China's Dual Structure-Based Growth Accounting —Theoretical and Empirical Analysis of Introducing the Labor Employment Rate

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The role of the dual structure in economic growth is often weakened by the use of neoclassical growth models, resulting in the defect of strong theoretical but weak empirical evidence. We take the labor employment rate as an abstract attribute of the dual stage and construct a growth accounting equation that can conduct unified growth accounting among economies at different stages of development and among different stages of development of the same economy. On this basis, we measured the potential contribution of increasing the labor employment rate to economic growth in the future. The results show that the elimination of the dual structure will continue to be an important source of China's medium and long term economic growth.

Keywords: growth accounting, labor employment rate, demographic transition, dual structure, employment expansion

1. Introduction

Expanding employment capacity and providing as many jobs as possible to the working-age population is the fundamental way to improve wealth creation. The labor force employment rate is a method of assessing the employment capacity and is the proportion of the actual employed population to the working-age population. The main difference between real and nominal employment is surplus labor. Real employment is obtained by subtracting surplus labor from total employment. China's labor employment rate increased from only 39% in 1952 to about 69% in 2020, and the expansion of employment made a huge contribution to economic growth. With the changing demographic situation, the extent to which China can rely on the expansion of employment capacity, a traditional source of growth, in the future is a question worth further discussion.

After the 2010 census, the risk of population decline attract attention, and the aging age structure of the population arouses concern. In recent times, the main concern of the academic community comes from the influence of the demographic transition

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theory, that is, the problem of demographic dividend. Specifically, there is still no clear and consistent answer to the question of the relationship between accumulation and consumption caused by aging and the change in the share of factor in the distribution of national income. As for the employment theory, there is still no clear and consistent answer to the question of whether China can continue to increase labor input, especially whether China's economy has reached the commercialization point in the dual economic theory. This is related to the judgment of whether China has reached the boundary of employment expansion.

This paper argues that the judgment of the asymptotic equilibrium between supply and demand in the labor market is based on the premise that the employment of employees increases the labor cost of enterprises, which in turn leads to a relative decrease in the aggregate demand of the labor market, and at the same time, the slow increase of the real wage rate and the threshold effect inhibits the total labor supply, and under this premise, the equilibrium between supply and demand may be a short- and medium-term phenomenon. From the perspective of the long-term trend of employment expansion, the labor employment rate in advanced economies is generally around 80%, while in China it is less than 70%, and the proportion of agricultural employment is 14 percentage points higher than that of agricultural added value. There is still a long way to go to expand employment.

In summary, in the context of demographic transition, the topic of China's sustained economic growth attract much attention, but there are different judgments on the main risks in the field of labor and employment, and there is a tendency to generalize the demographic transition to employment issues, and there is also a tendency to regard the short-term equilibrium of the job market as a long-term equilibrium. Both of these tendencies bring resistance to promoting labor transfer and expanding employment capacity, and bring great risks to the formulation of macroeconomic regulation and control policies. From the perspective of the stage of economic development, this paper intends to introduce the dual economic theory into the unified growth theory based on the previous research (Cai, 2013), and introduce the labor employment rate into the growth accounting as an abstract attribute of the dual stage, and analyze the contribution of demographic transition and dual structure, so as to illustrate the important contribution of employment expansion in the future.

2. Labor Employment Rate of the Dual Economic Theory

2.1. Historical Performance of the Labor Employment Rate

In employment theory, there are three variables from population to employment, which are the dependency ratio, the labor participation rate, and the employment rate. *Total Population/(1 + Dependency Ratio) = Working-Age Population, Working-*

*Age Population × Labor Participation Rate = Economically Active Population, Economically Active Population × Employment Rate = Total Employment.*The proportion of the economically active population that is unemployed is known as the unemployment rate. As a result of statistical practice, some people who lost their jobs may be counted as dropping out of the labor market rather than being unemployed, and therefore are not classified as economically active people, at which point the labor participation rate falls. Therefore, in short-term economic fluctuations, there is a substitution relationship between the unemployment rate and the labor participation rate.

In the long run, the substitution relationship between the labor participation rate and the unemployment rate does not constitute a trend, while the combination of the labor participation rate and the employment rate show some regularity, but some data processing is needed. In the early days of industrialization, if there was surplus labor in agriculture, it would be classified as agricultural employment, which is a part of total employment because of the statistical system. This is not a problem in industrialized economies, where the share of agricultural employment is not much different from the share of agricultural output, but for developing economies, aggregate employment is overestimated, so that surplus agricultural labor needs to be subtracted from total employment to obtain real employment. At the same time, due to the differences in agricultural resource endowments, different economies may have the same share of agricultural output, but the share of agricultural employment required may be quite different, so the calculation of agricultural surplus labor needs to consider agricultural resource endowment. According to the agricultural resource endowment (Zhao and Cheng, 2014), the economies are divided into three groups. One is that economies with land equipment ratios around 100 percent tend to replace labor with machinery in agriculture from the point of view of induced technological progress, such as in the New World countries. The second is the economy with a land equipment ratio of around 10 percent, and most economies are in this group. Third, economies with land equipment ratios around 1 percent, such as Japan and South Korea, tend to replace land with fertilizers. The agricultural resource endowment coefficient is the minimum value of the five-year average of the "share of agricultural employment / share of agricultural output" of a group of economies with similar agricultural resource endowments. With the same share of agricultural output, an economy with a lower land equipment ratio will have more real employment in agriculture. *Labor Employment Rate = Labor Participation Rate × Real Employment rate=(Non-Farm Employment + Total Employment × Proportion of Agricultural Output × Agricultural Resource Endowment Coefficient) / Working-Age Population* is the actual employment proportion of the working-age population, which indicates the utilization of labor resources. In this way, empirically, the labor employment rate shows characteristics related to the stage of development.

