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# The Effect of Labor Reallocation and Economic Growth in China

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**Abstract:** In recent years, China's economic growth rate has slowed down significantly, exceeding the normal range of cyclical fluctuations in terms of declining rate and period. However, the research on the structural problems of the economic slowdown from the sector level is still limited. This paper uses a novel index decomposition method to decompose the covariant effect according to the influence of factors. It separates the labor input effect (LIE), labor reallocation effect (LRE), and labor productivity effect (LPE) from China's economic growth rate from 1989 to 2019. The evolving characteristics and influence of these effects are revealed. It also focuses on the structural problems of the economic slowdown caused by the LRE. The study found that: (i) the economic contribution rate of LIE declined during the study period and had recently shown a negative value; (ii) the economic contribution rate of LRE peaked in 2014 and then rapidly declined; (iii) LPE has always been an essential contributor to China's economic growth, with an annual contribution rate of 80%. The key factors behind China's downward economic growth are the decline of the new labor force input, the weakening of LRE, and the technological progress rate in some sectors that have declined. The analysis of the LRE found that 37% of the economic slowdown could be explained by it. The reason behind economic slowdown lies in how the labor force transfers: (i) from agriculture to non-modern services without manufacturing; and (ii) from high-productivity sectors (usually manufacturing) to low-productivity sectors (usually non-modern services). In order to reduce the downward pressure of economic growth, future development intervention measures should focus on improving the employment absorption capacity of manufacturing, enabling enterprise innovation, correcting distorted industrial development policies, and prudently treating environmental protection policies and industrial upgrading policies.

**Keywords:** economic growth rate; structural transformation; labor reallocation; labor productivity; manufacturing; non-modern services; development policy; developing economies



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## 1. Introduction

The labor reallocation effect can be defined as an output change, the difference in output obtained by allocating the same labor in different sectors due to productivity. When this effect is facilitated by the transfer of labor from low-productivity to high-productivity sectors, it usually results in economic growth. This growth mechanism has always been valued by scholars [1–6] and is generally considered an essential contributor to China's growth miracle [7–12]. Behind China's average annual growth rate of 9.4% in the past 30 years is precisely the large-scale transfer of agricultural labor to non-agricultural sectors, with over 200 million laborers realizing a non-agricultural transformation. However, the foundation on which this growth miracle depends may have changed. With the continuous non-agriculturalization, the proportion of non-agricultural employment in China reached

75% in 2019 (Figure 1). At present, the transfer of the industrial labor force to the service has become a significant trend of employment change in China [13].

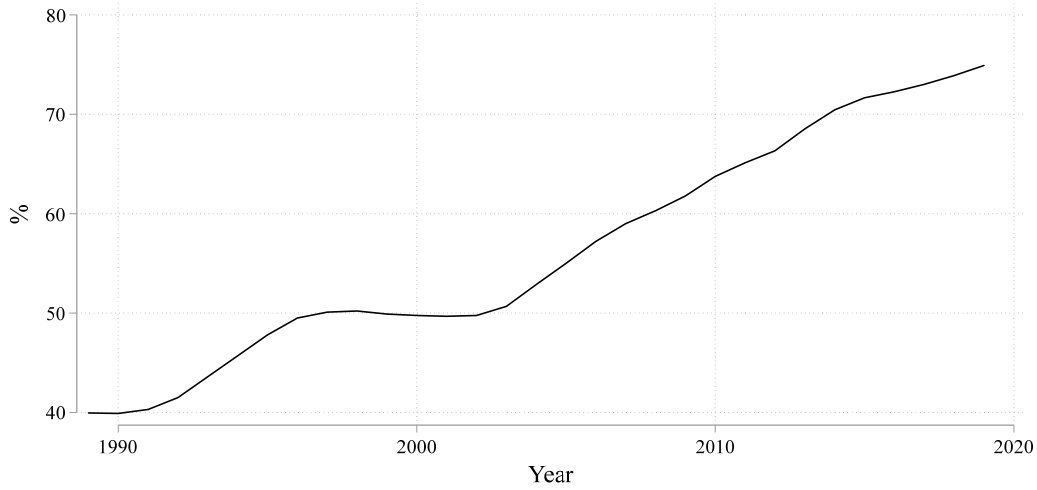


**Figure 1.** The ratio of non-agricultural employment to total employment in China, 1989 to 2019. Note: The data are obtained from the statistical yearbooks of China and its provinces and are calculated by the authors.

As Figure 2 shows, China's economic growth rate began to slow after peaking at 14.2% in 2007, to less than 6% in 2019. The government and domestic scholars have called this state of slowdown development China's "New Normal." However, more and more students and policymakers believe that the slowdown in China's economic growth rate exceeds normal cyclical fluctuations and is a permanent supply-side driven economic slowdown [14]. As an essential part of the supply, labor may significantly impact the economic slowdown. This study focuses on the impact of labor factors on China's economic growth, especially the impact of labor reallocation. The possible marginal contribution of this paper is to construct the employment and output data set of China's sub-sectors and deconstruct the mechanism of labor effect affecting economic growth based on the sector perspective, which will make up for the deficiencies of the existing research mostly from agricultural–non-agricultural, or three industry analysis. Given the size of China's labor force and the size of the economy, the conclusions of this paper may help to illuminate the future economic trends of China and the world.

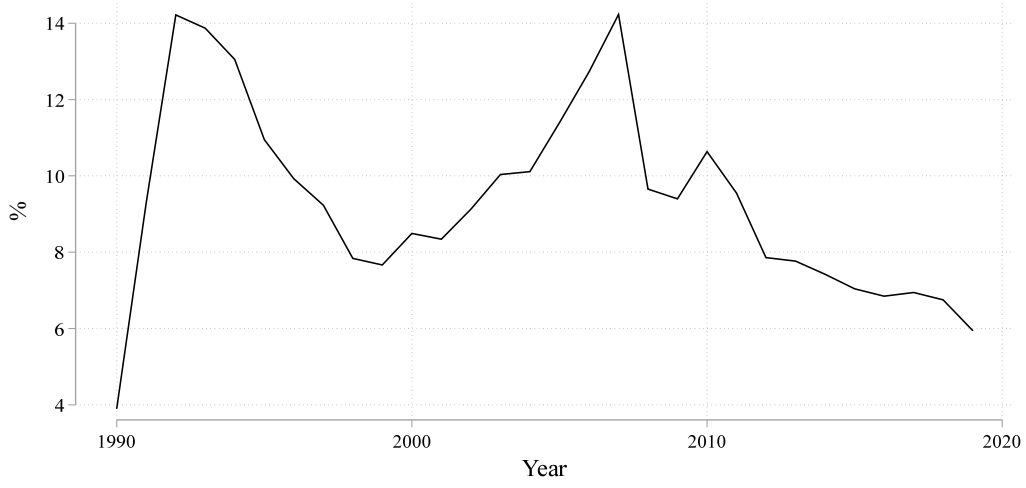


**Figure 2.** China's annual growth of GDP, 1990 to 2019. Note: The data are obtained from the statistical yearbooks of China and its provinces and are calculated by the authors.

The article is structured as follows. The following section is a literature review. In Section 3, we introduce the index decomposition method. Section 4 introduces the sources of the data and their processing methods. The results are presented in Section 5, and Section 6 discusses the study's findings. Conclusions are drawn in Section 7.

## 2. Literature Review

Gollin et al. found that labor productivity in non-agricultural industries is generally two to three times higher than that in agriculture, even in developed economies [15]. In other words, the reallocation effect of labor transfer from agriculture to non-agriculture will inevitably promote economic growth. However, if we only consider labor reallocation among non-agricultural industries, the answer is not the only one. The non-agricultural industry includes a wide range of sectors. Although it is generally more productive than agriculture, there is a significant disparity in production efficiency among different sectors. Different labor transfer directions bring different economic growth effects [16].

Rodrik's study found that the manufacturing industry has a strong convergence of labor productivity [17] and is an escalator for the economic development of backward countries. However, the premature separation of the labor force from manufacturing has resulted in slow economic growth in Latin American and African economies [18]. In other words, manufacturing's ability to absorb employment will significantly impact economic growth. On the other hand, from the research of Baumol [19], it can be seen that the transfer of employment to the traditional service may harm economic growth due to the difficulty in improving its production efficiency. These viewpoints indicate that sectors' economic growth performance achieved by different labor reallocation modes is quite different.

