Some Thoughts on the Possibility of Changes in Trend Growth

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Abstract

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I'd like to discuss the possibility of recent and future changes in the trend rate of growth of output per worker for the U.S. economy. I'll first summarize some work I did recently, Jones (1999), suggesting that a likely direction for a future change is actually downward rather than upward. Then I'll discuss several ways in which the recent fascination with the New Economy could be interpreted in this framework. This analysis suggests that one possible view of recent events is that the growth rate of output per worker has risen, but that this rise is only temporary.

1 The Upcoming Slowdown

Let me begin by documenting a few key facts. Given my limited time and space, please forgive me for omitting several caveats and the sources for the facts; these can be found in Jones (1999), available on my web page.

1. As shown in Figure 1, GDP per capita over the last 125 years or so is well-represented by a log-linear time trend with a slope of about 1.8 percent per year. In particular, actual GDP per capita does not deviate from this time trend by very much for very long. This kind of evidence underlies the conventional view that the U.S. economy is very close to a balanced growth path.

2. Contrary to this conventional view, however, a number of variables that can be thought of as investment rates have actually trended upward in recent decades. In particular, the fraction of their lifetime that individuals spend obtaining education (a human capital investment rate) and the fraction of the labor force engaged in R&D have both increased, as shown in Figures 2 and 3. Similar increases in these investment rates are observed throughout the OECD.[1]

[1]For the investment rate in human capital, I'm simply reporting average educational attainment in years. Life expectancy has risen more slowly than educational attainment, while the length of the working life, i.e. adjusting for retirement, may actually have declined somewhat. Therefore the basic upward trend would survive these normalizations.

Figure 1: U.S. GDP Per Capita, Log Scale

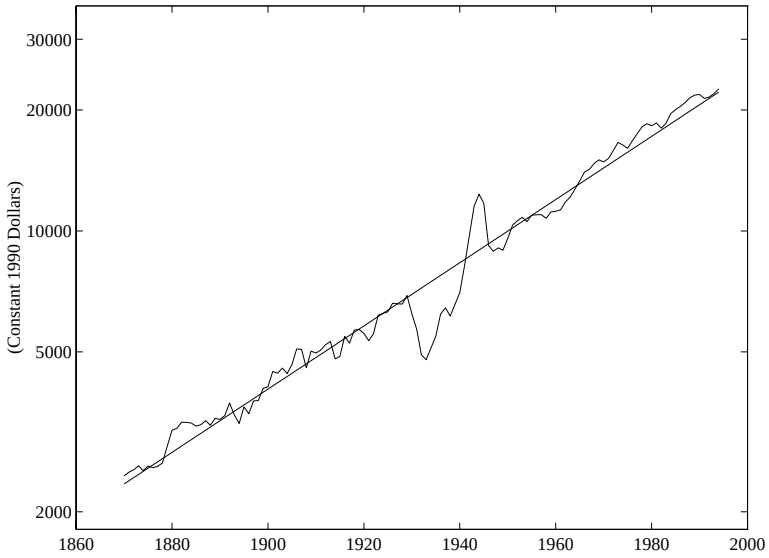


Figure 2: Average U.S. Educational Attainment, Persons Age 25 and Over

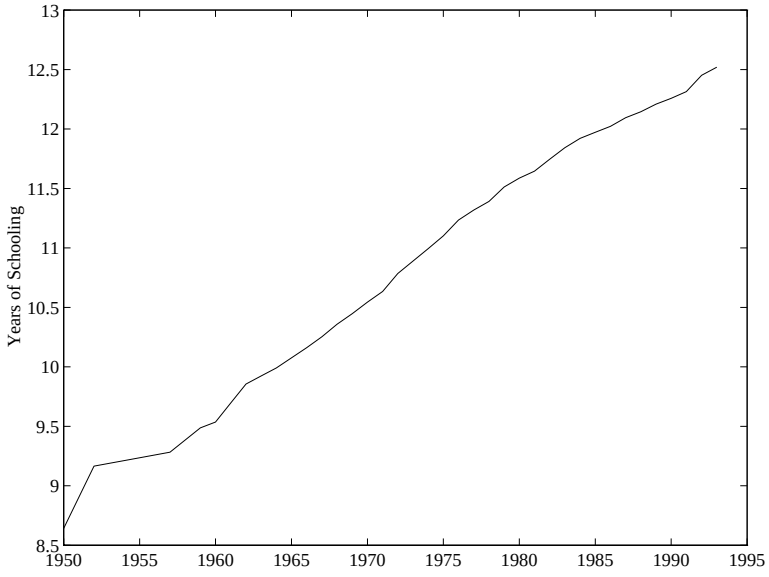
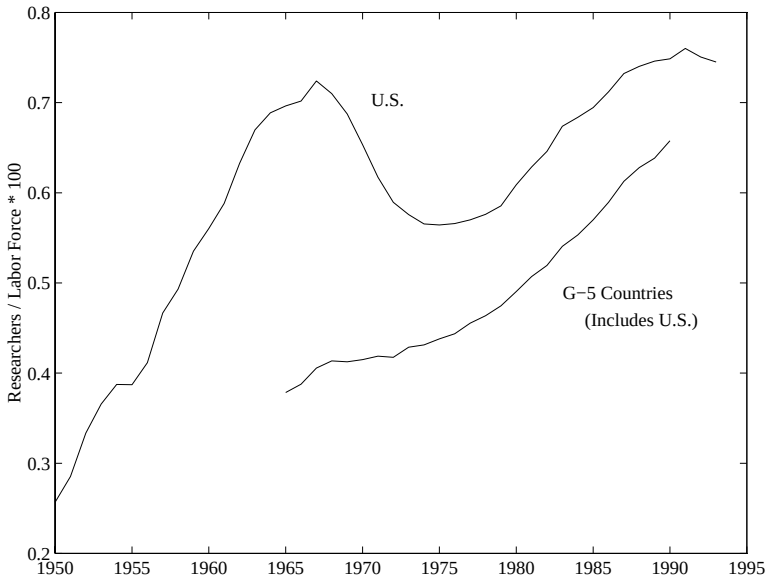