A number of facts can be found from international experience. First, if the labor employment rate is calculated in terms of nominal employment, only the developed economies show a trend of upward trend in the labor employment rate, while the developing economies do not show a trend. That is, the rate of labor employment does not seem to be related to the stage of development. This is a disturbance from the overestimation of agricultural employment. Second, the labor employment rate, calculated in terms of the actual size of employment (Figure 1), shows some patterns. The more developed the economy, the higher the labor employment rate. At present, the developed economies are generally close to 0.8, and Japan reaches 0.88, which is the result of economic, social, cultural and technological influences. The slope of the labor employment rate is small in advanced economies and large in developing economies. Although there is a big difference between the two, they can be roughly connected in terms of the size of the labor employment rate values and the time point of the development stage, and there may be an inflection point. In Figure 1, South Korea and Taiwan, China have crossed the inflection point during the observation period, showing a slope of the intermediate value.

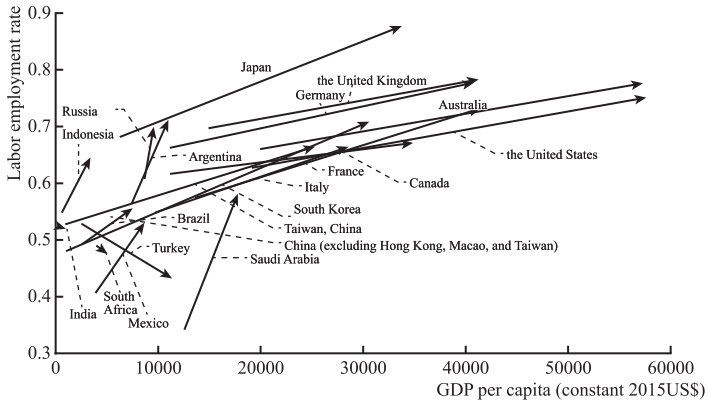

Figure 1. Labor Employment Rate in 20 Economies at Different Stages of Development: 1960–2020
Note: (1) The 20 economies are the G20 (excluding the European Union) and Taiwan, China.

The data in Figure 1 are from the mid-20th century. So, do other advanced economies historically be like South Korea, and Japan, where there is a marked inflection point in the slope of the labor employment rate at some point? Collating the data of the pre-industrialization period in Britain and France, we can find that there is a long-term upward trend in the labor employment rate during the centuries-long industrialization process, but it is difficult to say that there is a short period in which the slope of the labor employment rate curve changed significantly. From the experience of other developing economies, there has been very little experience in growing from developing to advanced since the post-World War II period, so it is

not possible to draw conclusions, at least for the time being, that inflection points are widespread among late-developing economies. In other words, from the perspective of the global scale or the scope of late-developing economies, an inflection point of the labor employment rate may be a unique phenomenon in East Asian economies, while the trend increase in labor employment rate is likely to be a common phenomenon.

2.2. The Theoretical Origins of the Labor Employment Rate

Lewis and later research (Arthur, 1954; Gustav and John, 1961) conduct a two-sector model based on classical economic theory, put forward concepts such as surplus labor, and formed a system of dual economic theory. It argues that one of the paths for late-developing economies to achieve economic take-off is through the transfer of labor from traditional sectors to high-productivity modern sectors in order to achieve the necessary national savings. This is widely studied and supported as one of the basic frameworks of development economics, and of course is widely opposed. Neoclassical theory does not recognize the assumptions of classical attributes of traditional sectors, because similar conclusions can be reached based on the assumptions of neoclassical theory. The dual theory assumes an unlimited supply of labor at a real wage rate fixed at the level of the subsistence wage. In neoclassical theory, the industrial sector will never be able to obtain labor unless there is a more significant increase in agricultural labor productivity without sacrificing agricultural output, but this is contrary to the assumption that the subsistence wage is fixed at the initial agricultural productivity in the dual economic theory. Lewis argues that whether marginal productivity is zero or not is not fundamentally important to analysis. Lewis mentioned that marginal productivity can be a mistake, because it just leads to an inconsequential controversy. Dual theory provides a mechanism to explain how the share of savings in national income increase rapidly in the early stages of the expansion of the capitalist form of production (Arthur, 1972). What is really important is that "dual theory will continue to be an appropriate mode of analysis until a single employment market evolves" (Arthur, 1979). In this sense, the transformation of the two employment markets into a single employment market is the essence of the dual economic theory, and the labor employment rate is the indicator to observe this transformation.

Both the dual theory model and the neoclassical theory model recognize that the process of declining the proportion of employment in the traditional sector and increasing the proportion of employment in the modern sector is the basic fact that the Malthusian stage to the Solow stage. Regardless of whether there is fake employment in the traditional sector or real unemployment in the modern sector, the apparent growth of the population is the basic fact that the Malthusian stage to the Solow stage. From this, two questions can be asked. First, does the end of the Malthusian stage means the beginning of the Solow stage? Or is it necessary to introduce a dual

stage in between? Second, if the dual stage is considered to be the only way from the Malthusian stage to the Solow stage, then how to bridge the gap between dual and neoclassical theory? Or is the dual stage a special case or a general rule?