Although researchers have reached a consensus on the slowdown of China's economic growth, their understanding of the causes of the slowdown is quite different. The most discussed issues are the decline in the growth rate of labor supply [20–22], the slowdown in capital accumulation, and technological progress [23–26]. Some students began to pay attention to the negative impact of labor allocation on economic growth [27–29]. We re-examined this kind of literature to better understand the contribution of various factors of China's economic growth and explore possible vital omissions.

From the perspective of rural labor mobility, the authors of [27,29] judge that the labor reallocation effect harms China's economic growth based on China's population structure changes. However, this does not offer an accurate quantitative description. The author of [28,30] investigates the three effects of the labor force in China based on the three industrial classifications, a rare quantitative description of the changes in the three effects. However, his method cannot reveal the heterogeneity existing in non-agricultural sectors. In the existing research, the common problem is that the research perspective is mainly focused on the labor transfer from agriculture to non-agricultural industries [31,32], rural to urban labor transfer [27,33], and labor transfer among the three industries [34]. These research paradigms do not involve detailed sectors divisions. It is difficult to accurately reveal the impact of labor structure on economic growth [16], especially the negative impact of labor reallocation on economic growth. Meanwhile, some researchers can judge that China has entered the stage of weakening the labor reallocation effect according to the development stage [7,10,22,34]. However, due to the dualization or analysis of the three industries only, the reasons for weakening the labor reallocation effect cannot be explained precisely.

In addition, there is controversy surrounding the quantitative analysis of the impact of labor reallocation on economic growth. For example, Cao et al. and Dekle et al. estimate that labor reallocation promotes China's economic growth by approximately 1.5–2% per year [31,35], Ye et al. estimates that the effect of labor reallocation in China has decreased from the peak average of 1.76% per year to only 0.25% per year at present [36]. In contrast, Cao et al. and Bulman et al. consider that labor reallocation contributes little to China's economic growth [37,38].

There are two reasons for this situation. One is the limitation of research data provided by the above-mentioned sector classification methods, especially binary classification; the other is the short period of the research data. China's economic growth rate did not show an inflection point until around 2013–2015. Only the latest changes provide a sufficiently long time series to comprehensively summarize the impact of labor reallocation on China's economic growth.

Given the above analysis, based on the perspective of structural change, this paper uses the index decomposition method to decompose the covariant effect according to the proportion of factors; measures the labor effect including labor input, labor reallocation, and labor productivity; focuses on the development and evolution characteristics of labor structure effect in China's economic growth from 1990 to 2019 and its contribution to China's economic growth; and tries to clarify the structural problems of China's recent economic slowdown. We eliminate the limitation of industry dualism commonly used in the literature, and study the impact of the labor force structure effect on China's economic growth rate from a more detailed sector division, which is of more referential significance to explore economic growth potential, formulate sustainable economic growth policies, and realize the sustainable development of the regional economy. At the same time, it is also of referential significance to policymakers in developing countries in formulating policies on the regional development of the labor force.

## 3. Methodology

Separating structural effects from economic growth is a difficult point in growth accounting. Maddison was the first to propose to separate the labor force structure effect from the labor productivity growth rate by the index method [39], which was popularized and used by subsequent research [40,41]. However, this method only separates the labor structure effect in the labor productivity growth, not the labor structure effect in the economic growth. In addition, this decomposition method does not provide a decomposition method for the factor interaction term. In estimation, the influence effect of each factor in the interaction term cannot be distinguished, which results in overestimation or underestimation of the influence effect of a single factor [20].

Massell was the first to propose the use of the differential method to separate the labor structure effect and capital structure effect from the total factor productivity growth rate [42]. Unfortunately, the output elasticity coefficient of labor and capital in each sector is the same, which is far from the actual situation and is challenging to be accepted by similar research. Subsequent studies, such as [43–45], improved the output elasticity of various sectors and capital to a certain extent but failed to solve the problem of determining the output elasticity coefficient of labor and capital. For example, Denison divided the production sector into agricultural and non-agricultural sectors; the labor output elasticity coefficient of the agricultural sector was indirectly calculated according to the definition. In contrast, the labor output elasticity coefficient of the non-agricultural sector was replaced by the labor proportion of national income, resulting in inconsistent elasticity coefficients [43]. In addition, according to the research of Denison, the core variable of labor force structure effect is the rate of change of labor force proportion in each industry, which corresponds to the output elasticity coefficient of labor force proportion, rather than the output elasticity coefficient of labor force [44]. The two are quite different, which presents another problem: the differential method cannot separate structure effect from economic growth.

The research ideas provided by the index method are convenient. The fundamental difficulty lies in the decomposition of the interaction term, i.e., covariant effect. One desirable method is to use the incremental analysis method of index [28,30,46], decomposition economic growth rate and labor productivity change rate, and decompose the covariant effect according to the proportion of factors to separate the labor force structure effect in economic growth. We call this method the index decomposition method. From the labor force perspective, the GDP can be expressed as the product of labor force and labor productivity. With Y, L, and P representing the total output, employment, and labor productivity of the

economy, respectively; superscripts 0 and $t$ representing the base period and the end period respectively; and $\dot{Y}$, $\dot{L}$, and $\dot{P}$ representing the change rate of total output, employment, and labor productivity during the investigation period respectively, the decomposition formula of economic growth rate is obtained:

$$\dot{Y} = \frac{Y^t - Y^0}{Y^0} = \frac{P^t L^t - P^0 L^0}{P^0 L^0} = \frac{L^t - L^0}{L^0} + \frac{P^t - P^0}{P^0} + \frac{P^t - P^0}{P_0} \cdot \frac{L^t - L^0}{L^0} = \dot{P} + \dot{L} + \dot{P}\dot{L} \quad (1)$$

Suppose the economic growth rate is decomposed according to the idea of Formula (1); $\dot{P}_i$ represents the change in labor productivity in sector $i$ (the sector segmentation approach adopted in this paper is described in Section 4.4.), $\dot{R}_i$ represents the change in employment proportion in sector $i$, and $y_{i0}$ represents the base period output proportion in sector $i$, the expression for the cumulative growth rate of labor productivity $\dot{P}$ is as follows:

$$\dot{P} = \frac{P_t - P_0}{P_0} = \frac{P_{i0}R_{i0}}{P_0} \times \frac{\sum P_{it}R_{it} - \sum P_{i0}R_{i0}}{P_{i0}R_{i0}} = \sum\left(y_{i0}\dot{P}_i\right) + \sum\left(y_{i0}\dot{R}_i\right) + \sum\left(y_{i0}\dot{P}_i\dot{R}_i\right) \quad (2)$$

On the right side of the Formula (2), $\sum\left(y_{i0}\dot{P}_i\right)$ represents the labor productivity effect, $\sum\left(y_{i0}\dot{R}_i\right)$ represents the labor transfer effect, and $\sum\left(y_{i0}\dot{P}_i\dot{R}_i\right)$ is the interaction of the two effects. Bring the Formula (2) into the Formula (1) and the economic growth rate formula is rewritten as follows:

$$\dot{Y} = \sum\left(y_{i0}\dot{P}_i\right) + \sum\left(y_{i0}\dot{R}_i\right) + \sum\left(y_{i0}\dot{P}_i\dot{R}_i\right) + \dot{L} + \dot{L}\left[\sum y_{i0}\dot{P}_i + \sum y_{i0}\dot{R}_i + \sum\left(y_{i0}\dot{P}_i\dot{R}_i\right)\right] \quad (3)$$

