Macroeconomic Policy and Long-Run Growth

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The long-run trend of productivity growth is the sole important determinant of the evolution of living standards. The current recession has seen as large a fall in American consumption per capita as any post-World War II recession--a year-over-year decline of about 2.3 percent. Yet the post-1973 productivity slowdown in the United States has been an order of magnitude more significant, reducing current consumption by nearly thirty percent. And the post-1973 productivity slowdown has been more severe outside than inside the United States. While the growth rate of output per worker in the United States slowed by 1.4 percentage points per year comparing the 1950-73 with the 1973-90 period, productivity growth has slowed by 4.5 percentage points per year in Japan, 4.2 percentage points per year in Germany, and by 1.9 percentage points for the OECD as a whole.

This paper addresses the role of macroeconomic policies in determining long-run rates of productivity growth. We begin by highlighting aspects of the interspatial and intertemporal variation in productivity growth which suggest that much of what is important for raising growth rate lies in the domian of structural policy, since macroeconomic policies are less than dominant in determining rates of productivity growth. We then take up what we regard as the two fundamental macroeconomic decisions any society makes: how aggregate demand (or its near-equivalent nominal income) will be managed, and how total output will be allocated between consumption and various forms of investment. Our policy conclusions can be stated succinctly:

- Much of the variation in productivity growth rates cannot be traced to macroeconomic policies and must be attributed to structural and external factors. It is implausible that the deterioration in productivity performance between the 1970s and 1980s is the result of macroeconomic policies that were inferior in the 1980s. Bad macroeconomic policies can insure dismal performance. But good macroeconomic policies, while necessary, are not sufficient for outstanding productivity performance.

- Monetary policy that either encourages high inflation or permits large-scale financial

collapse can inflict severe damage on productivity growth. Countries in which workers, investors, and entrepreneurs have confidence in the political independence of an inflation-fighting central bank have attained significantly more price stability. There is some evidence, however, of productivity costs from excessively zealous anti-inflation policies.

• Even substantial increases in investments that yield social returns of even fifteen percent per year will have only modest effects on observed rates of productivity growth. Only increases in specific investments with *very high* social returns well in excess of private returns have a prospect of arresting any substantial part of the productivity slowdown.

• International comparisons suggest a special role for equipment investment as a trigger of productivity growth. This suggests that neutrality across assets is an inappropriate goal for tax policies, and that equipment investment should receive special incentives.

The paper is organized as follows. Section I examines the productivity growth record, focusing on the extent of variations in productivity growth across countries and across decades. Section II considers the role of nominal demand management policy. Section III examines the relationship between rates of investment and rates of return. It highlights the difficulty of raising growth rates by magnitudes comparable to the extent of the productivity slowdown through general increases in investment, and emphasizes the importance of strategic high-return investments. Section IV highlights the special role of equipment investment in spurring growth. Section V concludes by commenting further on the policy implications of our analysis.

I. The Growth Record

A. The Slowdown in Productivity Growth

The principal information that is available for making judgements about the determinants of productivity and the role of policies is the historical record. Table 1 reports rates of output per worker growth by decade for the United States, other major OECD economies, and other industrial economies. In the U.S., GDP per worker as estimated by Summers and Heston (1991)[1] grew at 2.0 percent per year in the decade from 1950 to 1960, by 2.5 percent per year in the decade from 1960 to 1969,[2] and by only 0.5 percent per year in the decade from 1969 to 1979. It has only partially recovered to 1.4 percent per year in the decade from 1979 to 1990. Comparing the past two decades to the two decades beginning in 1950, the rate of growth of output per worker has fallen by sixty percent. A doubling of output per worker took 31 years at the pace of growth seen over 1950-69; it would take 73 years at the pace of growth of 1969-1990.

While the American productivity slowdown has been pronounced, table 1 demonstrates that it has been relatively mild by international standards: the slowdown of 1.3 percentage points per year experienced by the United States comparing the '70s and '80s to the '50s and '60s has been smaller than the slowdown in the average OECD, or industrial economy. Rates of growth throughout the industrial world in recent decades have been far below the rates seen in the first few post-World War II decades that workers, managers, and politicians then took for granted. From 1950 to 1960 GDP per worker in the OECD grew at a rate of 3.0 percent per year, and from 1960 to 1969 growth was 3.5 percent per year. But from 1969 to 1979 average growth in output per worker in the OECD was only 1.8 percent per

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[1]Throughout this paper we use the Summers and Heston (1991) estimates of GDP per worker levels (the most current version of the cross-country database also discussed in Summers and Heston (1988 and 1984)), extended from 1988 to 1991 using OECD estimates of real growth rates. The Summers and Heston estimates have the merit of paying close attention to accurately measuring purchasing power parities, and have the further merit of assessing growth rates at a constant set of prices. However, analyses using World Bank or OECD estimates of relative GDP per worker growth rates do not lead to significantly different conclusions as long as we restrict our attention to relatively rich and industrialized economies..

[2]We end the decade of the 1960s in 1969 so as not to distort long-run growth estimates by having one of our periods end during the trough of the 1970 recession. Similarly, we end the decade of the 1970s at the peak of 1979, and we end the 1980s at the peak of 1990 so as not to conflate shifts in long-run growth with the effects of the transitory recessions.

year, and over 1979 to 1990 only 1.6 percent per year.

In light of the fact that productivity growth has declined much more rapidly outside than inside the US, it may seem surprising to foreign observers that concerns about future living standards and about competitiveness are so especially pronounced in the United States. Part of the explanation may lie in the increasing openness of the American economy over the last decade, and in the emergence of large trade deficits. Another part of the explanation is surely that other countries continue to grow more rapidly than the US, albeit by a smaller margin even as they approach US productivity levels. Relatively slow U.S. productivity growth was much less of a concern when American standards of living were far ahead of standards of living abroad then it is today, as foreign standards of living approach American levels. We therefore turn to a consideration of the extent to which the patterns of growth illustrated in table 1 can be explained by the convergence hypothesis--the idea that the further a country is behind the more rapidly it can grow by importing technology in order to catch up.

B. Cyclical Adjustment

Figure 1 plots centered five-year moving averages of annual growth in cyclically-adjusted output per worker[3] since 1950 in the three largest OECD economies: the United States, Japan, and West Germany.[4] Figure 2 plots a centered five-year moving average of output per worker growth in the OECD. The cyclical adjustment makes no significant difference to the pattern of productivity growth. The 1980s see a marked productivity growth slowdown relative to the 1950s and the 1960s--the U.S. is the only economy in which the 1980s appear better than the 1970s. And the late 1980s show signs of a deterioration of cyclically-adjusted productivity growth in the U.S. back to the rates of the 1970s.

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[3]In calculating our centered moving averages for the most recent years 1990-92, we use OECD forecasts of output and employment growth rates over 1992-94 .

[4]Our cyclical adjustment procedure is based on a regression of year-to-year productivity growth on the change in the unemployment rate separately for each economy. It allows for a one percentage point rise in the natural rate of unemployment in Germany as a result of reunification.

Even after an adjustment for the business cycle, it appears clear that productivity growth in the industrialized world is much slower than it was two decades ago. And for the industrialized world as a whole, productivity growth appears to have declined further in the 1980s from its relatively disappointing level in the 1970s. It is apparent that for the OECD as a whole, for Japan, and for Germany that cyclically adjusted productivity growth has become markedly slower in the 1980s than it was even in the 1970s. The U.S. is an outlier in experiencing faster trend productivity growth in the 1980s than in the 1970s. And U.S. underlying productivity growth is noticeably slower in the late than in the mid 1980s.

C. Growth and "Convergence"

When World War II ended, there was an enormous gap in technology, organization, and productivity between the United States and other industrial economies. This gap had widened over the preceding quarter century, as Europe served as the battleground for two extraordinarily destructive wars punctuated by an era of instability and slow growth. This has led many to attribute fast post-World War II growth in the non-U.S. OECD to "catch-up" or a "rubber-band effect" as other industrial economies quickly covered the ground the U.S. had broken in the 1920s and 1940s.[5] Some have attributed the larger productivity growth slowdown outside than inside the United States to the reduced opportunities for "catch-up" and technology transfer left after the successful growth of the first post-World War II generation.