This paper argues that the first problem can be the introduction of dual stage before the neoclassical stage. In economic history, the factors that can enter the theorists' field of vision, such as population, land, capital, technology, are all important, and these factors do not lose their role because of the evolution of the stage of development, but the importance of the role varies from stage to stage. Only the factors that dominate the economic development of a certain stage are the characteristics of that era, and they are also the basis for distinguishing that era from other eras. In this sense, the dual stage is fundamentally different from other stages. From the perspective of growth accounting, the way in which dual stage investment drives growth is suitable for description by the AK model, which is obviously different from the production function form of the power function form of neoclassical theory. If there is a "coherent" unified growth theory, the dual economic theory should enter the mainstream growth accounting, rather than be in a parallel position to the mainstream theory, but its role in other stages of development is not as important as that in the dualistic stage. The second issue, the core disagreement is the concept of surplus labor with unlimited supply. The role of surplus labor is to demonstrate that the transfer of labor from the traditional sector to the modern sector can lead to food shortages and unsustainable economic growth. If the essential attribute of the dual structure is abstracted as the transfer of labor from the traditional sector to the modern sector, that is, the increase in the labor employment rate. Then, without even resorting to the assumption of technological progress in agriculture, relying only on the most basic classical theory of comparative advantage, the process of industrialization can be achieved without being interrupted by the problem of food shortage, and it can be supported by historical experience.[1]

To sum up, the dual stage can increase the labor employment rate quickly, while the neoclassical stage cannot. This is an important difference between the dual stage and the neoclassical stage. Regardless of whether there is a statistical surplus of labor at a particular stage of development in an economy, the change in the labor employment rate is determined by the spurious employment squeezed out by the transfer of labor between the two sectors, and as a result the increase in the actual number of employment in the working-age population. This is in line with Lewis's judgment that the productivity of the traditional subsistence sector will eventually be equal to the

[1] The fact that Britain switched from grain exports to imports in the mid-18th century supports another theory: the classical doctrine of comparative advantage can bypass the problem of surplus labor. Suppose an economy with a comparative advantage in industry transfers labor from its agricultural sector to the industrial sector, then, according to the principle of comparative advantage, the increased industrial output will be exchanged for more imported food than it was before the transfer of labor, regardless of the existence of surplus labor in that economy.

productivity of the modern capitalist sector, thus ending the dual structure, and that it can also be used to describe the employment market in both developed and developing economies using a unified formula in preparation for a unified form of growth accounting.

3. Accounting of the Growth by Introduing Labor Employment Rate

3.1. The Form of the Accounting Equation

The endogenous growth model, which includes knowledge production, is one of the latest achievements in growth accounting research (Paul,1990). Jones tested Romer's knowledge production function (Charles,2002), and introduced it into neoclassical growth accounting $Y = A^{\sigma} K^{\alpha} \left(L_Y h\right)^{1-\alpha}$:

$$\frac{Y}{L} = \left(\frac{K}{Y}\right)^{\alpha} \bullet \ l_Y \bullet \ h \bullet A^{\frac{\sigma}{1-\alpha}}$$

Among them, l_Y indicates the proportion of employment who are not engaged in scientific research to total employment. On this basis, Fernard and Jones express the knowledge production function as: $\dot{A} = Rf\left(A\right) = \beta RA^{\Phi} = \beta \bullet \left(R \,\&\, D\right) \bullet \ L_W \bullet A^{\Phi}$, introducing the knowledge production function into the neoclassical growth equation $Y = K^{\alpha} \left(\mathrm{A}Lh\right)^{1-\alpha}$ (John and Charles, 2014).

Knowledge creativity is determined by the number of scientists and engineers R, the existing knowledge stock A, and the parameter Φ. The number of scientists and engineers is the product of the propotion of scientists and engineers employed in the world $R\&D$ (representing the intensity of scientific research in the world) and the employment in the world L_W (representing the size of the market). Since the growth rate g of steady state A is constant, denote $\gamma = 1/\left(1-\Phi\right)$, then $g = \frac{\dot{A}}{A} = \beta RA^{(\Phi-1)} = \frac{\beta R}{A^{(1-\Phi)}} = \beta\left(\frac{R^{\gamma}}{A}\right)^{(1-\Phi)}$, this means that there is a γ such that $\gamma = g/\left(\frac{\dot{R}}{R}\right)$. Therefore, the parameters γ can be calculated. In this way, the spillover effects, the intensity of world scientific research, and the world's employment are introduced into the accounting equation, which may be called the FJ model:

$$\frac{Y}{L} \approx \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} \bullet h \bullet (R\&D)^{\gamma} \bullet L_w^{\gamma} \tag{1}$$

The output per labor *Y/L* is determined by the ratio of capital output *K/Y*, the number of years of education per capita *h*, the world's scientific research intensity *R&D*, and the number of employments in the world L_W. The elasticity of scientific research output γ measures the spillover effect of scientific research, and when the old knowledge is eliminated at an accelerated pace, the spillover effect of new knowledge and creativity increases.

The FJ model decomposes the U.S. per capita output from 1950 to 2007 into Solow (capital), Lucas (education), R/AH/GH (scientific research), and J/K/S (market size), and the four types of factors contribute 100% to the growth of per capita output. By eliminating the accounting surplus, the FJ model avoids the subjective setting of total factor productivity and is of great value for economic forecasting, and because it can include the previous major growth theories, the FJ model is labeled as a "unified" growth accounting.

From China's experience, there is room for improvement in the FJ model. The FJ model examines the ratio of total output to the number of hours worked by employed persons from 1950 to 2007. The assumption that there is no dependant population is not entirely due to data availability, but also to the implications of labor input at different stages of growth. Before industrialization, the self-employed economy accounted for an absolute proportion, and every surplus population had to work, and there was no clear distinction between employment and unemployment, work and retirement, and the economic significance of population and labor was not very different. It is not until the industrial economic stage, when clear labor relations are developed, that there is a clear distinction between employment and unemployment, work and retirement, so employment is a concept that emerged during the Industrial Revolution. The prevalence of child labor and the short life expectancy are also important reasons for the population to be the labor. For advanced economies, labor input can be abstracted into homogeneous working hours, but for economies in the dual stage, although surplus labor is counted as employment, it does not contribute 100% of labor input, so the introduction of total employment into growth accounting will reduce the contribution rate of labor to economic growth and reduce the accuracy of international comparison. This is an important issue that is often overlooked in existing studies. Therefore, this paper makes the following modifications to the FJ model: the actual employment *L* is expressed as $L = (POP \bullet EP)/(1+DR)$, *POP* is the number of people, *DR* is the dependency ratio, and *EP* is the labor employment rate. Then we can get:

$$\frac{Y}{POP} = \frac{1}{1+DR} \bullet EP \bullet \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} \bullet h \bullet \left(R\&D\right)^{\gamma} \bullet L_w^{\gamma} \tag{2}$$