Decomposition of interaction term $\dot{P}\dot{L}$ according to a contribution rate of influencing factors:

$$\dot{Y} = \dot{P} + \dot{L} + \dot{P}\dot{L} = \dot{L} + \dot{P}\dot{L} \times \frac{\dot{L}}{\dot{P}+\dot{L}} + \dot{P} + \dot{P}\dot{L} \times \frac{\dot{P}}{\dot{P}+\dot{L}} + \frac{\dot{Y}\dot{P}}{\dot{P}+\dot{L}} \quad (4)$$

$$\dot{P} = \sum\left(y_{i0}\dot{P}_i \times \frac{\dot{P}_i+\dot{R}_i+\dot{P}_i\dot{R}_i}{\dot{P}_i+\dot{R}_i}\right) + \sum\left(y_{i0}\dot{R}_i \times \frac{\dot{P}_i+\dot{R}_i+\dot{P}_i\dot{R}_i}{\dot{P}_i+\dot{R}_i}\right) \quad (5)$$

Substituting the expression of (5) productivity into (4), the sectoral decomposition formula of economic growth rate is finally obtained:

$$\dot{Y} = \underbrace{\frac{\dot{Y}\dot{L}}{\dot{P}+\dot{L}}}_{\text{Labor Input Effect}} + \underbrace{\frac{\dot{Y}}{\dot{P}+\dot{L}}\sum\left(y_{i0}\dot{R}_i \times \frac{\dot{P}_i+\dot{R}_i+\dot{P}_i\dot{R}_i}{\dot{P}_i+\dot{R}_i}\right)}_{\text{Labor Reallocation Effect}} + \underbrace{\frac{\dot{Y}}{\dot{P}+\dot{L}}\sum\left(y_{i0}\dot{P}_i \times \frac{\dot{P}_i+\dot{R}_i+\dot{P}_i\dot{R}_i}{\dot{P}_i+\dot{R}_i}\right)}_{\text{Labor Productivity Effect}} \quad (6)$$

As shown in Formula (6), the connotation of the labor reallocation effect in this paper is the economic growth caused by the transfer of labor among different sectors due to the increase in the proportion of labor in sectors with higher labor productivity. Similarly, labor productivity effect refers to the economic growth created by the improvement of labor productivity in the sector.

## 4. Dataset Collection and Pre-Processing

### *4.1. Data Source*

This study contains two types of data: employment and added value. The data are mainly collected from the Compendium of Statistics for the Sixty Years of New China (1949–2008), China Statistical Yearbook (1990–2020), China Township Enterprises Statistical Yearbook (1989–2006), China Township Enterprises, Agricultural Products Processing Industry Yearbook (2007–2014), China Industrial Statistics Yearbook (1990–2020), and China Economic Census Yearbook (2004, 2008, 2013, and 2018).

### *4.2. Employment Data*

Currently, available employment data in China include total, urban, and rural employment, and three strata of industry employment. The employment data by sector are not comprehensive, only involving (I) industrial and commercial registered employed persons in private enterprises and self-employed individuals (ICEPS) and (II) the employment of urban non-private units (Table 1). There is a significant difference between the total employment of the two and the total employment of the whole country. This part of the difference is the employment of agriculture and some township enterprises. The reason why "some" of the employment of township enterprises is emphasized here is that the employment of township enterprises includes private and self-employed employment in the countryside, but statistics are different in different periods. In the national ICEPS, only urban ICEPS are further classified by sector, and rural ICEPS are not classified, but rural ICEPS can be obtained through calculation. In China's statistical data, the rural areas refers to the villages and towns excluding county governments stationed, while the urban areas refers to higher-level administrative areas except the rural.

**Table 1.** Employment by sector. Data published in China's statistics.

| ISIC Rev 3 | Urban Non-Private Units | Private And Self-Employed |
|---|---|---|
| | Total Employment | Total Employment |
| A | Agriculture, Forestry, Animal Husbandry and Fishery | —— |
| B | Mining | —— |
| C | Manufacturing | Manufacturing |
| D | Production and Supply of Electricity, Gas and Water | —— |
| E | Construction | Construction |
| G | Transportation, Warehousing, Post and Telecommunications | —— |
| F | Wholesale and Retail Trades | Wholesale and Retail Trades |
| H | Accommodation and Catering Services | Accommodation and Catering Services |
| I | Information Transmission, Software and Information Technology | —— |
| J | Finance Intermediation | —— |
| K | Real Estate | —— |
| L | Leasing and Business Services | Leasing and Business Services |
| M | Scientific Research and Technical Services | —— |
| N | Management of Water Conservancy, Environment and Public Facilities | —— |
| O | Services to Households, Repair and Other Services | Services to Households, Repair and Other Services |
| P | Education | —— |
| Q | Health and Social Work. | —— |
| R | Culture Sports and Entertainment | —— |
| S | Public Management, Social Security and Social Organization | —— |

Note: "——" indicates that this item is not included in the statistics.

Based on the characteristics of the above statistics, we consolidated the data of various sectors. As there are no statistics on employment of public utilities in rural areas, compared with the employment of public utilities in urban areas which accounts for 3‰ of the permanent population in urban areas, and considering the relatively poor infrastructure, we estimate the employment of public utilities in rural based on the total population of 2‰. Since the township enterprises only count the employment in the mining above designated size after 2002 and considering the background of China's increasingly stringent environmental protection policies, we estimate the employment in mining under regulations in different periods in China by combining the data from the China Industrial Statistics

Yearbook and the Asian Productivity Organization (APO). In 2002–08, 2009–12, and 2013-19, 25%, 15%, and 10%, respectively, were multiplied by the employment in the mining above designated size to obtain the employment in mining below designated size.

Informal employment in urban areas is an integral part of urban employment. Due to job instability, temporary employment, labor dispatch, and other reasons, enterprises often do not record such employment in the statements and therefore are not counted by sector data [26]. Overall, the informal employment in urban China has been decreasing, from 110 million at the peak in 2010 to 8.27 million in 2019. Considering that this part of employment is mainly distributed in manufacturing (C), construction (E), wholesale and retail trades (F), accommodation and catering services (H), services to households, repair, and other services (O), this study breaks down "informal employment" based on these five relative proportions in urban employment and aggregates them into corresponding sectors.

We use the average value of adjacent years' data for smoothing for outliers. However, due to the change in China's statistical system, the employment growth in 1990 was much higher than that of the adjacent years. As this is the starting year of the study, it does not affect the subsequent analysis of changes, and we do not smooth it. We have also made the last necessary adjustment for the aggregated employment data by sector, i.e., to ensure that when different attributes aggregate the employment data, the results are consistent with the total employment, employment by urban and rural areas, and employment by three industries.

### *4.3. Added Value Data*

In order to make the data closer to the actual situation, we processed the nominal value-added data of China and calculated the real output data excluding the influence of price changes by using the price index of different sectors. The key steps involve the following aspects.

The first is the acquisition and processing of the price index by sector. We obtained China's value-added and value-added index from 1978 to 2008 from the Compendium of Statistics of New China for 60 Years and the value-added and value-added index data from 2009 to 2019 from the China Statistical Yearbook. Based on the three industry price indices and sub-sector value-added indices, excluding the impact of price fluctuations, we converted the three industry value-added and each sector value-added into constant prices in 2015, of which three industries were aggregated to obtain the comparable gross domestic product (GDP).

China's statistics provide price indices for three industries and some sectors. There are no price indices for mining, manufacturing, and utilities. We use industrial price indices to deal with them. We use the consumer price index for other sector segments for which there is no price index for constant price translation.

For outliers, we use the average value of the adjacent year data for smoothing. For the aggregated value-added data of sub-sectors, we also made the last necessary adjustment, i.e., to ensure that when different attributes aggregate the value-added data, the total value of each category is consistent with the GDP and the value-added data of the three industries.

### *4.4. Reclassification of Service Sector*

We have reclassified the service sector. China's statistics include 19 sectors, of which 5 are primary and secondary industries, while the other 14 are services. The essential concern of this study is to capture the intra-service differences in labor reallocation effects. According to the research in [47], there is a significant difference in the production efficiency within the service, so it is necessary to further divide the service from the perspective of economic growth to examine the effect of labor reallocation. At present, the typical approach in the analysis is to divide the service industry into production service and life service. In practice, the main challenge lies in achieving a more accurate division.