A substantial literature has by now examined the convergence hypothesis. A typical conclusion is that within the set of relatively well-to do economies there is evidence of a convergence effect, though such an effect is not present when very poor economies are

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[5]For example, see Wallich (1955) and Abramovitz (1986), which contain very good analyses of the post-World War II German *Wirtschaftswunder* and of long-run cross-country productivity growth, respectively. De Long and Eichengreen (1991) argue that rapid post-World War II western European growth was too fast to be attributed to a "rubber-band effect."

added to the sample unless additional control variables are included in the analysis. Figure 3 presents a scatter plot of ten year growth rates against initial relative incomes for all industrial economies for which data were available.[6] A negative relationship is apparent with the data suggesting that a percentage point increase in the gap between a country's relative income and the United States is associated with an 0.036 percentage point increase in its annual productivity growth rate. This estimate is relatively large compared to others in the literature on convergence.[7]

Given this estimate of the magnitude of the convergence effects, it is a simple matter to construct estimates of "convergence adjusted" growth rates. For example, Germany in 1960 was at 52 percent of the US productivity level, so convergence effects are estimated to account for .036*(1-0.52), or 1.7 percentage points' per year worth of its productivity growth between 1960 and 1970. By 1980, German relative productivity had risen to 73 percent of US productivity so convergence accounted for much less--only 0.9 percentage points' worth of German productivity growth.

Table 2 reports estimates of convergence-adjusted productivity growth rates. Since the United States is always the most productive country according to these estimates, its convergence adjusted growth rate is always just equal to the raw growth rate reported in table 1. Comparing tables 1 and 2, it is apparent that convergence accounts for much of America's relatively slow productivity growth compared to other OECD nations. But growth performance was poor in the 1970s and the 1980s even after adjusting for convergence effects. And even the convergence-adjusted slowdown has been greater outside the United States and Canada.

D. Causes and Consequences

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[6]We define an industrial economy as one in which GDP per worker levels as estimated by Summers and Heston exceed a quarter of the U.S. for more than one of the benchmark years demarcating decades. The industrial economies plotted in figure 1 are the same set included in table 1.
[7]See De Long (1988), Baumol and Wolff (1988), Dowrick and Nguyen (1989), and Baumol, Blackman, and Wolff (1989).

The principle lesson that emerges from this brief review of productivity growth experience is that no simple macroeconomic explanation is likely to account for a large part of the variations in productivity growth. Much of the problem for simple macro arguments comes from the slowdown between the 1970s and 1980s outside the United States. The very broad extent and long duration of the slowdown suggests that broad, general explanations are in order--not explanations that are limited in scope to particular economies in particular years. It is tempting to attribute the productivity slowdown to the rise of OPEC, and to conclude that the rapid rise in oil prices in the 1970s had longer-lasting and more damaging effects on industrial economies than people at the time realized. A major difficulty with this explanation is that although the 1970s see rapidly rising real oil prices the 1980s see falling real oil prices. Yet growth does not appear to have recovered.

It is also tempting to attribute responsibility to mistakes in monetary and exchange rate policy in the inflationary 1970s. Inflation harms the ability of the economy to allocate resources to appropriate uses, and interacts with the tax systems of industrial economies in important ways that threaten to significantly derange the market mechanism. Nevertheless, it is once again difficult to attribute much responsibility for the productivity slowdown to the long-run consequences of the inflation suffered in the 1970s, because the 1980s have not seen faster growth. [8]

To the extent that the 1980s did see deterioration in macroeconomic policy in individual nations, those nations were not the nations in which the slowdown gathered strength. It is the United States where macroeconomic policy is most often thought to have taken a seriously wrong turn. Yet the magnitude of the growth slowdown in the U.S., whether adjusted for convergence and for the business cycle or not, is less than in many other OECD

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[8]It may be that we are simply too impatient, that few believed until the later 1980s that inflation would remain below the four percent per year where it had been pushed over 1979-1983, that as a result few of the benefits of predictable low inflation were gained in the 1980s, but that the 1990s will see rapid growth as resources finally flow out of their low social return inflation havens and into activities where they yield high social rates of return but were in the past heavily taxed by inflation. To date we see few signs of such beneficial adjustment and reallocation in response to today's low-inflation environment. But we hope that we are wrong in our skepticism.

nations.

Yet another possibility is that the engine of growth is slowing down because we are reaching the limits of the technologies of the industrial revolution. All previous bursts of human technological creativity have eventually run into limits. Why should industrialization be different? Herman Kahn was perhaps the most prominent thinker to expect that in the end the industrial revolution would produce a rise in living standards and productivity levels that would follow not an exponential but a logistic curve.[9] Perhaps we are seeing the inflection point. This possibility should be kept in mind.

Even if changes in macroeconomic policies do not account for the bulk of variations in growth rates, it does not follow that they are irrelevant. We therefore turn in the next three sections to scrutinizing the relationship between macroeconomic policies and long-run growth. We consider in section II the role of demand management policy in creating the framework of price stability and high capacity utilization necessary for the market system to work well. In sections III and IV we consider the impact of policies on the savings and investment mix, and the influence of the savings and investment mix on growth.

II. The Management of Nominal Income

Despite the overwhelming importance of productivity growth as a determinant of living standards, most macroeconomic textbooks concentrate on cyclical fluctuations in output and employment, and on inflation.[10] To use slightly dated parlance, most of the emphasis is on stabilization rather than growth policies. This emphasis reflects broader social priorities. The media everywhere track unemployment fluctuations much more

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[9]See Kahn, Brown, and Martel (1976). The one of their arguments that we find most interesting is their belief that the technologies of the industrial revolution are of limited value in boosting productivity in the tertiary sector of non-agricultural, non-extractive, and non-industrial activities. They expected the primary and secondary sectors to shrink to such a small portion of the economy that even rapid continued technological progress in agriculture and industry would have only limited effects on living standards.
[10]With the exception of Mankiw (1990).

attentively than productivity fluctuations. Job creation is much more prominent in political debates than productivity enhancement.

Since the end of the Second World War, governments in most industrialized countries most of the time have felt an obligation to use the tools of monetary and fiscal policy to mitigate recessions and avoid depressions without allowing inflation to reach unacceptable levels. The textbook view has been that the macroeconomic objectives of output stabilization and inflation control are essentially independent of the objective of rapid long run growth. As the textbooks tell the story, cyclical fluctuations of an economy around its potential or full employment level of output depend on aggregate demand and its determinants. Long run growth depends on supply factors such as the accumulation of physical and human capital and technological progress. It is now generally accepted that while inflationary policies can impact levels of output in the short run, they cannot raise and run the risk of reducing long run levels of output.

Given the importance attached by policymakers to mitigating cyclical fluctuations and maintaining low inflation rates, it is worthwhile to inquire whether there are important connections between stabilization policies and productivity growth that are not reflected in the textbook model. Two potentially important connections stand out. First, as many monetarists argue, countries that are more credibly committed to price stability have as a consequence less inflation, and as a result the market system functions better.

Second, as many Keynesians argue, policymakers who are too willing to accept recessions may do semi-permanent damage to their economies. Recessions mean less investment in human and physical capital. When recessions lead to prolonged unemployment, human capital atrophies.[11]

A. Central Banks and Stable Price Levels

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[11]Thus the rise in European unemployment in the early 1980s appears to have had long-lasting detrimental effects on European economies' productive capacities far beyond any expected at the start of this decade. See Blanchard and Summers (1986).

The extent to which a country chooses to allow monetary policy to be made without political control is probably a good proxy for its relative commitment to price stability as opposed to actively combatting recessions. Here we extend some earlier work on central bank independence by considering its relationship to productivity growth.

To varying degrees, post-World War II industrial economies have delegated the management of nominal income to central banks. In some countries--like Italy, New Zealand, and Spain--the central bank is subject to relatively close control by the executive. In other countries--like Germany and Switzerland, with the U.S. relatively close behind--the central bank has substantial independence from the executive. The degree to which central banks are independent, and have the freedom to shape their own demand management policy safe from strong short-run political pressures, changes only slowly over time as institutions, attitudes, and operating procedures change.[12]

The strong inverse correlation between central bank independence and inflation has been has been highlighted by a number of authors, including Alesina (1988), and Grilli, Masciandaro, and Tabellini (1991). These authors consider two different ways of measuring central bank independence: the first the index constructed and used by Alesina (1988),[13] and the second an index constructed by Grilli, Masciandaro, and Tabellini (1991). Alesina's (1988) index rates the political independence of the central bank on a scale of 1 to 4 as determined by the institutional relationship between the central bank and the executive and the frequency of contacts between central bankers and executive branch officials. Grilli, Masciandaro, and Tabellini's (1991) index considers a wider range of considerations, of which the most important is the ability of the government to force the central bank to finance its deficits.[14]

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[12]See Rogoff (1985). As Alesina and Grilli (1991) make the argument, the median voter, the one whose preferences are decisive in elections, would want the management of nominal demand and the control of monetary policy to be in the hands of those who are more inflation averse than she is--though *ex post* such a voter would wish that monetary policy were more expansionary and that inflation were higher.
[13]Based on the index of Bade and Parkin (1982).
[14]For a more detailed explanation of the differences between the two indices, see Alesina and Summers (1991).