3.2. Two Types of Growth

3.2.1. Malthusian Growth of Constant Per Capita Income

Equation (2) has two extensions compared to the FJ model: Malthusian-type growth and Lewis growth. Malthusian growth refers to the fact that any disturbance conducive to higher output is short-lived, and that output higher than subsistence will lead to higher birth rates and lower mortality rates, which will lead to higher dependency ratios, which in turn will lead to deterioration of population-land relations. As a result, the intensification of land pressure will eventually bring per capita output back to an equilibrium level that is barely sufficient for subsistence, so that Malthusian growth is characterized by constant per capita output. Simplifying Equation (2), assuming that the parameters other than the dependency ratio are constant, we can obtain the steady-state income level determined by the steady-state dependency ratio:

$$\left(Y / POP\right)^{*} = \delta / \left[1+\left(DR\right)^{*}\right] \tag{3}$$

If the dependency ratio *DR* increases, it will cause *Y/POP* to fall below the steady-state level, that is, below the subsistence level $(Y/POP)^{*}$, and the population *POP* will decrease, thus pulling *Y/POP* back to the subsistence level, that is, the growth of total output and the growth of labor input are synchronized, and the per capita output remains unchanged, which is the so-called Malthusian trap. At the same time, since there is a demographic lower bound of the dependency ratio, it is not possible to increase per capita income in the long term by reducing the dependency ratio. The only way out of the Malthusian trap is to increase the generalized productivity δ, generate economic surplus, reduce mortality, wait for newborns to grow into the labor force, and reduce the dependency ratio, and ultimately increase per capita output.

Assuming that the typical economy is all agrarian during the Malthusian period, the relationship between population and labor is $\left(1+DR\right) = POP \bullet EP / L$, *DR* is the dependency ratio, and *EP* is the labor employment rate. The total output Y_a is determined by labor *L* and farmland *X*, $Y_a = F\left(X,L\right) = min\left\{A \bullet X, B \bullet L\right\}$. Due to technical reasons, it is difficult to change the rate of farmland equipment, and *X/L* can be regarded as a constant *C*. Under the production function with a fixed coefficient,

there is one factor that is in surplus. It depends on whether the historically determined supply of agricultural land is higher or lower than the product of the *B/A* exogenous given labor supply. Here it is clear that there is a surplus of labor, which is Malthus's description of population growth and a fixed amount of land.

Historically, agrarian civilization first appeared in areas with higher quality farmland, and as the population grew, the marginal output of gradually developed farmland decline. As a result, per capita income declines regardless of whether the population grows faster than or equal to the growth of agricultural land. Agricultural output, in addition to consumption, is also used for investment which reclaim of new land. The ratio of output used to reclaim new land to total output is $s = \dot{X} / X$. Then the increase in farmland per capita: $\dot{X} / POP = s \bullet Y_a / (A \bullet POP)$. The growth rate of agricultural land per capita $\hat{x}$ is equal to the growth rate of agricultural land minus the population growth rate *n*: $\hat{x} = \dot{X} / X - n$. Due to the limited ability of each labor force to cultivate agricultural land (the rate of agricultural land equipment remains constant), new agricultural land can only be cultivated with the newly added labor force: $x\dot{L} = \dot{X}$, this means that the per capita growth rate of farmland is zero, get $\dot{X} = X \bullet n = POP \bullet s \bullet Y_a / A$. Steady-state population growth is synchronized with income growth:

$$\frac{Y_a}{POP} = \frac{A \bullet C \bullet EP}{s} \bullet \frac{n}{1+DR} = \frac{A \bullet C \bullet EP}{1+DR} = \frac{\delta}{1+DR} \tag{4}$$

Equation (4) can be seen as a supplement to Equation (3). If productivity cannot be raised, the increase in the population growth rate *n* will be offset by the increase in the savings rate *s*, and any increase in the population growth rate *n* (an increase in the new population) will lead to the increase in the dependency ratio *DR*, which will eventually depress per capita income. This leads to Malthusian stagnation: the growth of aggregate output and population are synchronized, and the level of per capita income remains basically the same, and this mechanism of the Malthusian growth stage is like an automatic stabilizer of per capita income.

The introduction of Malthusian growth is a necessary condition for long-term growth accounting. From the above deduction, it can be seen that the Malthusian mechanism is not ineffective in contemporary times, but takes a back seat to a secondary position due to the large increase in generalized productivity δ, and in this sense, the dual structure is not ineffective after the commercialization point, but also takes a back seat to a secondary position. This is the logical basis for constructing a formally consistent growth accounting equation suitable for different stages of development. Importantly, the characteristic result of the Malthusian mechanism is that

per capita income remains unchanged in the long run, that is, it is manifested as the fluctuation of per capita income, which is in line with the author's basic judgment on the impact of demographic transition: demographic dividend and population debt occur alternately, and the impact is cyclical rather than trending.