Ideally, each sector in the service should be divided into service for productive activities and service for life components. For example, education industry and general

education should be included in the service for life, and vocational education should be included in the service for productive activities. Leases of large-scale production equipment should be considered part of services for production activities compared to ordinary leases of residential or commercial premises. However, allowing such nuanced data, China's existing statistics are inadequate. As a second-best solution, we divided the service in Table 1 into modern, non-modern, and real estate (Table 2). Non-modern service stresses the tertiary industry, which provides services for daily life. Modern service focuses on the tertiary industry, which provides services for production activities. The productivity level of these sectors is usually higher than that of other economic sectors, and they also have higher potential for technological upgrading and productivity improvement. Henceforth, we will analyze the effect of labor structure in China and its impact on economic growth by such sectors.

**Table 2.** Sectoral disaggregation and definition of the service sector.

| Industry | Sector | ISIC Rev 3 |
|---|---|---|
| Primary | Agriculture | A |
| Secondary | Mining | B |
| | Manufacturing | C |
| | Utility | D |
| | Construction | E |
| Tertiary | Non-Modern Service | F + H + L + N + OtS |
| | Modern Service | G + I + J + M |
| | Real Estates | K |

Note: See Table 1 for the specific contents indicated by the sector codes in the ISIC rev 3 column. "OtS" means sectors O, P, Q, R, S.

Tables 3 and 4 show the data for the selected years. It can be seen that the share of employment and output varies significantly among sectors. During the research period, each sector's employment and output share change is also relatively noticeable. The sum of employment share of manufacturing and non-modern service increased from slightly less than 30% to 58%, and the sum of output share increased from 41% to 56%.

**Table 3.** The sectoral composition of employment in China (1990–2019, selected years).

| | | Secondary Industry | | | | | Tertiary Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Ag** | | **Min** | **Man** | **Ut** | **Con** | | **N-Mod** | **Mod** | **Est** |
| 1990 | 60.1 | 21.4 | 1.5 | 15.1 | 0.5 | 4.2 | 18.5 | 14.5 | 3.9 | 0.1 |
| 1995 | 52.2 | 23.0 | 1.5 | 15.7 | 0.5 | 5.3 | 24.8 | 20.4 | 4.2 | 0.1 |
| 2000 | 50.2 | 22.6 | 1.1 | 14.5 | 0.6 | 6.4 | 27.2 | 22.7 | 4.3 | 0.1 |
| 2005 | 45.0 | 23.5 | 1.0 | 14.9 | 0.6 | 7.0 | 31.5 | 26.8 | 4.5 | 0.2 |
| 2010 | 36.3 | 28.7 | 1.3 | 17.8 | 0.6 | 9.0 | 35.1 | 30.2 | 4.6 | 0.3 |
| 2015 | 28.3 | 29.7 | 1.0 | 19.0 | 0.7 | 9.1 | 41.9 | 36.0 | 5.4 | 0.5 |
| 2019 | 25.1 | 27.5 | 0.7 | 17.2 | 0.6 | 9.0 | 47.4 | 41.1 | 5.7 | 0.7 |

Note: All numbers are in percentage terms. Sources: According to the statistical data of China, the author obtains the processing method as shown in Section 4.

**Table 4.** The sectoral composition of GDP in China (1990–2019, selected years).

| | | Secondary Industry | | | | | Tertiary Industry | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Ag** | | **Min** | **Man** | **Ut** | **Con** | | **N-Mod** | **Mod** | **Est** |
| 1990 | 34.4 | 36.8 | 3.4 | 27.7 | 1.6 | 4.1 | 28.9 | 13.3 | 12.5 | 3.1 |
| 1995 | 23.6 | 44.5 | 4.0 | 32.9 | 1.9 | 5.8 | 32.0 | 16.5 | 11.8 | 3.6 |
| 2000 | 18.4 | 43.7 | 4.2 | 31.0 | 3.1 | 5.3 | 38.0 | 20.9 | 13.2 | 3.9 |
| 2005 | 13.9 | 46.0 | 5.4 | 31.3 | 3.9 | 5.4 | 40.3 | 22.9 | 13.0 | 4.4 |
| 2010 | 10.1 | 46.3 | 5.0 | 31.4 | 3.3 | 6.6 | 43.8 | 24.0 | 14.2 | 5.6 |
| 2015 | 8.4 | 41.0 | 2.8 | 29.0 | 2.4 | 6.9 | 50.8 | 27.4 | 17.2 | 6.2 |
| 2019 | 7.4 | 38.7 | 2.4 | 26.7 | 2.4 | 7.1 | 54.1 | 29.3 | 17.7 | 7.1 |

Note: All numbers are in percentage terms. Sources: According to the statistical data of China, the authors obtained the processing method as shown in Section 4.

## 5. Results

### *5.1. The Historical Change of Labor Structure Effect*

Table 5 shows the labor force's three effects separated from China's cumulative economic growth in selected years based on the index decomposition method. From 1989 to 2019, China's economy grew 13.5 times, with an average annual economic growth rate of 9.4%. The cumulative economic growth contribution rates of labor input, labor reallocation, and labor productivity from 1989 to 2019 are 4.1%, 15.4%, and 80.6%, respectively. Based on the economic growth rate of 9.4%, the three effects have promoted China's economic growth by 0.39%, 1.45%, and 7.58% annually in the past 30 years.

**Table 5.** The decomposition of cumulative economic growth effect and contribution rate in China.

| **Year** | **Economic Growth** | **Economic Growth Effect (%)** | | | **Contribution Rate of Economic Growth Effect (%)** | | |
|---|---|---|---|---|---|---|---|
| | | **Labor Input** | **Labor Reallocation** | **Labor Productivity** | **Labor Input** | **Labor Reallocation** | **Labor Productivity** |
| 1990 | 0.0 | 0.0 | 0.0 | 0.0 | 62.3 | 0.4 | 37.3 |
| 1995 | 0.9 | 0.1 | 0.1 | 0.7 | 10.6 | 12.1 | 77.4 |
| 2000 | 1.8 | 0.2 | 0.1 | 1.5 | 11.4 | 5.1 | 83.6 |
| 2005 | 3.5 | 0.4 | 0.3 | 2.8 | 10.9 | 9.5 | 79.7 |
| 2010 | 6.6 | 0.5 | 1.0 | 5.2 | 7.2 | 14.4 | 78.6 |
| 2015 | 10.2 | 0.5 | 1.9 | 7.8 | 5.2 | 18.3 | 76.7 |
| 2019 | 13.5 | 0.6 | 2.1 | 10.9 | 4.1 | 15.4 | 80.6 |

Note: The economic growth in the table is based on the fixed growth rate with 1989 as the base year. For example, the economic growth in 2010 was 6.6, which means that the total economic growth in 2010 was 6.6 times higher than that in 1989. In addition, the data in the table are rounded; for example, "0.0" indicates that the data is less than 0.05.

In terms of the change of contribution rate of the three effects, the cumulative contribution rate of labor input effect to economic growth in China is declining, closely related to the decrease of China's newborn population yearly. The cumulative contribution of labor reallocation effect to economic growth experienced an increase first, peaked (19%) in 2014, and then declined (Figure 3). The rising process may mainly benefit from China's gradual integration into the global market after China accedes to the WTO, and the world's demand for Chinese industrial products has caused the amount of labor to be transferred into the industrial field.

The declining trend shows that China's industries' ability to absorb employment has weakened in recent years.

Unlike the cumulative effect in Table 5, Table 6 decomposes the three effects of the labor force in the annual economic growth rates from 1990 to 2019. From the 1990s to the beginning of the 20th century, China's labor input contribution to the annual economic growth often reached more than 10%. If the average annual economic growth rate is 9.4%, only the newly added labor input during this period drives China's economic growth by as much as 1% per year. The turning point occurred in 2005, after which the effect of

labor input began to decrease significantly, and the economic drag occurred in 2010–2011 and 2018–2019 (Table 6). The effect of labor reallocation has played a significant role in promoting economic growth in most years. In 17 out of 30 years, it has promoted economic growth by more than 1%, in 10 years it has promoted economic growth by more than 2%, and the highest was 3.3% in 2005. The labor reallocation effect had a significant effect on economic growth from 1992 to 1996 and 2004–2014, but it also became negative after the implementation of the reform of state-owned enterprises in 1998, which was a drag on economic growth, and also a drag on economic growth in 2016 (Table 6).