Here we reproduce and extend Alesina and Summers' (1991) analysis of the relationship between central bank independence and real aspects of economic performance. Alesina's (1988) index covers sixteen OECD nations.[15] Grilli, Masciandaro, and Tabellini calculate index values for fourteen of these nations. We interpolated values of the GMT index for the two missing OECD nations, Norway and Sweden, from a linear regression of the GMT index on the Alesina index. We then scaled both indices to have a mean of zero and a unit standard deviation, and averaged them to obtain a single overall index of "central bank independence." A higher value of the index corresponds to a more independent central bank. In our sample the two most independent central banks are those of Switzerland and Germany, followed by the United States. The least independent are New Zealand, Spain, and Italy.

Figure 4 plots the average inflation rate, in percent per year, experienced by an OECD economy over 1955-1990 on the vertical axis and the value of the "central bank independence" measure on the horizontal axis. This graph shows a near-perfect inverse correlation between central bank independence and average inflation rates.[16] In this sample four-fifths of the variation in average inflation rates over the 1955-1990 generation can be accounted for by the Alesina-Grilli, Mascandiaro, and Tabellini measure of central bank independence. Given that the index was constructed without reference to inflation outcomes by examining the institutional structure of the central bank-government relationship, this is a remarkably high correlation.

The institutional independence of the central bank, as measured by the Alesina and by other indices, is usefully thought of as determined before and independently of the macroeconomic shocks and policies of the post-World War II era. Central bank laws and traditions change only slowly, and do not in the short run reflect the relative aversion of

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[15]Including the twelve nations considered in Bade and Parkin (1982). The sixteen nations in Alesina's (1988) sample are Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, New Zealand, Spain, Sweden, Switzerland, the U.K., and the U.S.

[16]As Alesina and Summers report, there is a strong correlation between central bank independence and low inflation variability as well.

individual governments or finance ministers for inflation. In the long run periods of high

inflation do appear to trigger reform of the central banking laws in a way to grant the bank

more independence.[17] But in the short run it is difficult to think that the association between

low inflation and central bank independence reflects anything but central bankers'

willingness to act according to their own aversion to inflation, whenever the institutional

structure allows them freedom to do so.[18]

     Do independent, inflation-averse central banks buy low rates of price increase at the

price of high unemployment, or low growth? Alesina and Summers (1991) report no

association--either substantively or statistically significant--between central bank

independence and high unemployment or slow growth--and conclude that "the monetary

discipline associated with central bank independence reduces the level and variability of

inflation, but does not have either large benefits or costs in terms of real macroeconomic

performance." Here we make an even stronger case for the positive effects of central bank

independence. Alesina and Summers (1991) examined the correlation between central bank

independence and GDP per worker growth, and found no relation, as is shown in figure 5.

     Here we regress GDP per worker growth over 1955-90 on both the degree of central

bank independence and also on the initial level of GDP per worker, to pick up the

convergence effects discussed in the preceding section. Figure 6 plots the partial scatter of

output per worker growth and central bank independence. The difference between a point's

vertical location and the dotted horizontal line in the middle of the graph measures the

difference between the actual output per worker growth rate over 1955-90 and the level of

growth that would have been predicted, given the correlation between initial GDP per

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[17]The most striking example is the independence of German central bankers since the 1923 hyperinflation. As Alesina and Summers (1991) note, disappointment with relatively high inflation in Canada and New Zealand has recently triggered increases in the independence of their central banks. Cukierman, Webb, and Neyapti (1991) discuss how this generation's inflation shapes next generation's central banking laws.

[18]Italy, for example, had in 1950 a tradition of aversion to inflation: it had used its Marshall Plan aid to pay off its government debt, and before the Great Depression the Fascist government had thought it willing to deflate internal prices by one-third to reëstablish the exchange rate at the *quanta novanta.* Yet since 1955 with a central bank largely dependent on the executive, Italian inflation has been the third highest in our OECD sample.

worker levels and subsequent growth, if central bank independence had no association with growth. The horizontal axis scale is determined by the difference between the actual measure of central bank independence and what one would have expected central bank independence to be given the correlation of independence and the initial GDP per worker level.[19] A partial scatter plot shows the relationship between a pair of variables after each has been adjusted by the relationship it has with the other factors included in the analysis. Economies that were relatively rich in 1955 tend to have independent central banks. But such economies also have smaller opportunities for rapid growth through technology transfer. Figure 6 shows that, holding constant initial output per worker levels, a shift in degree of independence from that possessed by Italy's central bank to that possessed by the U.S. Federal Reserve--an increase of 2 units in the Alesina--Grilli, Mascandiaro, and Tabellini index--is associated with an increase in the rate of GDP per worker growth of 0.8 percentage points per year.

Figure 6 cannot be interpreted as a structural relationship, showing that independent central banks are the key to very rapid growth. All of the other determinants of economic growth are omitted from the regression. The inclusion of some of these other determinants, such as investment, greatly attenuates the significance and magnitude of the central bank independence variable. Furthermore, it may be that the association between central bank independence and rapid growth is spurious. Both may reflect organized disciplined and market-committed governments.

Nevertheless, the strong partial correlation between growth and central bank independence is striking. There is surely no reason to suspect that inflation-averse central banks have significantly lowered growth rates in the OECD over the past generation: anyone wanting to make such a case would have to make the unconvincing argument that the

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[19]The R^2 from the regression of average GDP per worker growth on initial level and central bank independence is 0.72, with a standard error of the estimate of 0.53 percent per year. On average, a unit increase in the index is associated with an increase in growth rates of 0.408 percentage points per year, and this coefficient has an estimated t-statistic of 2.51.

negative effects of central bank independence on growth have been overbalanced by other factors that by coincidence just happened to also be present in economies with independent central banks. Some portion of the positive association between central bank independence and economic growth may well arise because an independent central bank and a low-inflation environment allow the price system to work more effectively.

B. Can There Be too Much Pursuit of Price Stability?

The evidence in the preceding subsection provides no support for the idea that a more politically driven and therefore recession sensitive monetary policy increases long run productivity growth. And there is some weak suggestion in the data that it may even reduce productivity growth. This should not be too surprising. As figure 7, based on Alesina and Summers (1991) demonstrates, there is no evidence that more politically responsive monetary policies actually mitigate cyclical variability in output. And there is no sign that they lead to lower rates of unemployment. Hence, they do not reap any benefits from avoiding recessions.

In light of the zero inflation targets that have been set in a number of countries, periodic proposals for a zero inflation target in the United States, the very low rates of inflation now prevailing in much of the industrialized world, and the commitment of many traditionally inflationary economies to a fixed exchange rates, it seems worthwhile to ask: can austerity be overdone? At the grossest level, the answer to the question is surely "yes." Monetary policies in the early years of the Depression in the United States by allowing a deflation that penalized debtors at the expense of creditors surely contributed to the depth of the Depression. As historians of the Great Depression like Friedman and Schwartz (1962) and Temin (1990) have long emphasized, the U.S. Federal Reserve allowed the money stock to contract in Depression in large part because they feared the inflationary consequences of being seen to move away from the operating procedures they believed had been traditional

under the gold standard.

Even leaving dramatic instances of policy failure like the Depression aside, we suspect it would be a mistake to extrapolate the results on the benefits of central bank independence too far. On almost any theory of why inflation is costly, reducing inflation from ten percent to five percent is likely to be much more beneficial than reducing it from five to zero. So austerity encounters diminishing returns. And there are potentially important benefits of a policy of low positive inflation. It makes room for real interest rates to be negative at times, and for relative wages to adjust without the need for nominal wage declines. It may also be more credible than a policy of zero inflation and therefore it may require smaller output losses as the public overestimates the monetary authority's willing to meeet nominal demands. More generally, a policy of low inflation helps to avoid the financial and real costs of a transition to zero inflation.

OECD experience does not permit a judgment of the merits of very low inflation, since the two countries with the lowest average inflation rates after 1955, Switzerland and Germany, have inflation rates that have averaged three percent per year, a rate at which prices double every generation. As figure 6 illustrated, these two countries have growth records that are less than what one would have predicted on the basis of convergence effects and an assumption that each additional point on the central bank independent indices carries the same growth benefits.

Furthermore, the macroeconomic strain associated with strong disinflation in New Zealand and Canada in recent years, and the extraordinary strains imposed on European countries as the ERM forced rapid disinflation up to its recent suspension, both point up the potential transition costs of moving to regimes of strict price stability.

These arguments gain further weight when one considers the recent context of monetary policy in the United States. A large easing of monetary policy, as measured by interest rates, moderated but did not fully counteract the forces generating the recession that began in 1990. The relaxation of monetary policy seen over the past three years in the United

States would have been arithmetically impossible had inflation and nominal interest rates both been three percentage points lower in 1989. Thus a more vigorous policy of reducing inflation to zero in the mid 1980s might have led to a recent recession much more severe than we have in fact seen.

