Literature Review: Long-Run Economic Growth

Effendy Juraimin

California State University, Hayward

Focusing on aggregate demand will only affect output level in the short run. When economy runs below capacity or potential output, increase in government spending and money supply might increase output in the short run. But in the long run, this fiscal and monetary measures will only increase price level (P) with minimal or no increase in output (Q) as economy reaches its potential output (see Figure 1). Unless we begin to expand the aggregate supply, a real output (GDP) growth will be flat or even declined in the long run.

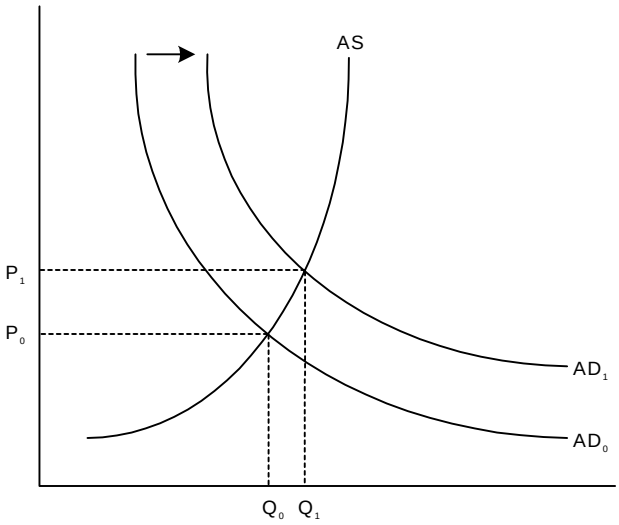

Figure 1

Over the long run, the aggregate supply depends on the following factors which affect the potential output (Nordhaus and Samuelson, pp. 531):

- Human resources (labor supply, education, motivation)
- Natural resources (land, fuels, climate, environmental quality)
- Capital formation (factories, equipment, infrastructure)
- Technology (science, engineering, management, entrepreneurship)

We all agree that all of these factors have positive impact on economic growth. But what is the relative importance of each factor in determining long-run growth? Let us look at theories of economic growth in order to answer this question.

I. Classical View

Early economists stressed the importance of land (natural resources) and labor (human resources) in economic growth. In the *Wealth of Nations* (1776), Adam Smith began with "original state of things, which precedes both the appropriation of land and the accumulation of (capital) stock." As population grew to occupy the free land, so did the output. After all the lands were occupied, output would grow slower than population did. With new labor added to fixed land, which decreased land-labor ratio, each labor had less land to work with. This meant marginal product of labor would decline, and real wages would fall.

But how low could real wages fall? Malthus predicted that when real wages felt below subsistence level, mortality rate would be high and population would decline to the stable equilibrium level.

II. Neoclassical Overview

Malthus did not realize that other growth factors, which were capital formation and technology, could overcome the declining output due to increasing population and limited land resources. Neoclassical model of economic growth, pioneered by Robert Solow (1956) of MIT, gives us some insight into how the capital accumulation and a technological change affect the economic growth.

If Classical uses land-labor ratio to discuss economic growth, Neoclassical introduces capital-labor ratio (K/L) to explain the growth process. Assuming for the moment that the technology remains constant. And businesses invested heavily in capital goods, such as factories, overtime. This so-called Capital Deepening process increases the capital-labor ratio. As workers have more factories or capital to work with, output per worker (Q/L) also increases. When all existing factories have been replicated, additional investment in new factories produces less output and earns lower rate of return to the investor. In the long run, the capital-labor (K/L) ratio stops increasing and the capital deepening process ceases. See Aggregate Production Function (APF) in Figure 2.

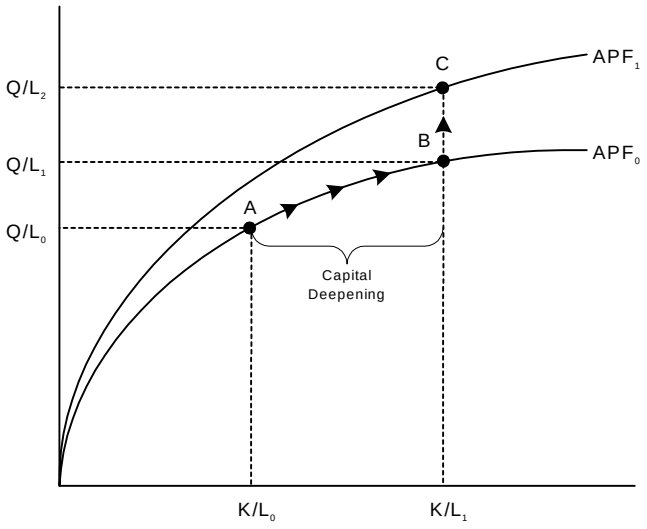

Figure 2

When we allow technology to advance, the same capital and labor (inputs) can produce more output. A new production process, for example, enables the same capital-labor (K/L) ratio to have a higher output per worker (Q/L) and the APF shifts upward. Therefore, the technology improvement brings a new life to the capital deepening process and allows the output per worker to increase overtime.