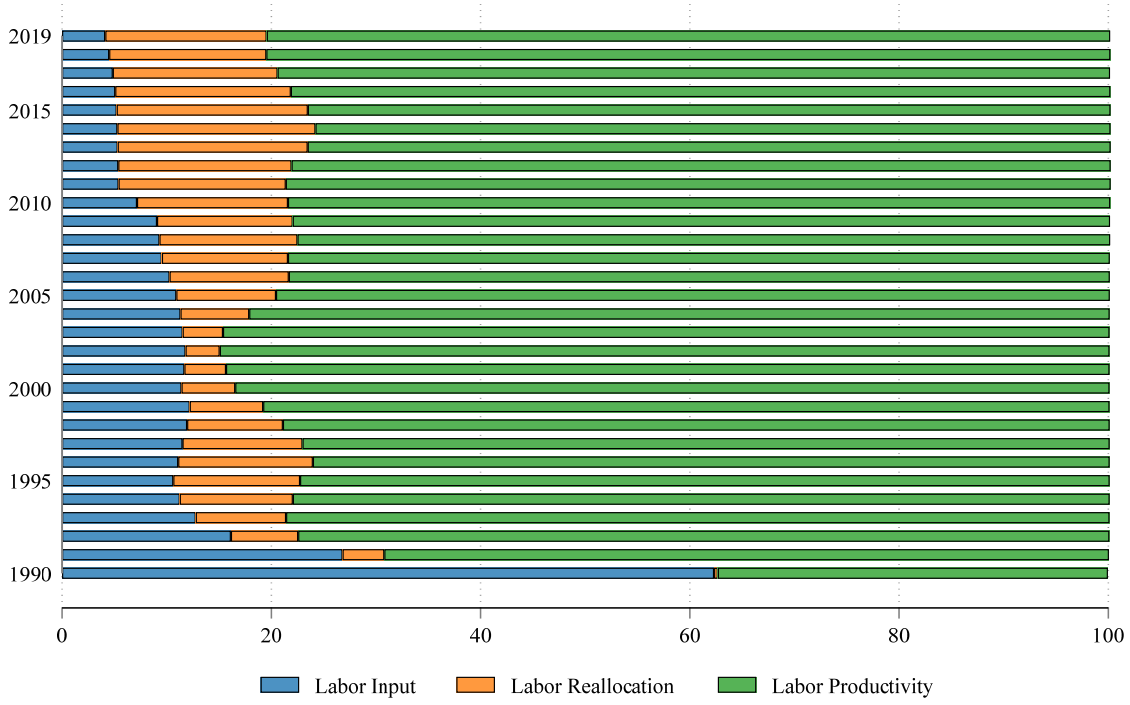


**Figure 3.** Decomposition of contribution rate of cumulative economic growth effect in China (1990–2019). Note: The data are obtained from the statistical yearbooks of China and its provinces and are calculated by the authors.

**Table 6.** Decomposition of China's annual economic growth effect and contribution rate (1990–2019).

| Year | Economic Growth (%) | Economic Growth Effect (%) | | | Contribution Rate of Economic Growth Effect (%) | | |
|---|---|---|---|---|---|---|---|
| | | Labor Input | Labor Reallocation | Labor Productivity | Labor Input | Labor Reallocation | Labor Productivity |
| 1990 | 3.91 | 2.43 | 0.01 | 1.46 | 62.3 | 0.4 | 37.3 |
| 1991 | 9.29 | 1.16 | 0.51 | 7.64 | 12.5 | 5.4 | 82.2 |
| 1992 | 14.22 | 1.02 | 1.21 | 12.01 | 7.2 | 8.5 | 84.5 |
| 1993 | 13.87 | 1.00 | 1.70 | 11.19 | 7.2 | 12.3 | 80.7 |
| 1994 | 13.05 | 0.98 | 2.11 | 9.98 | 7.5 | 16.2 | 76.5 |
| 1995 | 10.95 | 0.91 | 1.86 | 8.20 | 8.3 | 17.0 | 74.9 |
| 1996 | 9.93 | 1.31 | 1.63 | 7.00 | 13.2 | 16.4 | 70.5 |
| 1997 | 9.23 | 1.28 | 0.34 | 7.63 | 13.8 | 3.7 | 82.6 |
| 1998 | 7.84 | 1.18 | −0.56 | 7.22 | 15.1 | −7.1 | 92.1 |
| 1999 | 7.67 | 1.08 | −0.71 | 7.30 | 14.1 | −9.2 | 95.2 |
| 2000 | 8.49 | 0.49 | −0.72 | 8.74 | 5.7 | −8.5 | 102.9 |
| 2001 | 8.34 | 1.15 | −0.40 | 7.60 | 13.8 | −4.9 | 91.2 |
| 2002 | 9.13 | 1.15 | −0.18 | 8.17 | 12.6 | −2.0 | 89.5 |

**Table 6.** *Cont.*

| Year | Economic Growth (%) | Economic Growth Effect (%) | | | Contribution Rate of Economic Growth Effect (%) | | |
|---|---|---|---|---|---|---|---|
| | | Labor Input | Labor Reallocation | Labor Productivity | Labor Input | Labor Reallocation | Labor Productivity |
| 2003 | 10.04 | 0.97 | 0.79 | 8.29 | 9.6 | 7.9 | 82.6 |
| 2004 | 10.11 | 0.99 | 2.63 | 6.50 | 9.8 | 26.0 | 64.3 |
| 2005 | 11.40 | 0.94 | 3.31 | 7.18 | 8.2 | 29.0 | 63.0 |
| 2006 | 12.72 | 0.80 | 2.90 | 9.03 | 6.3 | 22.8 | 71.0 |
| 2007 | 14.23 | 0.77 | 2.23 | 11.25 | 5.4 | 15.7 | 79.1 |
| 2008 | 9.65 | 0.71 | 2.21 | 6.78 | 7.3 | 22.9 | 70.2 |
| 2009 | 9.40 | 0.65 | 1.04 | 7.71 | 7.0 | 11.1 | 82.0 |
| 2010 | 10.64 | −0.88 | 2.78 | 8.76 | −8.2 | 26.1 | 82.4 |
| 2011 | 9.55 | −1.01 | 2.87 | 7.74 | −10.6 | 30.1 | 81.0 |
| 2012 | 7.86 | 0.39 | 1.82 | 5.67 | 5.0 | 23.1 | 72.1 |
| 2013 | 7.77 | 0.37 | 2.83 | 4.59 | 4.7 | 36.4 | 59.1 |
| 2014 | 7.42 | 0.36 | 2.10 | 4.97 | 4.8 | 28.2 | 67.0 |
| 2015 | 7.04 | 0.31 | 0.70 | 6.05 | 4.4 | 9.9 | 85.9 |
| 2016 | 6.85 | 0.23 | −0.21 | 6.84 | 3.3 | −3.0 | 99.8 |
| 2017 | 6.95 | 0.12 | 0.14 | 6.67 | 1.8 | 2.0 | 96.1 |
| 2018 | 6.75 | −0.01 | 0.34 | 6.45 | −0.2 | 5.1 | 95.5 |
| 2019 | 5.95 | −0.11 | 1.31 | 4.76 | −1.8 | 21.9 | 80.0 |

Note: The economic growth in the table is the current year's data, for example, 10.64 in 2010, which indicates that GDP in 2010 increased by 10.64% compared with 2009. The "−" indicates a slowdown in economic growth. The data in the table have been rounded off.

In the past five years, China's actual average annual economic growth rate has been around 6.7%, with an average annual growth rate of 9.4% from 1989 to 2019, having dropped by 2.7%. From Table 5, it can be seen that labor input and labor reallocation have promoted China's economic growth by an average of 1.9% per year from 1989 to 2019, while as shown in Table 6, the two effects have promoted economic growth by an average of 0.56% per year in the past five years, with a decrease of 1.34%. In other words, labor force input and labor force reallocation can explain 50% of China's economic slowdown, while the other 50% is explained by technological progress.