III. Reversing the Productivity Slowdown: Higher Investment

One of the most fundamental economic decisions that any society makes is the decision as to how resources are to be allocated between the present and the future, or equivalently between consumption and investment. Strategies for increasing the rate of growth in living standards invariably emphasize in some way increasing investment in the future, while sometimes recognizing that this will mean reduced consumption in the present, at least in a fully-employed economy. Here we examine briefly the potential contribution of increased investment to economic growth. We highlight some relatively dismal scientific arithmetic demonstrating that only very high-return investments or huge increased in investment rates have the potential to dramatically alter growth rates.

A very simple arithmetic relationship, equation (1), is useful in thinking about the relationship between investment and growth:

(1) $g = r \ (I/Y)$

In words, the equation says that the instantaneous increase in an economy's growth rate from an increase in its investment share is the product of two things: the increase in the share of output that is invested, and the social rate of return on the investment. For example, if an economy increases its investment share by three percent of GDP and the investment yields a ten percent rate of return, its instantaneous output growth rate will rise by 0.30 percentage points.

For the purpose of thinking about long-run growth rates, the instantaneous growth rates of equation (1) exaggerate significantly the potential of increased investment for two reasons. First, as more and more capital of any given type is accumulated diminishing returns are likely to set in. Second, capital depreciates and so an increase in the investment rate ultimately leads to a higher capital stock, but not one permanently increasing at faster than the long-run output growth rate. Calculations presented in Delong and Summers (1991) suggest that for standard growth models calibrated to the U.S. experience a given boost to investment would increase growth rates over a twenty-year period by approximately half of the boost's initial effect on the growth rate.

Equation (1) has dismal implications for both efforts to explain variations in growth rates on the basis of differences in investment rates, and efforts to increase growth rates by increasing investment shares. In section I we noted that productivity growth in the OECD as a whole has fallen by 1.8 percentage points per year comparing the 1960s to the 1980s. To boost long-run growth back up to its earlier, higher level through increasing investment shares--even investments that yielded fifteen percent per year--would on the basis of De Long and Summers' (1991) calculations require an increase of twenty-four percentage points in the investment share of national product. It is logic of this type that explains why growth--accounting exercises in the tradition of Solow (1957) typically assign so small a role to capital accumulation in accounting for productivity growth.

With respect to living standards, the arithmetic is even more discouraging. If investments earn even a fifteen percent return, it will be seven years before permanent increases in investment begin to pay off by generating higher levels of consumption: for the first six years the increase in output generated by past higher investment is more than offset, in terms of current consumption, by the deduction necessary to finance this year's higher investment.

What are the policy implications? The first obvious implication is that raising the *quality* of investment is very important relative to raising the quantity of investment. With most

economies investing in excess of a quarter of GDP in private capital, schooling, infrastructure, and research and development, relatively small percentage-point changes in the rate of return on investment can induce large increases in growth. Finding the highest return investments, and managing public investments as efficiently as possible, is therefore crucial.

Second, it appears very unlikely that there are many investments left open that have ex-ante private returns far above ten percent per year. Take as an example investing in going to college. At present the average gap in earnings between young (25 to 34) white males with no college and with B.A.'s is about seventy percent. This is a huge gap: in today's America, going to college is one of the best investments anyone can make. But spending four years in college has substantial costs: the four years' worth of wages not earned while the student is out of the labor force, and perhaps half again as much in the direct cost of education. Comparing the seventy percent increase in wages accruing to those with B.A.'s to the roughly six years' worth of income that the B.A. costs to acquire reveals that investments in higher education promise a rate of return of about ten percent per year. Thus even an investment as worthwhile for an individual, and as attractive for society, as college is in the class of investments that cannot be expected to lead to large boosts in the growth rate.

In order to identify investments with high enough social returns to have a substantial impact on growth, it is necessary to find investments with substantial external benefits--benefits not captured by the entity undertaking the investment. Identifying and promoting such strategic investments is a critical way in which public policy can promote growth. Much of this involves policy with a structural or microeconomic dimension, which lies outside the scope of this paper. We do present some evidence in the next section suggesting that policies promoting equipment investment can have large external benefits.

Third, it appears that in the U.S. today deficit reduction can have at most a minor impact on long-run growth rates. It is surely worthwhile to reduce the deficit: from the point of view of the country as a whole deficit reduction has no cost--what we would pay now in

increased taxes we would save in lowered future taxes--and promises significant benefits by evening out the cross-generational tax burden and removing a source of uncertainty about the long-run commitment of the United States to low inflation. But deficit reduction is not a policy that would reverse the productivity slowdown. Since one percentage point of GDP's worth of deficit reduction would not induce a full percentage point's increase in national savings, the effect of each percentage point of deficit reduction on long-run growth would in all likelihood be smaller than even the modest increases calculated above.

We are led to conclude that policies to boost the share of output devoted to investment in general are worth undertaking on their own terms: they do promise benefits worth more than their costs. But they are not going to advance the ball very far in the game of economic growth. "Three yards and a cloud of dust" is what they will produce. Only "long ball" investments that have large external benefits and promise extremely high social returns will have the potential to significantly accelerate growth.

The observations that economies do exhibit substantial differences in their rates of productivity growth, and that these differences must be a consequence of decisions about resource allocation suggest that such high-return investments do exist. The challenge for economic research and policy is to find them.

IV. Supernormal Returns: Investment in Equipment

A. *The Cross-Section Correlation of Growth and Equipment Investment*

Is there in fact reason to believe that shifts in rates of investment, especially of particular kinds of investment, might have large effects on economic growth rates? In earlier work, De Long and Summers (1991),[20] we argued that the cross-sectional distribution of growth rates across economies in the post-World War II period strongly suggests that

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[20]See also De Long (1992), Jones (1992), or De Long and Summers (forthcoming).

investments in machinery and equipment are a strategic factor in growth, and do carry substantial external benefits.

The idea that machinery investment might be necessary for rapid productivity growth is not new. Economic historians have written of the close association of machinery investment and economic growth since the beginning of the Industrial Revolution. New technologies have been *embodied* in new types of machines: at the end of the eighteenth century steam engines were necessary for steam power, and automatic textile manufacture required power looms and spinning machines; in the early twentieth century, assembly line production was unthinkable without heavy investments in the new generations of high-precision metal shaping machines that made parts interchangeable and assembly lines possible. Recent innovations fit the same pattern: basic oxygen furnace and continuous-casting steel-making technologies need oxygen furnaces and continuous casters. "Flexible system" implementations of mass production need numerically-controlled machine tools.

Here we document the close association of equipment investment and economic growth. We present regressions of economic growth on equipment investment, and on other factors that are plausible determinants and correlates of growth, over a period 1960-85 chosen to maximize the number of economies in our sample. We restrict our attention to that group of economies, whose growth we tracked in section II, that had already proceeded relatively far along the road of industrialization by 1960.[21] Our sample is further restricted by data availability.

Since we study the correlation of growth not with just total investment but with the different subcomponents of investment, our sample is restricted to nations that were surveyed in one of the U.N. International Comparison Project benchmarks, and for which we have relatively detailed information on relative price and quantity structures, at least for benchmark years. In the end, our sample consists of forty-seven economies.[22] An important

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[21]We eliminate the poorest economies from our sample because we are not certain that their experience contains useful lessons for the analysis of growth in the rich OECD.
[22]The data underlying the cross-sectional regressions are a later vintage of the data used in De Long and

additional advanatge of our ICP data is that it takes account of differences across countries in the relative prices of capital goods. Other comparisons of investment across countries measure "investment effort"--how much of consumption is foregone as a result of the investment decisions made in an economy. Since relative prices of capital goods vary widely, investment effort can be a poor guide to the actual quantity of new capital purchased and installed. We believe that this is one reason why the conventional wisdom is that the cross-nation investment-growth relationship is weak. ICP data is sensitive to this potential difficulty: it allows us to study not the association between growth and investment effort but the association between growth and investment.

Figure **8** and equation (2) below[23] show the strong association between differences in machinery investment rates and differences in economic growth rates that we typically find. Equation (2) below reports the estimated equation from a regression of growth in GDP per worker over 1960-85 on five factors. First comes the 1960 productivity gap vis-a-vis the United States. This factor is included to account for the potential gains from acquiring and adapting the technologies of the industrial west open to poorer economies. Because of this factor, we would expect poorer economies to grow faster than richer ones if other things were equal. The second factor is the rate of labor force growth. A faster rate of growth of the labor force implies that a greater share of national product must be devoted to investment-- both in physical capital and in education--simply to keep the average level of skills and the amount of physical capital used by the average worker constant.

The third factor is the average secondary school enrollment rate over the sample. This is a proxy for the rate of investment in human capital through formal education. However, it is not a very good proxy (see Schultz, 1992). In our regressions the secondary school education rate does not appear to be a strong and significant independent correlate of

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Summers (1991). See De Long and Summers (1992) for more details.

