Study on Pareto Improvement of Technological Progress, Economic Growth and Employment

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Abstract. Technological progress promotes economic growth, and economic growth promotes employment expansion, but technological progress and employment also present the obvious repelling effect, so the three have intrinsic contradictory relations. Looking from the present development phase, China must continue to achieve economic growth and full employment which can help to build a socialist harmonious society, and continue to introduce and develop advanced technology to improve international competitiveness. Therefore, this article further studies the relationship among technology advancement, economic growth and employment from the economic angle, and seeks effective measures of Pareto improvement to promote the three communal developments while technology advancement, economic growth, also lower impact of technological progress on employment.

Introduction

The classical economic growth theory states that to guarantee economic growth requires not only labor force increases and capital accumulation, but also progress. The relationship among technological progress, economic growth, and employment is complicated. Therefore, correctly understanding and handling the relationship of the three and using effective means to achieve Pareto improvement can realize economic growth and full potential employment.

Influence Relations among the Three

According to the viewpoint of the American economist, Arth Okun the unemployment and economic growth hold sway above the flux meaning the faster economic growth, the more it can absorb labor, so the relationship between economic growth and employment is directly. There are two main views about the impact of technological progress on employment. One is that technological progress tends to make the marginal employment elasticity decline leading to "technical unemployment" that can reduce the demand for employment while increasing economic growth, then directly causing unemployment. The other view is that even though technological progress directly leads to unemployment, it also indirectly creates employment by multiple ways, the overall result of which is to achieve employment growth\cite{1}. From this point of view, technological progress promotes economic growth, and economic growth promote employment, while technical progress affects employment. These relationships can be expressed in the following figure:
Figure 1. Relations of technological progress, economic growth and employment.

The Cobb-Douglas production function is introduced to further prove their relationship:

Suppose \( Y = A \cdot L^\alpha \cdot K^\beta \), where, “\( Y \)” is the gross national product, “\( L \)” is the labor input from the production angle, which is the labor demand, “\( K \)” is the capital investment, “\( A \)” expresses technological progress, and \( \alpha, \beta \) are the coefficients. Taking the logarithm of both sides, the equation is:

\[
\ln Y = \ln A + \alpha \ln L + \beta \ln K
\]  
(1)

Take the derivative of time of the above formula and get

\[
\frac{dY}{dt} = \alpha \frac{dA}{dt} L^{\alpha-1} K^{\beta} + \beta \frac{dK}{dt} L^{\alpha} K^{\beta-1}
\]  
(2)

The growth rate of a variable refers to variational velocity; that is, the growth rate of \( Y \) is \( \frac{dY}{dt} \), the growth rate of \( A \) is \( \frac{dA}{dt} \), the growth rate of \( L \) is \( \frac{dL}{dt} \), and the growth rate of \( K \) is \( \frac{dK}{dt} \).

According to the production function, get a decomposition formula that describes the relationship among the growth rates of input elements, the growth rates of output and the growth rate of technological progress is:

\[
G_y = G_A + mG_L + nG_K
\]  
(3)

Where “\( G_y \)” is the growth rate of output, “\( G_A \)” is the growth rate of technological progress, “\( G_L \)” and “\( G_K \)” respectively refer to the growth rate for the labor and capital; \( m \) and \( n \) are positive parameters which are the output elasticity of labor and capital, respectively.

It can be seen from comparative static analysis on the decomposition formula of the growth rate that economic growth is a long term result, and that technological progress, capital accumulation, labor force increases and the other factors interact. Economic growth and employment growth should be interactive, and are related. Relatively rapid economic growth should be appropriate to promote employment growth and reduce unemployment rate.

Solving for the growth rate of technological progress of the above equation, the equation is:

\[
G_A = G_y - mG_L - nG_K
\]  
(4)
It can be seen that there are negative correlations between technical progress and capital deepening and between technological progress and labor growth in the case of other constant factors. In the long run, technological progress increases labor productivity, raises output, causes the capital total quantity to increase, expands the scale of production, raises the society consumption level, and especially may promote the development of tertiary industries which have labor-intensive characteristics, thus realizing a "compensation effect" that technical progress effects employment. Therefore, we need to take some measures to get pareto improvement with advanced technology, economic growth and expanded employment, to achieve their benign interaction.

Analysis on Pareto Improvement

From the proof of relationship among technological progress, economic growth and employment; technological progress promotes economic growth, which in turn reduces the employment rate. Under what circumstances the one hand growth was not affected, at the same time the other two also increased and achieving Pareto optimal?

First of all, we should analyze from the viewpoint of supply and demand of labors:

Establish a production function:

\[ Y = ALD^\alpha K^\beta, \]

(5)

Take the derivative of \( DL \) on both sides of the above formula, and get

\[ \frac{dY}{dL} = AK^{\beta} \alpha L_{D}^{\alpha - 1} \]

(6)

Where, \( \frac{dY}{dL} \) is the marginal product of labor demand.

Because the principle of manufacturers using elements is that the marginal products value of elements is equal to the price[2], that is \( P \cdot MP_{L} = W \)

Here, “P” represents product price, “W” is labor price namely monetary wages. And since enterprises pursue maximum profits, and the first order condition for maximum profit is that marginal investment is equal to marginal output in labor demand, \( \frac{dY}{dL_{D}} = (W / P)_{D}, (W / P)_{D} \) is seen as the real price of labor or real wages [3].Therefore, the following formula can be concluded:

\[ (W / P)_{D} = AK^{\beta} \alpha L_{D}^{\alpha - 1} \]

(7)

Since China's labor supply will belong to relative excess in the long run, it can be assumed that the labor supply curve remains unchanged, in the case of technological progress improvements. According to the formula (7), we discuss how to realize economic growth (or stability) and improved employment level, so as to achieve Pareto improvement.