### *5.2. Sector Heterogeneity of Labor Reallocation Effect*

#### 5.2.1. Agriculture

The evolution of the labor reallocation effect in agriculture can be roughly divided into two stages: the first stage is that before China entered into WTO, the negative effect of labor reallocation slowly increased and entered a relatively stable period around 2000. The second stage is that after China entered into WTO, the negative effect of labor reallocation continued to increase rapidly. After the reform and opening up, China's non-agricultural economy has developed rapidly, but the number of jobs provided each year is still relatively small. Until China fully integrates into the global market, many non-agricultural jobs, especially manufacturing jobs, will continue to be created, which drives the rapid non-agricultural transformation of the agricultural labor force. During the research period, the negative effect of agricultural labor reallocation continued to increase, and the negative effect expanded to −0.55 in 2019 (Table 7). The negative contribution of agricultural labor transfer to economic growth shows no apparent signs of narrowing (Figure 4). It implies that an amount of the labor force will be transferred from agriculture to other sectors in the future, i.e., the labor reallocation effect generated by labor non-agriculturalization will still be an essential source of economic growth.

**Table 7.** Cumulative economic growth effect of labor reallocation and contribution rate by sectors.

| Year | Economic Growth Effect | | | | | | | | Contribution Rate of Economic Growth Effect (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ag | Min | Man | Ut | Con | N-Mod | Mod | Est | Ag | Min | Man | Ut | Con | N-Mod | Mod | Est |
| 1990 | 0.000 | 0.001 | −0.004 | 0.000 | −0.001 | 0.002 | 0.000 | 0.001 | 0.7 | 2.2 | −10.5 | 0.7 | −1.6 | 4.8 | 0.4 | 3.7 |
| 1991 | −0.002 | 0.001 | −0.004 | 0.001 | −0.001 | 0.005 | 0.002 | 0.004 | −1.5 | 0.7 | −3.1 | 0.4 | −0.5 | 3.9 | 1.2 | 2.9 |
| 1992 | −0.009 | 0.000 | −0.001 | 0.001 | 0.002 | 0.016 | 0.003 | 0.008 | −3.1 | −0.1 | −0.5 | 0.3 | 0.6 | 5.3 | 1.1 | 2.8 |
| 1993 | −0.022 | 0.001 | 0.001 | 0.000 | 0.010 | 0.036 | −0.002 | 0.016 | −4.7 | 0.2 | 0.2 | 0.1 | 2.2 | 7.6 | −0.3 | 3.4 |
| 1994 | −0.036 | −0.001 | 0.008 | 0.000 | 0.013 | 0.058 | 0.008 | 0.022 | −5.4 | −0.2 | 1.2 | 0.0 | 1.9 | 8.7 | 1.2 | 3.3 |
| 1995 | −0.051 | −0.001 | 0.012 | 0.001 | 0.016 | 0.082 | 0.017 | 0.027 | −6.0 | −0.1 | 1.4 | 0.1 | 1.8 | 9.7 | 2.0 | 3.1 |
| 1996 | −0.065 | −0.002 | 0.022 | 0.003 | 0.021 | 0.098 | 0.027 | 0.029 | −6.2 | −0.1 | 2.1 | 0.3 | 2.0 | 9.5 | 2.6 | 2.8 |
| 1997 | −0.070 | −0.003 | 0.024 | 0.005 | 0.024 | 0.105 | 0.025 | 0.031 | −5.7 | −0.3 | 1.9 | 0.4 | 2.0 | 8.6 | 2.0 | 2.5 |
| 1998 | −0.071 | −0.009 | −0.002 | 0.009 | 0.034 | 0.113 | 0.018 | 0.036 | −5.1 | −0.6 | −0.1 | 0.6 | 2.4 | 8.1 | 1.3 | 2.6 |
| 1999 | −0.068 | −0.015 | −0.026 | 0.008 | 0.036 | 0.116 | 0.022 | 0.037 | −4.3 | −0.9 | −1.6 | 0.5 | 2.3 | 7.3 | 1.4 | 2.4 |
| 2000 | −0.067 | −0.025 | −0.046 | 0.008 | 0.039 | 0.123 | 0.019 | 0.042 | −3.7 | −1.4 | −2.6 | 0.4 | 2.2 | 6.8 | 1.0 | 2.3 |
| 2001 | −0.066 | −0.032 | −0.059 | 0.006 | 0.041 | 0.128 | 0.014 | 0.048 | −3.2 | −1.6 | −2.9 | 0.3 | 2.0 | 6.3 | 0.7 | 2.4 |
| 2002 | −0.067 | −0.041 | −0.072 | 0.000 | 0.038 | 0.144 | 0.014 | 0.060 | −2.9 | −1.8 | −3.1 | 0.0 | 1.6 | 6.2 | 0.6 | 2.6 |
| 2003 | −0.076 | −0.040 | −0.076 | 0.000 | 0.039 | 0.172 | 0.022 | 0.060 | −2.9 | −1.5 | −2.9 | 0.0 | 1.5 | 6.5 | 0.8 | 2.3 |
| 2004 | −0.099 | −0.033 | −0.066 | 0.005 | 0.047 | 0.228 | 0.039 | 0.076 | −3.3 | −1.1 | −2.2 | 0.2 | 1.6 | 7.6 | 1.3 | 2.5 |
| 2005 | −0.124 | −0.022 | 0.004 | 0.014 | 0.059 | 0.260 | 0.050 | 0.092 | −3.6 | −0.6 | 0.1 | 0.4 | 1.7 | 7.5 | 1.4 | 2.6 |
| 2006 | −0.151 | −0.009 | 0.084 | 0.008 | 0.072 | 0.293 | 0.062 | 0.101 | −3.7 | −0.2 | 2.1 | 0.2 | 1.8 | 7.3 | 1.5 | 2.5 |
| 2007 | −0.176 | 0.007 | 0.141 | 0.006 | 0.090 | 0.324 | 0.063 | 0.118 | −3.7 | 0.1 | 3.0 | 0.1 | 1.9 | 6.8 | 1.3 | 2.5 |
| 2008 | −0.196 | 0.065 | 0.191 | 0.005 | 0.091 | 0.353 | 0.064 | 0.128 | −3.7 | 1.2 | 3.6 | 0.1 | 1.7 | 6.7 | 1.2 | 2.4 |
| 2009 | −0.221 | 0.027 | 0.240 | 0.003 | 0.126 | 0.382 | 0.051 | 0.158 | −3.7 | 0.5 | 4.1 | 0.0 | 2.1 | 6.5 | 0.9 | 2.7 |
| 2010 | −0.255 | 0.048 | 0.326 | 0.004 | 0.151 | 0.420 | 0.060 | 0.203 | −3.8 | 0.7 | 4.9 | 0.1 | 2.3 | 6.3 | 0.9 | 3.1 |
| 2011 | −0.282 | 0.048 | 0.426 | 0.020 | 0.166 | 0.429 | 0.094 | 0.275 | −3.8 | 0.7 | 5.8 | 0.3 | 2.3 | 5.8 | 1.3 | 3.7 |
| 2012 | −0.308 | 0.042 | 0.528 | 0.023 | 0.189 | 0.436 | 0.100 | 0.320 | −3.8 | 0.5 | 6.6 | 0.3 | 2.4 | 5.4 | 1.2 | 4.0 |
| 2013 | −0.354 | −0.009 | 0.525 | 0.047 | 0.196 | 0.569 | 0.167 | 0.444 | −4.1 | −0.1 | 6.0 | 0.5 | 2.2 | 6.5 | 1.9 | 5.1 |
| 2014 | −0.399 | −0.032 | 0.555 | 0.044 | 0.158 | 0.738 | 0.240 | 0.485 | −4.2 | −0.3 | 5.9 | 0.5 | 1.7 | 7.8 | 2.5 | 5.1 |
| 2015 | −0.433 | −0.064 | 0.488 | 0.039 | 0.152 | 0.872 | 0.301 | 0.507 | −4.2 | −0.6 | 4.8 | 0.4 | 1.5 | 8.6 | 3.0 | 5.0 |
| 2016 | −0.452 | −0.098 | 0.377 | 0.033 | 0.145 | 1.002 | 0.302 | 0.530 | −4.1 | −0.9 | 3.4 | 0.3 | 1.3 | 9.1 | 2.8 | 4.8 |
| 2017 | −0.477 | −0.122 | 0.296 | 0.026 | 0.132 | 1.132 | 0.316 | 0.554 | −4.0 | −1.0 | 2.5 | 0.2 | 1.1 | 9.6 | 2.7 | 4.7 |
| 2018 | −0.508 | −0.141 | 0.199 | 0.019 | 0.136 | 1.261 | 0.337 | 0.596 | −4.0 | −1.1 | 1.6 | 0.2 | 1.1 | 10.0 | 2.7 | 4.7 |
| 2019 | −0.545 | −0.164 | 0.173 | 0.021 | 0.148 | 1.347 | 0.412 | 0.687 | −4.1 | −1.2 | 1.3 | 0.2 | 1.1 | 10.0 | 3.1 | 5.1 |