3.2.2. Lewis Growth after Agriculture Involution

Whether an economy's demographic changes conform to the law of demographic transition can be used as a criterion to determine whether population growth is caused by disturbances of special or cyclical factors, or whether it is a demographic transition with a long-term trend linked to economic development. When a long-term trend occurs, the characteristics of population growth are fundamentally different from those of the Malthusian period, that is, the number of dependents increases at the same time as the number of providers increases, thus preparing for Lewis type growth. Considering the case where productivity can be increased to $A' > A$ all at once. At the steady state of the Malthusian stage $L^* = Y_a^* / (A \bullet C)$, due to the increasing of productivity, per capita income increase from y^* to $A' \bullet C$. However, this short-term increase in per capita income would set in motion the Malthusian process. Since the per capita income is now higher than y^*, the population is starting to increase, which will bring the per capita income back to y^*. At this point, although per capita income does not change before and after productivity increases, the population size increases because the steady-state L^* is a function of productivity A. This is the population growth shown at the beginning of the permanent demographic transition, as well as the accumulation of a large amount of labor within agriculture. This is manifested in a decline in the labor employment rate EP in a given historical period. Deform Equation (4) as follows:

$$EP = \frac{Y_a \bullet (1 + DR)}{A \bullet C \bullet POP} \tag{5}$$

First, the expansion of agricultural land is limited by natural boundaries, and X does not change. Since the total size of farmland remains unchanged, the scale X/C of the necessary labor force for agriculture is also unchanged due to the limitation of the equipment rate of farmland. In contrast to the Malthusian trap state, the involution demographic transition begins to show surplus labor, that is, the difference between labor force L and agricultural necessary labor force X/C. In short, the demographic transition is a prerequisite for the formation of the dual structure, and of course the curtain call for Malthusian growth. From the perspective of the employment market, the working-age population L_{EP} can be divided into three parts. The first is the labor L_a necessary to maintain agricultural production, the second is the labor L_m absorbed

by the non-agricultural sector, and the third is the surplus labor L_u. In the process of non-agricultural conversion, the proportion of L_m increases, the proportion of L_u decreases, and the labor employment rate $EP = \left(1 - L_u / L_{EP}\right)$ continues to increase. Before the Lewis inflection point, the capital-output ratio *K/Y* is growing at a very slow rate, and the continuous increase in labor employment and the resulting capital super-accumulation are the main factors driving economic growth. If Equation (2) is simplified, it is assumed $\delta = \frac{POP}{1+DR} \bullet h \bullet \left(R\&D\right)^{\gamma} \bullet L_W{}^{\gamma} \bullet L_D{}^{\gamma}$ does not change over time, there are:

$$Y = \delta \bullet \left(1 - L_u / L_{EP}\right) \bullet \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} \tag{6}$$

That is, capital accumulation, the share of factor remuneration, and surplus labor together determine the change of aggregate output. The faster the accumulation of capital, the higher the share of capital returns, the smaller the number of surplus labor, and the faster the economy will grow. When surplus labor is reduced to zero, and the labor employment rate reaches a steady-state level determined by both the natural rate of unemployment and the labor participation rate, the economy enters the Solow neoclassical stage. Finding the marginal return on capital for Equation (6), obatin:

$$MPK = \alpha \bullet \delta^{1-\alpha} \bullet \left(\frac{K}{EP}\right)^{\alpha-1} \tag{7}$$

In general, the marginal return on capital tends to decrease as capital accumulates, but economies with the dual growth model tend to have higher growth rates. Equation (7) shows that the increase of the labor employment rate contributes to the increase of the marginal return on capital. Under the same conditions, different economies may grow at very different rates due to different levels of change in the rate of labor employment. Under the dual growth model, the labor employment rate $EP = \left(L_a + L_m\right) / \left(L_a + L_m + L_u\right)$. The increase of *EP* is mainly the result of the expansion of the non-agricultural employment L_m and the contraction of the surplus labor L_u. When the surplus labor L_u shrinks to a stable level (determined by the labor participation rate), the transferable surplus labor disappears, and the commercialization point arrives, entering neoclassical growth. After that, the expansion of non-agricultural employment will have to compete with agriculture for labor. The amount of labor that agriculture can transfer depends on the rate at which agricultural productivity

increases, or the availability of imported food, provided that the food supply is stable. As a result, it can be observed that East Asian economies that have undergone the dual stage in the post-war period have a high dependence on food imports and a rapid rate of increase of agricultural productivity. This is in line with the previous idea that the theory of comparative advantage can replace the concept of surplus labor.

4. Validation of the Applicability of the Growth Accounting Model

Because of the large disparities in the level of development among economies, some latecomers retain some important characteristics of the earlier growth stage, which are covered by the national accounts established since the 1940s. In order to validate the growth accounting model, this paper calculates the growth of 20 economies, including the G20 economies (excluding the European Union) and Taiwan, China, after considering the quality of the data. China (excluding Hong Kong, Macao and Taiwan), South Korea and Taiwan, China have had obvious dual structural characteristics since 1960. The United Kingdom, Germany, France, the United States and Canada are selected to illustrate that the accounting equation is applicable even in advanced economies without dual structural characteristics during the observation period. Brazil, India and Russia are selected to compare the growth characteristics of different types of developing economies. The accounting of the endogenous growth model requires the world's scientific research and employment data, and these 20 economies account for more than 60% of the population and more than 80% of the GDP, which meets the accounting needs. Data are compiled from national statistical departments, the World Bank's WDI and Penn World Tables, and refer to the data from FAO and *Palgrave Historical Statistics*. The stock of physical capital is obtained using the perpetual inventory method. The average number of years of education of the labor force is calculated according to the composition of the educational level of the employed persons. World investment in scientific research is the weighted sum of the number of scientists and engineers in the 20 economies. Data for scientists and engineers are derived from World Development Indicators and Science and Engineering Indicators, as well as statistics for economies. Missing data are estimated using Jones's method.[1] The elasticity of capital output is the average of the share of capital returns over the observation period, according to the algorithm of Fernald and Jones (Table 1).[2] The results of Equation (2) are shown in Table 2.