III. Saving, population and Economic Growth

Let us take a step back to a constant technology state and look at the source of capital growth, which is saving, and source of labor growth, which is population. Specifically, we will look at the impact of increased saving rate and population growth rate on economic growth.

If people allocate a higher proportion of their income for saving, more savings are available for investment in capital goods. Assuming that labor growth is constant, capital-labor ratio (K/L) increases along the APF line in Figure 2. If population growth rate increases, more people are available to join the labor pool. Keeping the capital growth fixed, capital-labor ratio (K/L) decreases along the APF line. Only when capital grows at a faster pace than the labor force that we will see a higher movement along the line of APF or higher output per worker (Q/L). But the higher saving rate and the lower population growth rate does not bring a permanent growth of output per worker, because the APF line eventually increases at the diminishing rate; Unless technological advances come into play. Solow (1988) said it best in his Nobel lecture:

> "More precisely, the permanent rate of growth of output per unit of labor input is independent of the saving (investment) rate and depends entirely on the rate of technological progress in the broadest sense."

IV. Convergence, Conditional Convergence and Endogenous Growth

One of the implications of Neoclassical growth model is convergence. This means that economy tends to grow faster in per capita terms when it is further below the steady-state position. Figure 2 shows that economy below point B has a higher Q/L growth rate than economy above point B. Barro and Sala-i-Martin (1992) found that U.S. poor states tended to grow faster in per capita terms than U.S. rich states over periods from 1840 to 1988, by holding only initial per capital income or product constant.

But they also found a conditional convergence for a sample of 98 countries from 1960 to 1985. Conditional in this case means that only by holding certain variables constant that the estimated rates of convergence are close to those found in the U.S. states. Those variables are primary and secondary school enrollment rates in 1960, the average ratio of government consumption expenditure (exclusive of defense and education) to GDP from 1970 to 1985, proxies for political stability, and a measure of market distortions based on purchasing power parity ratios for investment goods. We can interpret these variables as factors that affect the rate of technological progress.

Recent development of economic growth model attempts to incorporate variables of technological progress into the model. In other words, the technological progress is endogenous or determined within the theory. For example, Romer (1986) used knowledge accumulation to explain an increasing marginal productivity, which enabled APF curve to shift up in our previous figure 2. Specifically, he argued that a capital investment in a research technology produced new knowledge at diminishing return. But a stock of this knowledge generated production of consumption goods at increasing return. The implication here is obvious and will be included in the conclusion section.

V. Empirical Evidence of US Economic Growth

Jorgenson (1988) analyzed the source of US economic growth between 1948 and 1979. He concluded that growth in capital and labor inputs were the driving force behind the expansion of the US economy between 1948 and 1979, with the growth in capital input was the most important source of growth in output. Labor growth was the next most important source, and productivity growth was the least important source. But he also mentioned a previous research by Denison (1985) who analyzed the slowdown in US economic growth since 1973. He attributed the slowdown primarily to the decline in aggregate productivity growth by saying that the decline in the aggregate productivity growth rate accounted for 80 percent of the decline in the output growth rate.

Empirical findings by Jorgenson and Denison seem to be consistent with the Neoclasical model of economic growth. Higher contribution of capital, versus labor, to US economic growth between 1948 and 1979 suggests that capital deepening occurs during that period. But a slowdown in 1973 due to a decline in productivity reminds us of the long-term limitation of capital deepening process without the aid of technological progress or higher productivity. As additional capital is becoming less productive, each labor produces less output and we have the slowdown in economy.

VI. Conclusion

If we concern about long-run economic growth, we should pay more attention to the aggregate supply and the four determinant factors of potential output: human resources, natural resources, capital formation, and technology. But which factor(s) we should pay more attention to? Historically, we have seen a shift of attention from labor (human resources) and land (natural resources) to capital and technology as sources of

long run growth. Then we learn that a higher saving rate contributes to a capital deepening process if population or labor grows at a slower pace than the capital growth rate. Capital deepening process eventually ceases if we have no technological progress. We also learn that convergence occurs conditionally. These conditions are variables that affect technological progress. Later we find that empirical facts of U.S. economic growth seem to support the modern theory of economic growth.

Based on what we have discussed so far, governments who are pro long-run economic growth should implement the following policies:

- Increase saving, as a source of capital formation
- Encourage investment in human resources, such as education and training, to enable an increased output per worker without an increased in capital
- Encourage investment in productive capitals, such as factories and infrastructure, to progress the capital deepening process
- Provide incentives for research and development to enable continuous revival of the capital deepening.

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