Note: The economic growth in the table is based on the fixed growth rate with 1989 as the base year. For example, agriculture in 2010 was −0.255, which indicates that the agricultural GDP increased by −25.5% in 2000 due to the transfer of agricultural labor to other industries. The data in the table have been rounded off. The following table is the same.

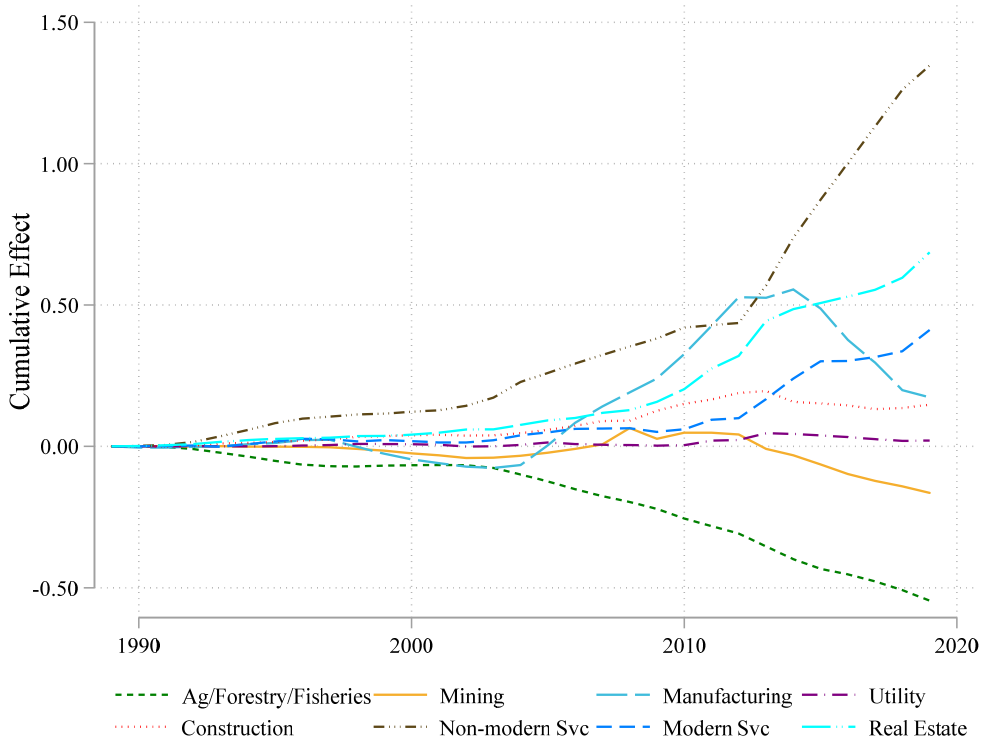


**Figure 4.** Cumulative labor reallocation effect by sector (1989–2019). Note: The data are obtained from the statistical yearbooks of China and its provinces and are calculated by the authors.

#### 5.2.2. The Secondary Industry and Its Sub-Sectors

The peak value of labor reallocation effect of the entire secondary industry appeared in 2012, with the highest contribution rate of 0.78 times to economic growth. At this time, the contribution rate to economic growth was 9.7%. By 2019, the secondary industry's cumulative contribution rate of labor reallocation effect to economic growth remained 0.18 times, accounting for only 1.3%. The labor reallocation effect in the secondary industry has crossed the peak and started to decline, which indicates that the labor force in China has separated from the secondary industry and is being transferred to the tertiary industry.

As the sector with the most significant employment intake in the secondary industry, the results show that the labor reallocation effect of manufacturing is not prominent, which seems to be a result against common sense. However, judging from the labor reallocation effect curve of manufacturing in Figure 4, its development process experienced two abrupt changes in 2003 and 2012, respectively, and during this period, the labor reallocation effect of manufacturing is significantly higher than that of other sectors. The labor reallocation effect of manufacturing was a drag on China's economic growth after 1998. It was not until China joined WTO in the 2000s that this state was changed. From 2003 to 2012, the labor reallocation effect of manufacturing experienced a much faster increase than that of other sectors, from −7.6% to 52.8%, which contributed to China's economic growth of 60.4% (Table 7). It suggests that the improvement of labor reallocation effect in China benefits from trade globalization to a large extent. The labor reallocation effect of manufacturing was the highest, which promoted economic growth by 0.56 times in 2014, and contributed 5.9% to cumulative economic growth. However, after a plateau in 2012–2014, the labor reallocation effect in manufacturing began to decline rapidly (Figure 4).

The labor reallocation effect of construction is second only to that in manufacturing, but it also peaked in 2013 (Figure 4), with the highest cumulative contribution to the economic growth of 0.2 times (Table 7). As a highly mechanized industrial sector, mining has a positive labor reallocation effect except in the period of global commodity boom around 2010, all of which show negative reallocation effect, and the negative effect has

continued to increase in recent years (Figure 4), indicating that labor will still be separated from mining. The change curve of the utility labor reallocation effect is almost parallel to the horizontal axis, with the highest contribution rate to economic growth reaching 0.5% around 2013. Due to the small employment base, mining and utility's labor reallocation effect contributed little to China's overall economic growth (Table 7). In the secondary industry, the labor reallocation effect of each sub-sector has passed the peak and entered the downward stage, which signifies that the industry's ability to absorb employment is weakening.

#### 5.2.3. The Tertiary Industry and Its Sub-Sectors

The tertiary industry is currently the sector with the most substantial labor reallocation effect in China, and its cumulative promoting effect on economic growth has been increasing continuously throughout the research period. From 1989 to 2019, the reallocation effect of the tertiary industry has promoted China's economic growth by 2.45 times, contributing 18.2% to economic growth (Table 7). However, as shown in Figure 4, the evolution law of labor reallocation effect in the three sub-sectors of tertiary industry is not synchronous. The cumulative effect of labor reallocation in non-modern service was surpassed by manufacturing in 2012 and ranked first in all other years. After 2012, the effect of labor reallocation in the non-modern service increased significantly (Figure 4). The labor reallocation effect of the modern service was slow to promote economic growth before 2013 (Figure 4). It only promoted economic growth by 10% in 1989–2012 but reached 41% in 2019 (Table 7). It shows that the development of China's modern service industry in recent years has, to a certain extent, ensured the exertion of the effect of labor reallocation. In addition, the reallocation effect of the real estate experienced rapid growth in 2008 (Figure 4) and contributed 68.7% economic growth in 2019, compared with 11.8% in 2007 (Table 7), which may be affected by the rapid development of China's real estate sales market after 2008.

### *5.3. Sector Heterogeneity of Labor Productivity Effect*

#### 5.3.1. Agriculture

The effect of agricultural labor productivity has steadily increased during the research period. From 1989 to 2019, the effect of agricultural labor productivity promoted China's economic growth by 1.19 times and contributed 8.8% to the cumulative economic growth rate (Table 8). As shown in Figure 5, after China acceded to the WTO, the effect of agricultural labor productivity has entered a state of rapid growth. However, compared with other sectors, the effect of agricultural labor productivity has increased at a moderate rate, lower than that of manufacturing, non-modern service, and modern service, and higher than that of other industries. From the cumulative effect curve of agricultural labor productivity shown in Figure 5, its development trajectory in recent years is an approximately straight line, indicating that the rate of agricultural technological progress (the second derivative of the curve) is approximately equal to 0, i.e., China's agricultural technological progress in recent years is almost at a standstill.

