may not be—and that businesses will certainly rationally assume is temporary?

Even if one sweeps difficulties in modeling a tax system in permanent flux and the residual uncertainties about the underlying incidence of the corporate tax system under the rug, it is not at all clear what the best policies to promote investment are. A desire to mitigate any revenue loss tends to push in the direction of marginal incentives: marginal research and development tax credits; marginal investment tax credits; and so forth. But our experience with designing "marginal" incentives is not a very heartening one. First, designing a "marginal" incentive requires an ability to tell what is marginal—and using a firm's own past investment or research expenditure as a base undermines the policy, because firms take account of the fact that current investment reduces their ability to claim tax credits in the future. At some stage the complexity of the tax code leads managers to in the most part throw up their hands: run their business as they see fit, and after the fact bring in consultants to figure out which tax benefits they might be able to claim.

In addition, the U.S. tax code is not a single system. Losses are treated asymmetrically to gains: carried forward without interest until they expire. Economists are not very good at understanding how the lack of symmetry in the treatment of losses and gains affects business behavior.

And there is the Alternative Minimum Tax—introduced and expanded to introduce what Joel Prakken has artfully termed “a perception of equity” into the tax code. The existence of the AMT weakens the power of whatever investment incentives have been put into place. The AMT in its present form exists because legislators in 1986 found themselves politically embarrassed by the fact that profitable companies were paying no corporate income tax because of their ability to exclude large quantities of income from taxes through accelerated depreciation, various exclusions, and tax credits. The AMT has come close to creating an entire alternative tax system for companies that have highly cyclical businesses and capital-intensive production processes. To the extent that these are the firms whose investment carries external benefits and that we do seek to boost, creating tax benefits does no good unless accompanied by a parallel change in the AMT.

There is an argument that the corporate income tax should be maintained separate from the personal income tax because it is the only effective way to tax the capital income of the non-profit sector. But the design and implementation of the AMT as it now stands seems to owe very little to an attempt to tax sources of income that would otherwise escape. Instead, it seems much more a result of the belief that corporations are people too—that just as rich people should pay taxes, so rich corporations should pay taxes.

Now corporations aren't people. They are nexuses of contracts. They are managed by rich people (who should pay healthy taxes). They are owned by rich people (and not so rich people) who should pay healthy taxes. But to the extent that low corporate tax bills arise because of accelerated depreciation and other investment incentives in which we believe, there is no case for removing this preference simply because a corporation's business is structured in such a way that it claims a large sum of it.

I certainly feel more strongly about this than I used to. And I feel more strongly because I have seen broad acceptance of the idea that "corporations are people too" lead to truly inane decisions. Perhaps the worst month of my life was the month in which I was part of a middle level staff group trying to convince Ira Magaziner that a large component of a 7% of payroll mandated "contribution" charged to the company for its workers' health insurance would be shifted onto workers, and show up as reduced wages and lowered take-home pay. "But it isn't being charged to the workers, it is being charged to the corporation," would be the response.

V. Conclusion: What Is at Stake

A view that investment has a larger role in boosting growth than the baseline Solow framework suggests leads in a lot of directions other than toward policies to balance the budget and to decrease taxes on new investment, especially investments in research and development, and in private investments that carry new generations of technology.

Perhaps public infrastructure has components that truly do promise high social returns. Pure research is bound to be underprovided if left to the private sector alone: a true public good. A large chunk of high-technology and telecommunications investment today appears to have a “network” character, in which case there may be space for a substantial public role.

In my mind, at least, the urgency of this growth agenda is strengthened by the recognition that the United States’ social insurance system was designed for the pre-1973 rapid rather than the post-1973 slow pace of growth. I value that system—I think that Medicare and Medicaid, SSI and Social Security, AFDC and Food Stamps have made America a much better place in which to live over the past generation.

Yet without faster long-term economic growth America’s social insurance system as we know it is unlikely to survive the next generation.

And to the extent that the crisis in financing the retirement of the baby boom generation leads to a renewal of deficits a large as or larger than those of the 1980s as a share of national product, the likely effects of renewed deficits depressing economic growth would be more gloomy than even the Concord Coalition projects.

Thus there is a sense in which the stakes at risk in the task of finding policies to spur American economic growth are larger for the left than for the right half of the political spectrum. All have an interest in faster economic growth: faster growth empowers the American people to better achieve their ends—whether their ends are sitting on beaches sunning themselves, raising their children, protecting endangered species, or increasing their level of education.

We on the left have an interest in the preservation of the twentieth century social insurance state. It has, I think, done a good job at providing social insurance and thus raising human welfare, and to some degree helped to make America a somewhat more egalitarian place. In the absence of faster economic growth than has been seen in the past two decades, the future of the social insurance state is easy to read: Medicare and Social Security devour the rest of the Great Society and the New Deal over the course of the next generation, and then two generations hence Medicare and Social Security run up against their own budget constraints and are transformed into something we cannot now forecast.

Perhaps it is permissible to generalize that a "liberal" state—as the Democratic Party uses the word "liberal" requires either a society that feels wealthy and flush, as in the 1960s, or a society that feels in desperate crisis, as in the 1930s. America today is feeling neither flush nor in crisis. It feels relatively impoverished—significantly poorer than it thought it would be by this time, in large part because of relatively slow economic growth over the past generation.

Is it an accident that it appears profoundly hostile to liberal notions of the public sector's role?

Some people argue that it would be easy to shift America's rate of economic growth for the better. Either (a) get rid of Alan Greenspan, or (b) cut income taxes some more. Others argue that this is as good as it gets.

I think that these are both wrong answers.

It is possible to shift the growth path of the American economy—it would take a big change in policy to do so, and to boost investment in this country by a few percentage points of GDP. Such a boost requires substantial, not marginal, changes in government fiscal balances and toward the taxation of investment. But an increase in economic growth in the range from 0.3% to 0.5% of GDP per year does not seem out of reach.

Moreover, there is strong reason to believe that the American economy invests too little—that the persistent budget deficits (which threaten to explode again in the next decade) are damaging, and that especially in times of inflation the tax system is badly-tuned to provide incentives for investment and growth. There is strong reason even if one holds to the baseline Solow framework, in which the economic growth rate is hard to move and successful policies with high cost-benefit ratios have little visible impact on time series of economic growth.

And as one moves away from the baseline Solow framework—first to the extended and augmented Solow model in which human capital plays an important role, and then to the externality-emphasizing "endogenous growth" perspectives—the case for tuning American economic policy in the direction of a budget surplus and low taxation on *prospective* investments becomes much stronger. The augmented Solow model generates impacts of policy changes on economic growth nearly twice as great as the Solow framework if one looks out at total cumulative effects twenty years in the future. The "endogenous growth" perspectives suggest potential benefits in increased economic growth that are greater still.

References

[Not yet completed]