Figure 3: Researcher Intensity in the G-5 Countries



Several puzzles are raised by these facts. If the U.S. economy is close to its balanced growth path, then the investment rates should be stationary. On the other hand, if investment rates are rising and the U.S. economy is not close to its balanced growth path, then we would not expect a simple log-linear time trend to fit the data well. For example, in a neoclassical growth model such as the Solow model, we would expect to see "level effects": each increase in the investment rate would permanently increase the level of per capita GDP above the time trend given by technical progress.

A possible resolution to these puzzles is that the sequence of "level effects" implied by the trending investment rates has given rise to a peculiar situation in which the growth rate is relatively stable at a level higher than the long-run growth rate. To see the intuition for this resolution, consider a simple Solow model with one kind of capital, in which the investment rate, rather than being constant, is growing exponentially. The increase in the

investment rate will tend to increase the growth rate in the short run. If this increase were to occur only once, the growth rate would then begin to decline. However, before the decline occurs, the investment rate increases again. To the extent that the investment rate continues to increase, it is possible for the growth rate to be relatively stable at a rate higher than the long-run growth rate.

To see this, recall that when growth rates are constant, the level of output per worker in the Solow model is given by

$$y^*(t) = \left(\frac{s(t)}{n+g+\delta}\right)^{\alpha/1-\alpha} A(t), \tag{1}$$

where the notation is fairly standard (see, e.g. Mankiw, Romer and Weil (1992)). If $s(t)$ grows exponentially, then the growth rate of output per worker in this situation will satisfy

$$g_y = \frac{\alpha}{1-\alpha} g_s + g_A > g_A. \tag{2}$$

This same intuition carries through in an idea-based growth model that incorporates human capital and R&D. In the model of new growth theory, it is not the investment rate in physical capital that is rising, but the investment rate in human capital and R&D. However, the implication is the same. In the long run, once these investment rates stop rising, as they must since the investment rates are bounded above at one, the growth rate of the economy must decline.

Parameterizing the new growth theory model in a fairly conventional fashion suggests that about 3/4 of U.S. growth in the post-war period (and perhaps before) is the result of this odd form of transition dynamics. The implication is that the long-run growth rate of the U.S. economy is approximately 1/4 its current level.

2 The New Economy?

The results from the preceding section stand in sharp contrast to a view that has recently received a great deal of attention: that a New Economy is underway, perhaps associated with a revolution in information technology, in which the growth rate is permanently higher. How does this view fit with the framework discussed above?

Three remarks on this tension come to mind.

First, as has been noted by many commentators on the New Economy, including Paul David, Brad DeLong, and Paul Krugman, the information technology revolution is just the most recent in a series of revolutions. As the 19th century waned, an electrical revolution was underway. Shortly thereafter, the internal combustion engine revolutionized transportation, on land as well as through the air. More generally, revolutions have been occuring throughout the 20th century in many other areas, including medicine, communications (radio and television), etc. From this perspective, looking for the IT revolution to raise the trend growth rate may be misplaced. Rather, it may well be that the information technology revolution is simply the next in a series of revolutions that *allow* the growth rate of the U.S. economy to remain above its long-run level.

Second, even if the IT revolution is somehow different from previous revolutions, it is not obvious that the New Economy should be characterized by a permanently higher growth rate. In virtually all idea-based growth models, both the original models of Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1992), and the semi-endogenous growth models of Jones (1995), Kortum (1997), and Segerstrom (1998), increasing the growth rate of output per worker permanently requires increasing the *rate* at which the stock of ideas rises. To the extent that the IT revolution is simply one or even several extraordinarily productive ideas, it will still only increase the level of income in the long-run, leaving the long-run growth

rate unaffected. To increase the long-run growth rate in all of these models, the IT revolution must actually change the shape of the idea production function itself, so that newer and better ideas are somehow obtained more easily *forever*. Of course, a very large increase in the level of income is itself a fantastic accomplishment, and to the extent that this occurs over several years or even decades, the growth rate may be temporarily higher. However, this is different in an important way from a permanent increase in the growth rate, and this difference can be important for policy (for example for projecting future budgetary problems associated with social security or medicare).

Finally, we should recognize the possibility that the idea production function itself could shift after all. It is possible that the IT revolution leads the economy to generate ideas at a permanently faster rate and this raises the growth rate forever. On the other hand, extreme possiblities on the other side are also possible. For example, while the productivity of the economy at producing goods and services generally increases over time (because of the discovery of new ideas), there is no reason to think this is the case for the productivity of the economy at producing ideas. It is certainly possible that the economy becomes increasingly better at producing new ideas, in a fashion analogous to Isaac Newton's famous remark about standing on the shoulders of giants. However, it is also possible that it becomes increasingly difficult to discover new ideas, as the most obvious ideas are discovered first. In fact, the idea production function could take virtually any imaginable shape. As just one example, it could be that some key ideas, perhaps including information technology, give rise to a large number of subsequent discoveries. However, it could also be that after these subsequent discoveries are exhausted, an idea "famine" sets in in which new discoveries are rare until the next Great Idea. Viewed from the start of the 21st century with so many technical advances apparently on the horizon, this seems like an extremely remote possibility, but it nicely illustrates a Knightian uncertainty

associated with the idea production function that should surely be kept in mind.

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