[1] The growth rate of the number of scientists and engineers in the United States is the proxy for the growth rate of scientists and engineers in other economies with missing data.

[2] Among them, the early years data of India are not available, and in recent years the value is around 0.5, so it is set to 0.5.

Table 1. Elasticity of Capital Output and Scientific Research Output: 1960–2016

	Elasticity of capital output	Elasticity of scientific research output		Elasticity of capital output	Elasticity of scientific research output
Brazil	0.474	0.112	Japan	0.494	0.507
Canada	0.338	0.235	Korea	0.523	0.846
China (excluding Hong Kong, Macao and Taiwan)	0.497	0.937	Russia	0.413	0.072
France	0.345	0.470	United Kingdom	0.389	0.342
Germany	0.325	0.441	United States	0.375	0.304
India	0.500	0.393	Taiwan, China	0.451	0.825

Table 2. GDP Per Capita Growth Rate and Its Sources (1960–2016)

	GDP per capita	Malthus	Lewis	Solow	Lucas	R/AH/GH	J/K/S
Brazil	2.07	0.46	0.25	0.45	0.45	0.27	0.19
	100%	22%	12%	22%	22%	13%	9%
Canada	2.06	0.25	0.49	0.06	0.28	0.56	0.40
	100%	12%	24%	3%	14%	27%	20%
China (excluding Hong Kong, Macao and Taiwan)	6.38	0.44	0.90	0.87	0.32	2.24	1.61
	100%	7%	14%	14%	5%	35%	25%
France	2.40	0.01	0.11	0.06	0.28	1.12	0.81
	100%	0%	5%	3%	12%	47%	34%
Germany	2.46	–0.04	0.33	0.04	0.32	1.05	0.76
	100%	–2%	14%	1%	13%	43%	31%
India	3.10	0.27	0.23	0.65	0.32	0.94	0.68
	100%	9%	7%	21%	10%	30%	22%
Japan	3.05	–0.10	0.36	0.58	0.13	1.21	0.87
	100%	–3%	12%	19%	4%	40%	29%
Korea	5.88	0.56	0.71	0.69	0.45	2.02	1.46
	100%	9%	12%	12%	8%	34%	25%
Russia	0.71	0.12	–0.07	–0.02	0.38	0.17	0.12
	100%	17%	–10%	–2%	53%	24%	18%
United Kingdom	1.99	–0.03	0.18	0.13	0.31	0.82	0.59
	100%	–1%	9%	6%	16%	41%	30%
United States	1.96	0.16	0.23	0.01	0.30	0.73	0.52
	100%	8%	12%	0%	15%	37%	27%
Taiwan, China	5.75	0.61	0.40	0.75	0.60	1.97	1.42
	100%	11%	7%	13%	10%	34%	25%

Note: The observation period is from 1990 to 2016 for Russia and 1960 to 2016 for other economies.

From 1978 to 2010, Malthusian growth contribute 0.79 percentage points and Lewis growth contribute 0.97 percentage points. After 2010, the dependency ratio change from the decline to the increase, with Malthusian growth contributing negative 0.84 percentage points, but the rapid increase of the labor employment rate offset the negative contribution of the dependency ratio, and the two together contributed 0.28 percentage points to the GDP per capita growth rate. According to Equation (2), the dependency ratio is simply linear with GDP per capita, and the demographic dividend in the early stage may be offset by the population debt in the later period, depending on the amplitude and wavelength of the population cycle. This paper calculates that the dependency ratio in China (excluding Hong Kong, Macao and Taiwan) will be about 0.5 in 2035 and 0.68 in 2050, which is equivalent to the level of 1995 and 1980. If an economy makes effective use of this condition during the period when the dependency ratio is declining, achieves higher rate of return on capital and economic growth, and accumulates enough social wealth, then it will be more relaxed to cope with the situation when it enters the period when the dependency ratio is rising, and it is still possible to maintain high savings rate and investment rate and achieve high economic growth rate.

At present, the labor employment rate in China (excluding Hong Kong, Macao and Taiwan) is about 0.69, and there is still a lot of room for improvement. By the time the labor employment rate reached 0.69, the share of agricultural employment in South Korea had fallen to about 6%, and in Japan to 9%. In Japan and South Korea, the conversion rate of rural migrants to employment is low, which is of course related to the shortage of agricultural resources and the forced implementation of stricter agricultural protection policies. China's (excluding Hong Kong, Macao and Taiwan) employment market is more efficient, with better agricultural resource endowments and stronger ability to release labor in agriculture. In the future, relying on the potential energy accumulated by the dual structure, the upper limit of the labor employment rate should be higher.[1] However, it should be noted that the female labor employment rate in China (excluding Hong Kong, Macao and Taiwan) is significantly lower than that of developed countries, and raising the upper limit of the labor employment rate depends on social development. In fact, Japan's current labor employment rate reaches 0.88, the highest among advanced economies, and the ratio of women to men reaches 0.81, much higher than the 70% level in China (excluding Hong Kong, Macao and Taiwan).

[1] During this period, China (excluding Hong Kong, Macao and Taiwan) had such high conversion rate, indicating that the supply of the employment market was relatively tight, and the high proportion of agricultural employment indicated that the flow of labor between urban and rural areas was hindered to a certain extent.

5. The Contribution of the Labor Employment Rate to Medium- and Long-Term Growth

5.1. The Basis for Judging the Stage of China's Economy

The judgment of the growth stage and main growth mode of China (excluding Hong Kong, Macao and Taiwan) is one of the basis for setting the forecast parameters below. In the dual economic theory, the Lewis inflection point is only the beginning of labor shortage and increase in the wages of ordinary workers. After 2012, China's large number of rural labor force continued to move to urban non-agricultural industries, and on the other hand, real wages increased, which should be a phenomenon after the Lewis inflection point, which was no later than 2011.