[23]An appendix table provides results for a number of different specifications, showing that the strong association of machinery investment and growth holds true for the inclusion or exclusion from the analysis of a number of different alternative sets of growth factors.

growth. But it is premature to conclude that education is not important: education almost surely is important. Instead, the lack of significance of our human capital investment proxies in our cross-national regressions should most likely be attributed to the large divergence between measured schooling and actual skills learned. The fourth factor is the average rate of investment over 1960-85 in machinery and equipment. This factor is a measure not only of accumulation but also a proxy for a number of ways in which investment might lead to higher productivity through technology transfer, and through learning by doing.

The fifth and last factor is the rate of investment in categories other than machinery and equipment. This factor measures the importance of capital accumulation in general, for there is no special reason to believe that non-machinery investment should be especially fruitful either as a carrier of new technologies or as a major source of informal education through learning-by-doing.

The data used are a later vintage of those used in De Long and Summers (1991).[24] Not suprisingly, the results are similar. Equipment investment has a very strong association with output per worker growth. In this sample, each extra percentage point of total output devoted to investment in machinery and equipment is associated with an increase of 0.26 percentage points per year in economic growth. Non-machinery investment has a statistically significant association with growth, but the magnitude of the coefficient is only one-quarter as large as for machinery investment--and is not out of line with what one would predict from the "standard model" discussed above. The difference between the equipment and the non-equipment investment coefficient is highly significant, with a t-statistic on the difference of more than three.[25]

Figure 8 shows the partial scatter of growth and machinery investment. Important

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[24]The major changes are the use of the trade data from Lee (1992) to sharpen estimates of the proportion of investment devoted to machinery and equipment, and a fuller exploitation of OECD real investment component estimates.

[25]De Long and Summers (1991) consider a number of alternative breakdowns of investment. The bifurcation into equipment and non-equipment is most successful at accounting for cross-national differences in productivity group.

observations in generating the high machinery investment coefficient include Singapore, Japan, Israel, and Brazil--all with high machinery investment rates and high growth rates-- and Argentina, Chile, Jamaica, Nicaragua, and Uruguay with low growth and low rates of machinery investment. U.S. vs. Japan thought: difference in equipment investment accounts for two percentage points of U.S.-Japan growth gap.

Non-machinery investment plays a much smaller role in accounting for differences in output per worker growth. And labor force growth and the school enrollment rate do not have any significant effect--although as noted above, this may tell us more about the inadequacy of the secondary school enrollment proxy than about the true relationship between schooling and growth.

B. Equipment Investment and Growth: Causation

The strong correlation between machinery investment and economic growth does not necessarily imply that a boost in machinery investment shares is the best road to a growth acceleration. It could be that machinery and growth are correlated not because an ample *supply* of machinery leads to fast growth, but because fast growth leads to a high *demand* for machinery. Even if a high rate of machinery investment is a cause and not a consequence of rapid growth, it is not necessarily the case that the entire estimated coefficient on machinery investment in our cross-nation regressions can be interpreted as measuring the growth boost that would be produced by a policy-induced shift in the machinery investment share. A high rate of machinery investment might well be a signal that an economy has a climate favorable to growth, and that a number of other growth-causing factors omitted from the list of independent variables are favorable as well. In this case, the high coefficient on machinery investment would reflect both the direct effect of machinery investment on growth and the extra correlation arising because a high rate of machinery investment is a proxy for the presence of other growth-producing factors.

The first possibility--that machinery is more effect of rapid growth than cause--we dismissed in De Long and Summers (1991) because a high rate of machinery investment and pace of growth were correlated not with relatively high, but with low machinery prices.[26] If machinery were the effect of fast growth, it would be because fast growth would shift the demand for machinery outward, and move the economy up and out along its machinery supply curve. Thus we would see fast growth and high machinery investment correlated with high machinery prices. Instead, we see fast growth and high machinery investment correlated with low machinery prices. To us, this supply-and-demand argument is powerful evidence that fast growth is not a cause but an effect of a high rate of machinery investment.

There remains the possibility that the high equipment investment coefficient arises in part because machinery investment is a good proxy for other, hard to measure factors making for economic growth. In such a case the association between equipment investment and growth would not be a "structural" one, and policy-induced boosts in rates of investment in machinery and equipment would be unlikely to raise output growth rates as much as the cross-nation correlations suggest.

In general, the assertion that the strong association between machinery investment and growth reflects a structural causal relationship running from machinery to growth is a claim that a given shift in machinery investment--however engineered--will be associated with a constant shift in growth. The next best thing to direct experimental evidence is the examination of different dimensions of variation in machinery to see whether dimensions of variation in machinery investment driven by different factors have the same impact on growth. To do this, we examine the relationship between growth and various components of equipment investment associated with different aspects of national economic policies.[27]

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[26]De Long and Summers (1991) examined the robustness of our conclusions by performing a number of additional tests as well. In addition to instrumental variables estimates like those reported below, we also examined the differential associations of extensive and intensive growth and machinery investment, and examined shifts in growth and machinery investment rates across subperiods of the post-World War II era.
[27]By examining the coefficient produced by different two-stage least squares regressions of growth on equipment investment with different sets of instruments. This procedure can be viewed as an informal Hausman-Wu test of the proposition that the equipment-growth relationship is a structural one uncomplicated

Table 3 reports such regressions of growth on different dimensions of variation in machinery investment. The estimated machinery investment coefficient measures the association between output growth and that portion of machinery investment that is correlated with the particular instrumental variable. In addition to the baseline case without any instruments, four sets of instrumental variables are used: the average nominal savings share of GDP over 1960-85, Aitken's (1991) estimates of the deviation of the real relative price of machinery and equipment from its value expected given the economy's degree of development, and World Bank estimates of tariff and non-tariff barriers to imports of machinery and equipment.

As table 3 shows, no matter which of these dimensions of variation in machinery investment we examine, the association of machinery investment and growth remains approximately the same. Estimated coefficients range from 0.196 to 0.271. The similarity of the association with growth of these different dimensions of variation in machinery investment provides powerful evidence that the machinery-growth nexus is "structural," and does not arise in any large part because a high rate of machinery investment is a signal that other growth-related factors are favorable.

In spite of the similarity of the estimated machinery investment coefficients, the different instrumental variables regressions do capture different aspects of the variation in machinery investment, as appendix figures A1 through A3, which plot the partial scatters of equipment investment and growth from the second stage of the instrumental variables regressions, show. In the second line of table 3--which shows the effect on growth of that component of machinery correlated with aggregate nominal savings rates--the most influential observations are the Asian trio of Japan, Singapore, and Hong Kong with high, and Ecuador, Uruguay, and Switzerland with low savings, equipment investment, and growth rates. The third line--showing the effect of that component of equipment investment correlated with a low real price of machinery--has fewer data points and a somewhat

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by omitted variables or simultaneity.

different set of influential observations: the three most influential high-growth high-investment low-price economies are Japan, Israel, and Greece.

The different regressions in table 3 do indeed examine different components of the variation of equipment investment rates across countries. Yet all of the estimated coefficients are very similar. We think it very unlikely that the association of growth with each of these components of equipment investment would be equally strong if equipment investment were merely a signal, and not an important cause, of growth.

The point made in this section--that there are some investments, investments in machinery and equipment, that have the potential to boost total factor productivity directly by sparking technology transfer and learning-by-doing--is far from new. It was a centerpiece of the analysis of Kennedy's Council of Economic Advisors, which blamed what they saw as slow productivity growth in the 1950s on a falling and misallocated share of investment (see Tobin and Weidenbaum, 1988). The 1962 *Economic Report of the President* called for increased investment in plant and equipment, subsidized by accelerated depreciation and an investment tax credit. In their view productivity growth and capital accumulation were closely linked:

> [When] investment was more rapid, there was an accompanying acceleration of
> productivity gains.…Investment in new equipment serves as a vehicle for
> technological improvements and is perhaps the most important way in which
> laboratory discoverise become incorporated into the production process. Without their
> embodiment in new equipment, many new ideas would lie fallow.… This interaction
> between investment and technological change permits each worker to have not only
> more tools, but better tools as well.[28]

This section has focused on equipment investment almost exclusively, because unlike other forms of potentially strategic high-return investment, like R&D or education, it is substantially influenced by macroeconomic policy tools. The policy instruments with the potential to increase equipment investment are clear enough, and are those identified by the

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[28]Tobin and Weidenbaum (1988), p. 215.

Kennedy Council of Economic Advisors in its 1962 reports: high rates of national saving by making possible looser monetary policy reduces the cost of capital and encourages equipment investment. Increased national saving caused by tighter fiscal policy or increased private saving. Tax incentives, such as the American investment tax credit, that favor equipment investment are particularly desirable because they are well-targeted. Trade policies that ensure that capital goods imports are not penalized are important in making sure that a high investment effort is translated into a high rate of equipment effort.