1. The real wages level \( (W / P) \) is relatively invariable. While technological progress increasing, unit labor input get more output, production function will be moved, then manufacturers will increase investment and decline effective demand for labor input. If technology continues to offset to the path of substitution of capital for labor, capital will grow faster than labor, ultimately affecting job growth and reducing employment. The result is economic growth, advanced technology, but reduced employment, then Pareto improvement cannot be achieved unless using the "compensation mechanism" for Pareto improvement. One method is implementing technology decomposition. Enterprises enhance technology in a key device to save costs and replace non-key parts with manual operation, while realizing the cost saving that affects employment promotion. The other is to increase the rest time of employees, such as shift work, which not only increases the quantity of employment but also increases the development of any tertiary industry. If the investment growth can continue to effectively drive more labor input to the production process, and the ratio of capital and labor remain
stable or moderate growth in employment can be guaranteed, then Pareto improvement can be achieved this time.  

② The real wage level relatively rises, and the labor force demand curve moves (as shown in Figure 2). At this time, levels of employment are higher than rigid wage and rigid price, which can obtain when “L” increasing, the level of employment raising. But as commodity prices fall relative to money wages, the manufacturer has the possibility not to continue to increase the investment, and has the possibility to transform to other industrial investment. Transforming to the tertiary industry investment will also promote an increased level of employment. From the perspective of these methods, both achieve Pareto improvement.

Figure 2. Analysis on supply and demand of the labor market[3].

③ Under the condition of \((W/P)\) relative decline, \(AK^\beta aL_D^{-1}\) decline, “L” reduce, and unemployment increase, no case can achieve Pareto optimum. The above analysis is expressed in figure 3:

Figure 3. Method of pareto improvement.
Policy Suggestions

The above arguments show that technological progress is directly related to economic growth, and economic growth is prerequisite for job growth, but this does not mean that technological progress promoting the economic growth simultaneously lead to increased employment. There is also a restriction relation between them. Therefore, in order to achieve the three common promotions, it is necessary to adopt appropriate macroeconomic policies according to the Pareto improvement.

A Accelerate the Development of the Tertiary Industry

From the perspective of technology development, we should place extra emphasis on the development of technological innovation using increased labor, and make more efficient use of labor resources. Marginal employment elasticity of tertiary industry is high and stable, and it is a leading industry that can compensate for slow employment growth caused by technological advances. In addition, as the inevitable result of industrialization, the tertiary industry will be a significant development in our country, so the government should provide a fair policy environment and regulate the management of order and render a wide range of social services especially in labor-intensive services. But also continue to encourage the development of traditional tertiary industry with relatively low start-up costs and labor-intensive, such as, tourism, catering, and trade circulation; while actively expanding new areas of new tertiary industries, with the focus on supporting community services, information consultation, legal services, accounting services and other emerging labor-intensive forms of service industries, and actively use of informal and flexible ways to promote employment and reemployment.

B Encourage the Implementation of Technology Decomposition

Under the market economy, technology, labor and capital are production factors of enterprises. The enterprise selects various quantity combinations according to profit maximization (cost minimization) in producing. Technology decomposition is one kind of breaking behavior in the system of advanced production technology, by which enterprises achieve cost savings. Technology decomposition is introducing advanced technology in the key part of a device, using manual operations in the non-key equipment components. Low-cost labor substitute for capital, at the same time, which brought the expansion of employment effects. There are rich human resources in our country, so it is highly probable that labor can substitute for capital. Implementing technology decomposition must adapt to the trend of world scientific and technological progress to improve national competitiveness, promote high-tech innovation, develop new industries, discover and use new resources, develop new products, improve production and the natural environment, ensure national security, enhance the competitiveness of science and technology and industrial competitiveness. Meanwhile, the Government should also formulate incentives and policies, creating the conditions for enterprise in the course of technology decomposition and enhancing dynamic. In the choice of technology, as far as possible using "appropriate technology" to reduce the effect that technological progress substitute for labor, and strengthen "compensation" function that technological progress open up new employment opportunities.

C Gradually Carry out Shift Work

At present, China's average per capita GDP has amounted to above 10,000 Yuan, the annual financial revenues reached more than 3 trillion Yuan, which prove the state has had the financial resources to further reduce working time to improve the quality of life. Implementing a system of several rounds and short work days through shortened shift working hours in some sectors and industries, increasing the number of shifts, and extending the scope of shifts will increase employment capacity under the existing employment patterns. By turning the current 8-hour shifts to 2x6 hours of two-shifts, 2x8 hours of two shifts to three shifts of 3x6 hours, 3x8 hours of three shifts to 4x6 hours of four classes System, according to preliminary estimates, implementing the short class wheel system can add employment capacity of more than 20 million people to one-third good benefit enterprise in a
secondary industry, add more than 30 million people to the tertiary industry. After the six-hour working system, enterprises can employ two groups of workers, even three or four groups in rotation on the same day. If the enterprise hired only one group of workers, they would need to pay three times wages at overtime, at the same time if the enterprise hired two groups of workers, low cost and high efficiency can be achieved. Implementation of the shift system, not only will enhance 30% employment opportunities, but also alleviate the work pressure, improve work efficiency, increase leisure time, and promote the development of the tertiary industry.

References