On the whole, China still has the dual characteristics of dual structure and neoclassical growth. There are three most important empirical supports for this judgment. The first is the labor employment rate. The labor employment rate in advanced economies has been in steady state since the 1960s, and although it has shown upward trend, it is mainly due to the improvement of the employment market rather than the transfer of surplus labor to non-agricultural industries, so the slope of the labor employment rate is small. China's (excluding Hong Kong, Macao and Taiwan) agricultural GDP still accounts for more than 7%, and agricultural employment accounts for more than 20%, and the potential energy of the dual structure will be released for a period of time. The second is the ratio of capital to output. If an economy's capital-to-output ratio increases at a faster rate, then it is likely to be ahead of the commercialization point. After the commercialization point, the economy enters the neoclassical stage, and the capital-to-output ratio should be relatively stable, in line with the description of the Kaldorian facts. The capital-to-output ratio of China (excluding Hong Kong, Macao and Taiwan) is still increasing rapidly, and the share of factor remuneration is still in a period of frequent adjustment, so it can be judged that China (excluding Hong Kong, Macao and Taiwan) is in the growth stage between the Lewis inflection point and the commercialization point. The third is the ratio of capital to labor. According to Kaldor, capital per capita in the neoclassical period is growing at a steady rate. There were no significant fluctuations in the trend of the capital-to-labor ratio in advanced economies from 1960 to 2016. The capital-to-labor ratio in China (excluding Hong Kong, Macao and Taiwan) is clearly accelerating (rather than stabilizing at a rate as Kaldor's fact), indicating that it has not yet entered the neoclassical stage.

5.2. Parameter Settings and Calculation Results

Based on the above judgment of China's growth stage,[1] this paper considers two

[1] China's labor employment rate, agricultural value-added ratio, agricultural employment ratio/agricultural GDP ratio, capital-output ratio, capital-labor ratio.

aspects of the five parameter settings. First, combining with the long-term goals for 2035 and the second centenary goal, especially the goal of reaching the level of moderately developed countries in terms of GDP per capita by 2035, China's capital-to-output ratio should reach the corresponding parameter level by 2050, so the capital-to-output ratio should be set at the long-term level of advanced economies, which is 4. According to the rate of advanced economies, China's capital-to-labor ratio will reach 0.2 by 2050, but according to China's growth rate over the past decade, it will reach 0.1534 by 2050. Given that China's capital-to-labor ratio is accelerating, the upper limit of the rate could be set at 0.0047 at the average annual growth rate of advanced economies, the result could be set at 0.18. Second, based on the relevant research and judgment of urbanization planning, China's agricultural resource endowment and international experience, the proportion of China's agricultural GDP, agricultural employment and labor employment in 2035 and 2050 is set, which reflects the characteristics related to the development stage. The parameter setting of the two aspects is the result of long-term experience of development economics, which forms hard constraint on economic growth forecasting and reduces the interference of subjective factors.

In addition, it is necessary to predict intermediate variables such as population size, dependency ratio, and years of education per capita. The Chinese population and population dependency ratio are projected according to the 1-year-old group. The total fertility rate is set at 1.0, 1.3 and 1.5. On the basis of the total fertility rate of 1.3 in 2020, the birth population is projected to 2050 according to the three set values of the geometric growth rate, and then the birth population is projected according to the fertility situation of women of childbearing age in the 1-year-old group, and the gender ratio at birth is set to decrease from 110 in 2020 to 105 in 2050 according to the geometric growth rate, and the surviving probabilities of the gender-specific 1-year-old group in 2020–2050 provided by the World Population Prospects 2019 of the United Nations Population Division are used. Finally, the total population and the population dependency ratio are calculated. The population and age structure of other economies are based on the results of the 2020–2050 medium scenario projections provided by the United Nations Population Division's World Population Prospects 2019 to obtain the total population and dependency ratios. The number of years of education per capita from 2020 to 2050 is calculated according to the distribution of primary, lower, high, junior college, undergraduate and postgraduate students in each 1-year-old age group, as well as the evolution of the working-age population and willingness to participate in the labor. Considering the postponement of the retirement age, delay the retirement age of 60 with a bachelor's degree and graduate degree to 65, getting the final number of years of education per captia. The share of scientists and engineers in employment is projected to 2050 based on the average annual growth rate of scientists and engineers in employment from 1960 to 2016 in each economy. The parameter settings are shown in Table 3.

Table 3. Parameter Settings and Intermediate Variables

	Total fertility	2020	2035	2050
China's population	1.0	1412120000	1368022270	1256757166
	1.3	1412120000	1379876563	1294157375
	1.5	1412120000	1383579780	1314867322
Total population of 20 economies	1.3	4649217600	4911615420	4965384930
China's population dependency ratio	1.0	0.460	0.489	0.657
	1.3	0.460	0.500	0.682
	1.5	0.460	0.506	0.699
China's average number of years of education	1.0	10.338	11.577	12.070
	1.3	10.338	11.580	12.075
	1.5	10.338	11.577	12.077
China's labor employment rate	–	0.69	0.729	0.80
The proportion of China's agricultural GDP	–	7.7%	3.998%	2.0%
China's share of agricultural employment/share of agricultural GDP	–	3.06	2.523	2.00
China's capital-to-output ratio	–	3.46	3.629	4.00
China's capital–to-labor ratio	–	0.05	0.988	0.18
Proportion of scientists and engineers in 20 economies	1.3	0.484%	0.805%	1.350%

The results are shown in Table 4. Based on the premise of the total fertility rate of 1.3, the average annual growth rate of Chinese GDP per capita will be about 3.4% in 2020–2035, about 3% in 2035–2050, and about 3.2% in 2020–2050. For China, in the GDP per capita growth from 2020 to 2050, the contribution of scientific research is the first, the second is the elimination of the dual structure, the third is capital, and the fourth is education. The contribution of market size and age structure of the population is negative. Aging is an important factor restricting the growth of Chinese GDP per capita. After splitting the dependency ratio into the child dependency ratio and the elderly dependency ratio, it is found that from 2020 to 2050, aging will drag down the average annual growth rate of GDP per capita by 0.35 percentage points, and the contribution rate will be about negative 11%. Considering two possibilities in the future, one is to increase China's total fertility rate to 1.5 by 2050, and the other is to reduce it to 1.0. The results show that changes in the total fertility rate have little impact on GDP per capita growth.