V. Conclusion

In concluding this paper in 1992, it is worth recalling the observation with which we begun. The productivity slowdown is not just an American phenomenon. It is a worldwide event that has occurred in countries with widely varying micro and macro economic policies. This suggests that even with all the political courage in the world, there is no macroeconomic magic bullet that has the potential to reverse the productivity slowdown. Better, more responsible macroeconomic management is surely helpful. And increases in national saving that flow into general increases in investment surely can make a contribution.

If public policy in the industrialized world does succeed in reversing any large part of the productivity slowdown, its success will have an important microeconomic component. Policy will succeed either by changing incentives in such a way that average returns on investment significantly increase, or by successfully raising the share of national output that is devoted to forms of investment that have large external benefits and therefore very high social returns.

In keeping with this paper's macroeconomic perspective and some of our own earlier research, we have highlighted equipment investment as a class of investment that is likely to

have especially large social returns by supporting the development and introduction of new technologies. Certainly cases can also be made for strategically selected investments in infrastructure and in education. These cases must rely on external benefits of a kind that are difficult to measure. Studies of the travel time savings from highways, or the wage increases from better schooling do not suggest the kind of extraordinary returns or externalities that are necessary if increases in these categories of investment are to offset a large part of the productivity slowdown. The quantification of the possible external benefits of various forms of public investment should be a critical research priority. And even in the absence of compelling evidence of external benefits, there is a case for increasing public investment in those countries where investment rates have lagged and are low by international standards.

A crucial remaining issue is the apparent conflict between our emphasis on support for critical strategic investments and conventional policy wisdom that reductions in budget deficits and increases in national saving are desirable in the United States and in Europe. In fact there is no conflict. Reductions in budget deficits over the medium term are desirable on stabilization policy grounds apart from any effect that they might have long run growth prospects. And, assuming strategic investments with very high returns can be identified, there is no reason why they should be financed out of reductions in other investment rather than out of consumption. Reducing budget deficits is good macroeconomic policy. But it is unrealistic to hold out the hope that reduced budget deficits alone will restore the magic of an earlier era, when standards of living in the industrialized world doubled in one generation rather than in two or more.

Appendix

Growth and Equipment Investment with Different Sets of Additional Growth Factors

Partial Scatters of Growth and Components of Equipment Investment: Second-Stage Regressions

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Table 1
Rates of Productivity Growth by Decade

Economy	1950-60	1960-69	1969-79	1979-90	1985-91
United States	2.0	2.5	0.5	1.3	1.2
Japan	6.7	8.4	4.4	3.0	3.8
Germany	6.4	4.1	2.5	1.6	2.9
France	4.3	4.8	2.8	1.1	1.9
U.K.	2.5	2.3	2.1	1.7	1.8
Canada	1.8	2.6	0.7	1.2	1.0
Italy	6.0	5.2	3.7	1.9	2.3
Total OECD [29]	3.0	3.5	1.8	1.6	
Industrial Pacific Rim Economies[30]	6.7	6.2	4.4	3.6	
Industrial Latin Amer. Economies[31]	2.7	2.8	2.1	-1.7	
Average Industrial Economy	3.3	3.7	2.4	1.0	

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[29]Total OECD product divided by number of OECD workers.

[30]Our list of industrialized Pacific Rim economies initially includes only Japan. Hong Kong and Singapore joins the list in 1960. Korea, Malaysia, and the economy of the Taiwan province are added to the list in 1979.

[31]Argentina, Chile, Colombia, Costa Rica, Mexico, Uruguay, and Venezuela.

Table 2
Convergence-Adjusted Rates of Productivity Growth by Decade

Economy	1950-60	1960-69	1969-79	1979-90	1985-91
United States	2.0	2.5	0.5	1.4	1.2
Japan	3.7	5.7	2.3	1.8	3.0
Germany	4.0	2.4	1.1	0.7	2.1
France	2.2	3.0	1.4	0.3	1.0
U.K.	0.8	0.7	0.5	0.3	0.5
Canada	1.3	2.1	0.2	0.7	0.5
Italy	3.6	3.1	2.1	1.0	1.6
Total OECD	1.5	2.0	0.6	0.4	
Industrial Pacific Rim Economies	3.3	3.1	1.4	1.5	
Industrial Latin American Economies	0.0	0.3	-0.4	-3.6	
Average Industrial Economy	0.9	1.6	0.5	-0.5	

Table 3

Instrumental Variables Regressions of Growth on Machinery Investment

Instrument	Machinery Investment	Other Investment	Labor Force Growth	Productivity Gap	R^2 (2nd Stage)	SEE	n
No Instruments	0.250 (0.040)	0.070 (0.028)	-0.030 (0.126)	0.034 (0.006)	0.652	0.008	47
Savings Rate	0.224 (0.059)	0.079 (0.034)	-0.037 (0.151)	0.031 (0.008)	0.507	0.009	46
Relative Price of Machinery	0.210 (0.086)	0.092 (0.045)	-0.103 (0.164)	0.040 (0.011)	0.610	0.008	31
Tariffs and Non-Tariff Barriers on Capital Goods	0.196 (0.136)	0.077 (0.048)	0.016 (0.208)	0.027 (0.011)	0.309	0.011	39

Table A1

Regressions of 1960-85 Growth on Equipment Investment and Different Sets of Additional Variables
for Industrial Economies

Equipment Investment	Other Investment	Productivity Gap	Labor Force Growth	Secondary Education Rate	Govern. Consump. Expend.	Public Investment	Continent	R^2	SEE
0.262 (0.048)	0.069 (0.028)	0.032 (0.007)	-0.082 (0.169)	-0.004 (0.010)				0.65	0.008
0.255 (0.039)	0.059 (0.027)	0.034 (0.006)	-0.025 (0.127)					0.63	0.008
0.256 (0.040)	0.060 (0.027)	0.034 (0.006)	-0.028 (0.126)		-0.027 (0.020)			0.65	0.008
0.240 (0.036)	0.059 (0.025)	0.035 (0.006)	-0.083 (0.118)			0.041 (0.076)		0.67	0.008
0.206 (0.048)	0.042 (0.030)	0.029 (0.007)	0.107 (0.181)				Continent: Prob(F) = .320	0.68	0.008

Africa = 0.026
(0.005)

Asia = 0.027
(0.004)

Europe = 0.027
(0.003)

North America = 0.020
(0.003)

Oceana = 0.017
(0.008)

South America = 0.019
(0.003)

Figure 1
Cyclically-Adjusted Real GDP per Worker Growth
Centered Five-Year Moving Averages of Cyclically-Adjusted Productivity Growth
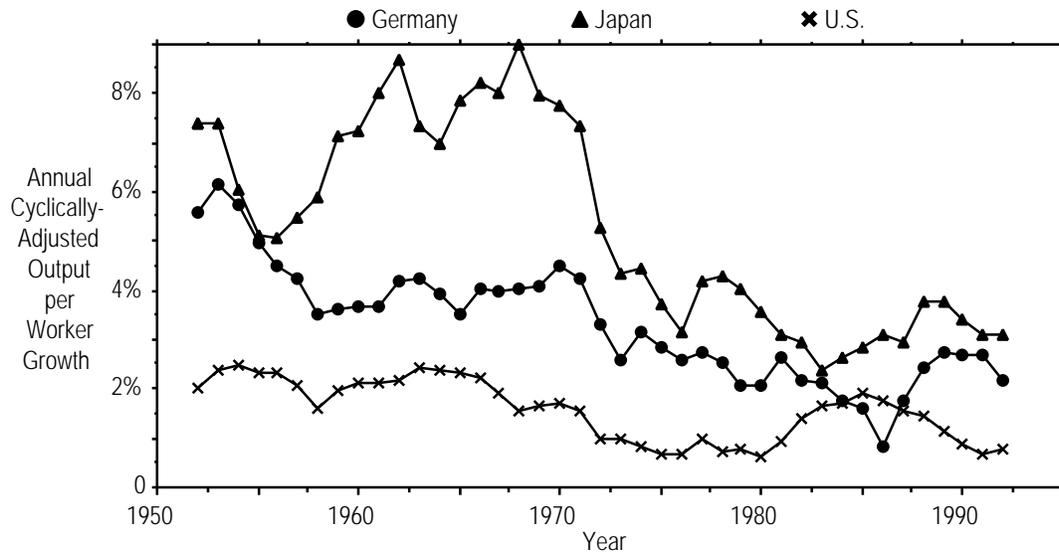
Figure 2
Cyclically-Adjusted Real GDP per Worker Growth
Five-Year Moving Average for the OECD

Figure 3
Inverse Relationship between Output per Worker Levels and Growth Rates in the Post-World War II
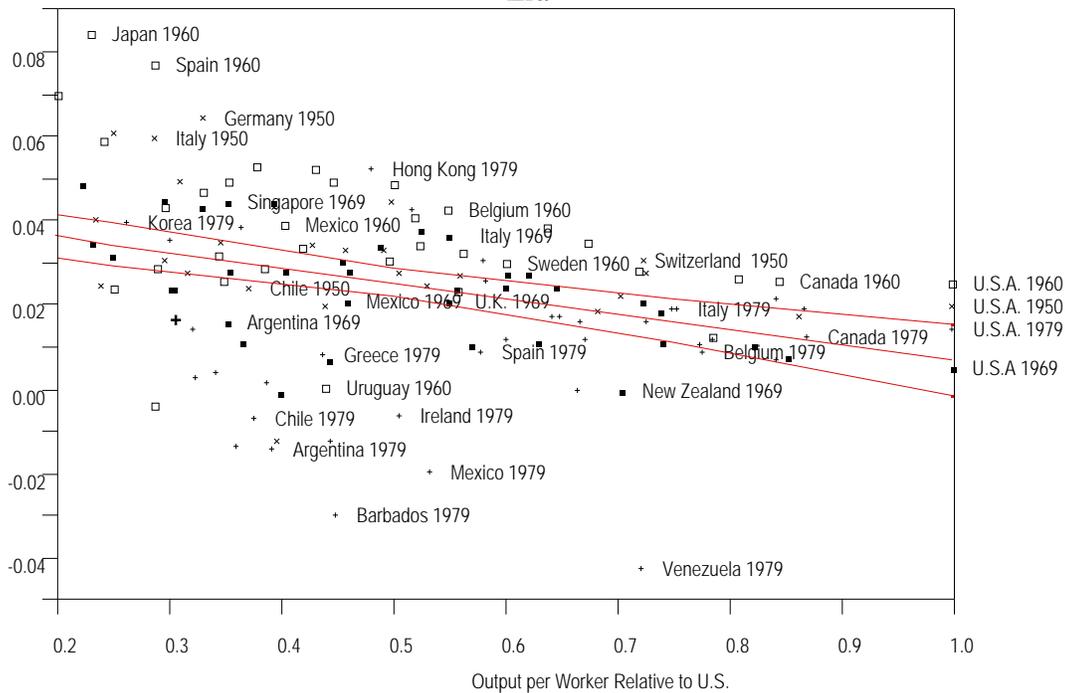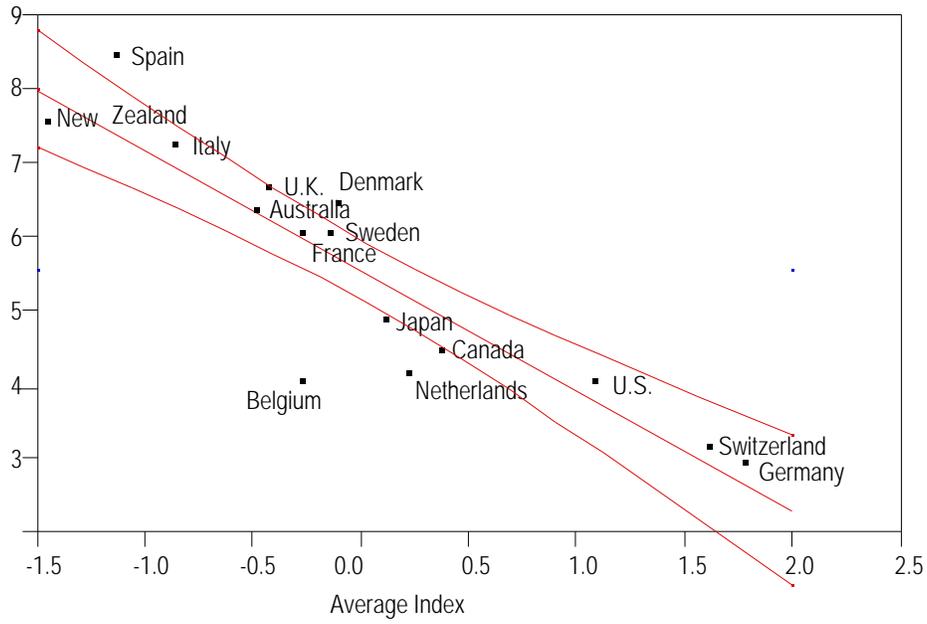Era

Figure 4
Inflation and Central Bank Independence

Figure 5
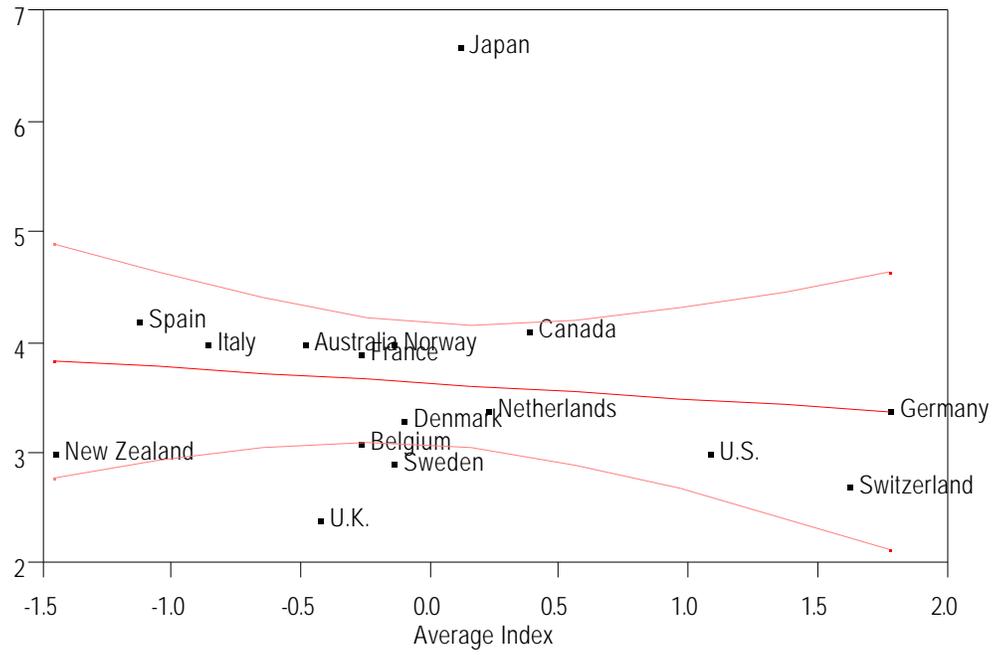Output per Worker Growth and Central Bank Independence