Table 4. GDP Per Capita Growth Rate and Its Sources: 2020–2050

		GDP per capita	Malthus	Lewis	Solow	Lucas	R/AH/GH	J/K/S
Total fertility rate 1.0	2020–2035	3.384	–0.137	0.375	0.310	0.305	2.421	0.109
		100%	–4%	11%	9%	9%	72%	3%
	2035–2050	3.054	–0.711	0.620	0.662	0.122	2.538	–0.176
		100%	–23%	20%	22%	4%	83%	–6%
	2020–2050	3.219	–0.424	0.498	0.486	0.214	2.479	–0.033
		100%	–13%	15%	15%	7%	77%	–1%
Total fertility rate 1.3	2020–2035	3.338	–0.183	0.375	0.310	0.306	2.417	0.112
		100%	–5%	11%	9%	9%	72%	3%
	2035–2050	3.000	–0.765	0.620	0.662	0.122	2.516	–0.154
		100%	–26%	21%	22%	4%	84%	–5%
	2020–2050	3.169	–0.474	0.498	0.486	0.214	2.467	–0.022
		100%	–15%	16%	15%	7%	78%	–1%
Total fertility rate 1.5	2020–2035	3.309	–0.212	0.375	0.310	0.305	2.421	0.109
		100%	–6%	11%	9%	9%	73%	3%
	2035–2050	2.964	–0.802	0.620	0.662	0.124	2.501	–0.141
		100%	–27%	21%	22%	4%	84%	–5%
	2020–2050	3.136	–0.507	0.498	0.486	0.215	2.462	–0.017
		100%	–16%	16%	15%	7%	79%	–1%

In order to explore the impact of the labor employment rate on future economic growth, this paper makes new assumptions about the capital-to-output ratio and the labor employment rate. Based on total fertility rate of 1.3, it is assumed that by 2050, the capital-to-output ratio and the labor employment rate will remain unchanged at 2020 levels, respectively. If the capital-to-output ratio remains unchanged at 2020 levels, the average annual growth rate of GDP per capita from 2020 to 2050 will increase from 3.169% to 3.655%, the increase of 15.3%. If the labor employment rate remains unchanged at the 2020 level, the average annual growth rate of GDP per capita from 2020 to 2050 will fall from 3.169% to 2.671%, the decline of 18.6%. This suggests that the employment market and capital accumulation are equally valid macroeconomic variables. From the perspective of general equilibrium, various growth factors interact with each other to jointly promote economic growth. Most of the economies with higher incomes than China have higher capital-to-output ratios than China, and based on their experience, China's rate of return on capital will gradually decline. However, China's dual structure makes it possible to delay the decline of the rate of return on capital. The accumulation of capital will increase the marginal productivity of labor, wages will rise, and subsequently the dual structure will accelerate the release of labor and promote faster economic growth.

6. Conclusions

One of the achievements of neoclassical growth theory is that it illustrates the first five canonical facts of Kaldo with only a simple model, conveniently describes the production possibility boundary in terms of the production function and several inputs that are freely substituted for each other, and is able to verify it with simple data. It provides a benchmark against which to compare the progress of growth theory. Nonetheless, China's facts show that growth theory should cover wider range of areas, taking the role of demographic transition and dual structures into account.

Under the traditional neoclassical accounting framework, the accounting method uses aggregate indicators such as capital and labor, and lacks structural indicators, which makes the total population and working-age population of China decrease, and the accounting conclusion is that the marginal return on capital decreases due to the decrease of labor input, so the policy recommendations for increasing the economic growth rate can only focus on improving total factor productivity. This paper constructs growth accounting equation that introduces the labor employment rate and finds that by eliminating the dual structure, there is still large space to increase the input of traditional production factors and expand the employment capacity, which is an important source of future economic growth.

The method proposed in this paper to calculate the contribution of the dual structure to economic growth can not only enable the data of developed economies to be included in it and obtain similar accounting results as those of previous studies, but also enable developing economies such as China to show the growth characteristics of the dual structure, which is convenient for international comparison and judgment of the development stage and advantages. Taking the trend increase of labor employment rate as an abstract feature of the dual stage, the equation does not change the form with the change of the development stage, which is also conducive to the integration of the dual economic theory and the unified growth theory. The introduction of the dependency ratio and the labor employment rate into the growth accounting is conducive to measuring the impact of demographic transition and dual structure on economic growth, especially to further understand the cyclical characteristics of the demographic dividend and the one-time characteristics of the dual structure dividend.

Once the demographic transition and the dual structure are introduced into growth accounting, it is easy to understand the two important facts of how Malthusian growth turns into Lewis growth and how to obtain the demographic dividend: the demographic dividend is a cyclical phenomenon of Malthusian growth, and the dual structure is a one-time dividend in the process of industrialization. Therefore, it is necessary to continue to remove the obstacles that hinder the flow of labor and increase the labor employment rate in order to reap this dividend. Moreover, according to international experience, when entering period of negative population growth, it is necessary to

pay special attention to expand the employment capacity to hedge the impact of the Malthusian cycle.

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