Figure 6

Central Bank Independence and Economic Growth, Controlling for Initial GDP per Worker Levels
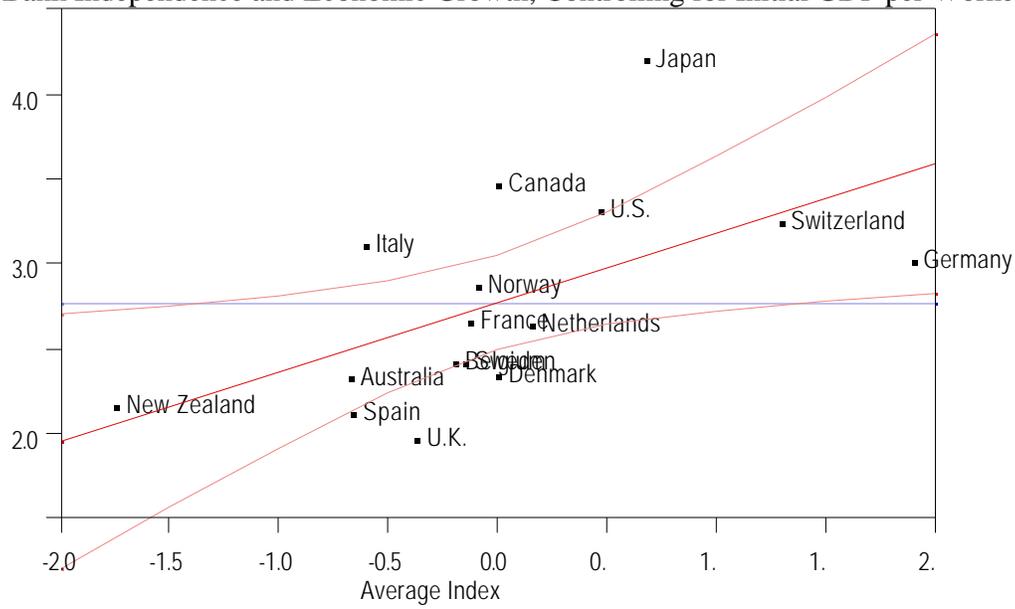
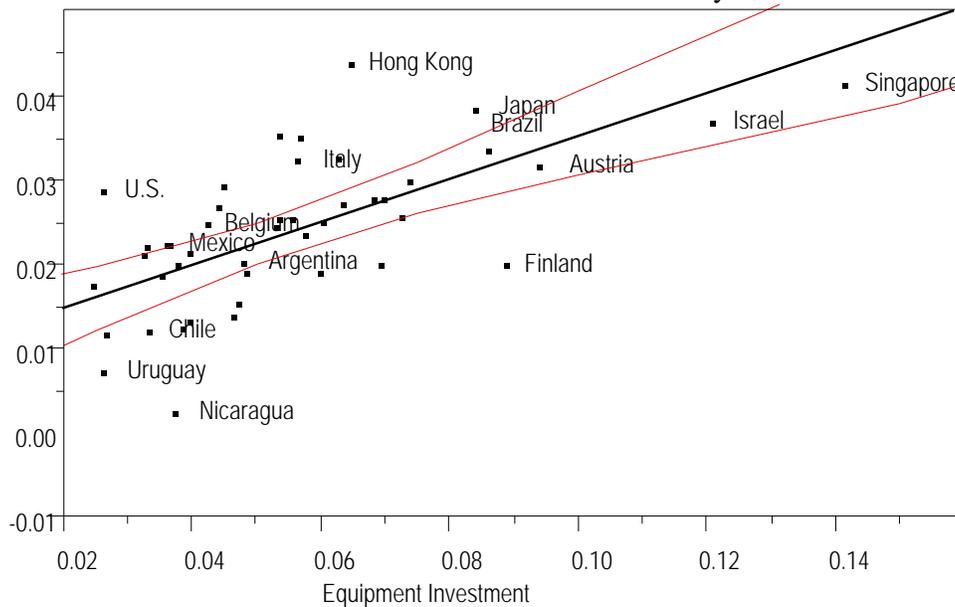Figure 7
The Variance of Real GDP Growth and Central Bank Independence
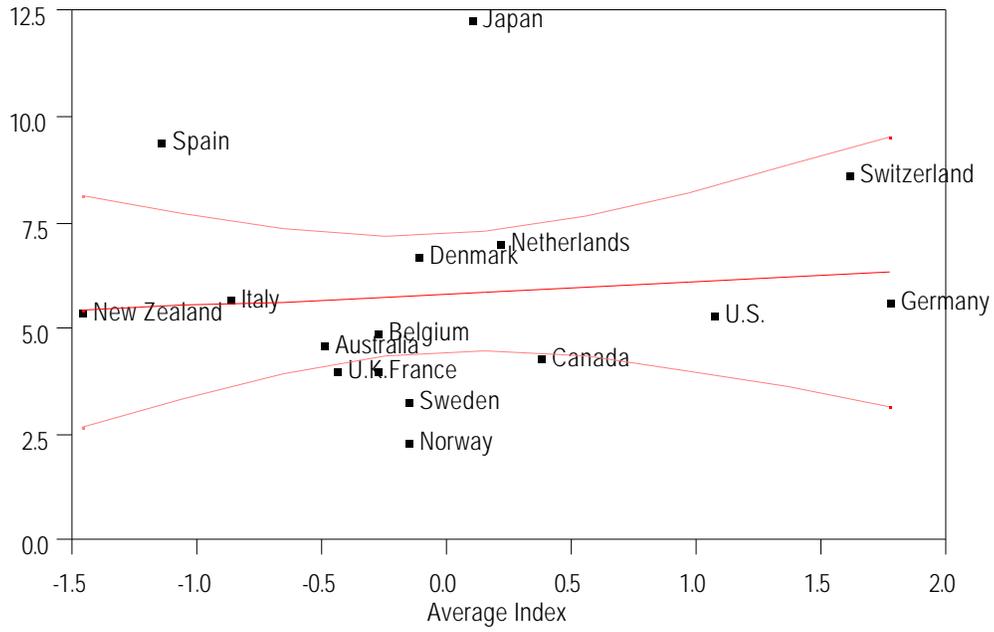
Figure 8
Partial Scatter of 1960-85 Growth and Machinery Investment

(2)	GDP/Wkr Growth =	0.262 (Eq. Inv.) (0.048)	+0.069(Non-Eq Inv) (0.028)	+0.032(Prod. Gap) (0.007)	-0.082(Lab. Fce. Gr) (0.169)	-0.004(Sec. Ed.) (0.010)

$R^2 = 0.654$ SEE = 0.0079   n = 47

Figure A1
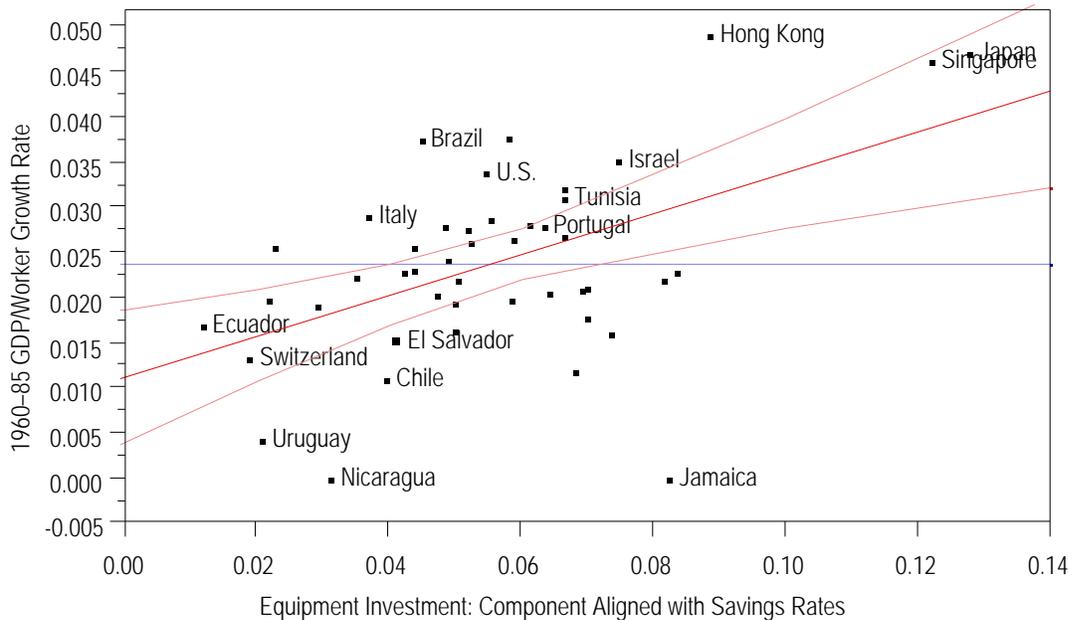Growth and the Component of Equipment Investment Aligned with Savings

Figure A2

Growth and the Component of Equipment Investment Aligned with LowRelative Machinery Prices
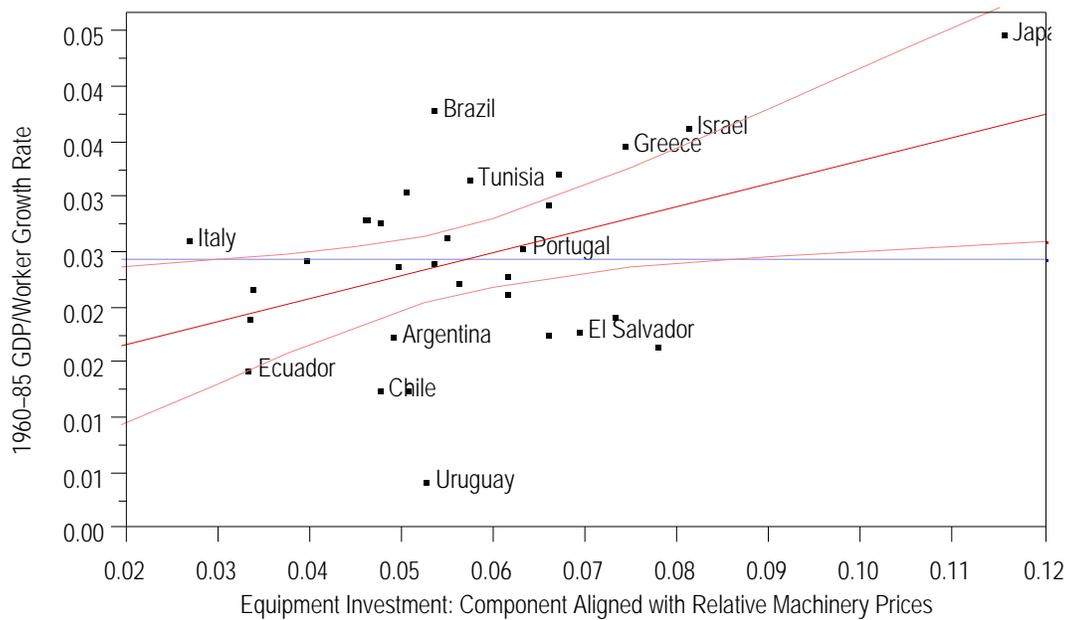
Figure A3
Growth and the Component of Equipment Investment Associated with Low Trade Barriers to
Machinery Imports