**Table 8.** Cumulative economic growth effect of labor productivity and contribution rate by sectors.

| Year | Economic Growth Effect | | | | | | | | Contribution Rate of Economic Growth Effect (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ag | Min | Man | Ut | Con | N-Mod | Mod | Est | Ag | Min | Man | Ut | Con | N-Mod | Mod | Est |
| 1990 | 0.016 | −0.001 | 0.000 | 0.000 | 0.001 | −0.003 | 0.001 | 0.001 | 41.0 | −3.4 | 0.8 | −1.3 | 2.6 | −7.9 | 2.4 | 3.1 |
| 1991 | 0.023 | 0.002 | 0.027 | 0.001 | 0.005 | 0.029 | 0.007 | 0.001 | 16.7 | 1.4 | 19.7 | 0.6 | 3.7 | 21.3 | 5.2 | 0.7 |
| 1992 | 0.043 | 0.009 | 0.078 | 0.003 | 0.016 | 0.051 | 0.022 | 0.008 | 14.5 | 3.2 | 26.2 | 1.2 | 5.4 | 17.0 | 7.4 | 2.7 |
| 1993 | 0.070 | 0.017 | 0.149 | 0.008 | 0.031 | 0.050 | 0.046 | 0.004 | 14.7 | 3.6 | 31.2 | 1.7 | 6.5 | 10.5 | 9.6 | 0.9 |
| 1994 | 0.096 | 0.028 | 0.216 | 0.013 | 0.038 | 0.067 | 0.058 | 0.007 | 14.3 | 4.2 | 32.2 | 1.9 | 5.7 | 10.0 | 8.7 | 1.1 |
| 1995 | 0.128 | 0.037 | 0.285 | 0.016 | 0.046 | 0.073 | 0.065 | 0.009 | 15.0 | 4.3 | 33.5 | 1.9 | 5.4 | 8.6 | 7.7 | 1.0 |
| 1996 | 0.158 | 0.046 | 0.340 | 0.018 | 0.052 | 0.090 | 0.076 | 0.009 | 15.2 | 4.4 | 32.8 | 1.7 | 5.0 | 8.7 | 7.4 | 0.9 |
| 1997 | 0.173 | 0.054 | 0.397 | 0.019 | 0.051 | 0.134 | 0.103 | 0.013 | 14.1 | 4.4 | 32.4 | 1.6 | 4.2 | 10.9 | 8.4 | 1.1 |
| 1998 | 0.185 | 0.063 | 0.445 | 0.019 | 0.052 | 0.185 | 0.136 | 0.021 | 13.2 | 4.5 | 31.8 | 1.3 | 3.7 | 13.2 | 9.7 | 1.5 |
| 1999 | 0.190 | 0.073 | 0.525 | 0.012 | 0.054 | 0.239 | 0.160 | 0.027 | 12.0 | 4.6 | 33.2 | 0.8 | 3.4 | 15.1 | 10.1 | 1.7 |
| 2000 | 0.198 | 0.101 | 0.566 | 0.060 | 0.057 | 0.291 | 0.202 | 0.033 | 11.0 | 5.6 | 31.4 | 3.3 | 3.1 | 16.1 | 11.2 | 1.8 |
| 2001 | 0.205 | 0.111 | 0.637 | 0.065 | 0.061 | 0.365 | 0.238 | 0.038 | 10.0 | 5.4 | 31.3 | 3.2 | 3.0 | 17.9 | 11.7 | 1.9 |
| 2002 | 0.214 | 0.150 | 0.691 | 0.088 | 0.077 | 0.434 | 0.273 | 0.041 | 9.2 | 6.5 | 29.9 | 3.8 | 3.3 | 18.7 | 11.8 | 1.8 |
| 2003 | 0.231 | 0.170 | 0.815 | 0.100 | 0.096 | 0.484 | 0.288 | 0.057 | 8.7 | 6.4 | 30.8 | 3.8 | 3.6 | 18.3 | 10.9 | 2.2 |
| 2004 | 0.282 | 0.170 | 0.931 | 0.126 | 0.106 | 0.484 | 0.324 | 0.056 | 9.4 | 5.6 | 30.9 | 4.2 | 3.5 | 16.0 | 10.8 | 1.8 |
| 2005 | 0.332 | 0.212 | 0.992 | 0.135 | 0.122 | 0.554 | 0.358 | 0.062 | 9.6 | 6.1 | 28.6 | 3.9 | 3.5 | 15.9 | 10.3 | 1.8 |
| 2006 | 0.384 | 0.227 | 1.096 | 0.164 | 0.143 | 0.628 | 0.443 | 0.085 | 9.5 | 5.6 | 27.1 | 4.1 | 3.5 | 15.5 | 11.0 | 2.1 |
| 2007 | 0.426 | 0.221 | 1.267 | 0.191 | 0.167 | 0.752 | 0.591 | 0.122 | 9.0 | 4.6 | 26.6 | 4.0 | 3.5 | 15.8 | 12.4 | 2.6 |
| 2008 | 0.477 | 0.262 | 1.374 | 0.152 | 0.209 | 0.889 | 0.657 | 0.108 | 9.0 | 4.9 | 25.9 | 2.9 | 3.9 | 16.7 | 12.4 | 2.0 |
| 2009 | 0.525 | 0.242 | 1.465 | 0.186 | 0.249 | 1.033 | 0.757 | 0.159 | 8.9 | 4.1 | 24.8 | 3.1 | 4.2 | 17.5 | 12.8 | 2.7 |
| 2010 | 0.597 | 0.281 | 1.637 | 0.221 | 0.285 | 1.182 | 0.839 | 0.179 | 9.0 | 4.2 | 24.7 | 3.3 | 4.3 | 17.8 | 12.6 | 2.7 |
| 2011 | 0.664 | 0.349 | 1.837 | 0.164 | 0.336 | 1.366 | 0.940 | 0.156 | 9.0 | 4.7 | 24.9 | 2.2 | 4.6 | 18.5 | 12.8 | 2.1 |
| 2012 | 0.722 | 0.324 | 1.894 | 0.184 | 0.366 | 1.581 | 1.066 | 0.149 | 9.0 | 4.0 | 23.6 | 2.3 | 4.6 | 19.7 | 13.3 | 1.9 |
| 2013 | 0.797 | 0.371 | 2.030 | 0.171 | 0.410 | 1.673 | 1.159 | 0.089 | 9.1 | 4.3 | 23.2 | 2.0 | 4.7 | 19.2 | 13.3 | 1.0 |
| 2014 | 0.874 | 0.355 | 2.181 | 0.156 | 0.512 | 1.769 | 1.252 | 0.084 | 9.2 | 3.8 | 23.1 | 1.7 | 5.4 | 18.7 | 13.2 | 0.9 |
| 2015 | 0.940 | 0.318 | 2.301 | 0.195 | 0.554 | 1.951 | 1.423 | 0.133 | 9.2 | 3.1 | 22.6 | 1.9 | 5.4 | 19.1 | 14.0 | 1.3 |
| 2016 | 0.989 | 0.335 | 2.519 | 0.214 | 0.608 | 2.144 | 1.555 | 0.217 | 9.0 | 3.1 | 23.0 | 2.0 | 5.5 | 19.6 | 14.2 | 2.0 |
| 2017 | 1.051 | 0.390 | 2.819 | 0.247 | 0.681 | 2.252 | 1.672 | 0.266 | 8.9 | 3.3 | 23.9 | 2.1 | 5.8 | 19.1 | 14.2 | 2.3 |
| 2018 | 1.117 | 0.416 | 3.115 | 0.282 | 0.758 | 2.394 | 1.819 | 0.303 | 8.8 | 3.3 | 24.6 | 2.2 | 6.0 | 18.9 | 14.4 | 2.4 |
| 2019 | 1.187 | 0.452 | 3.229 | 0.299 | 0.813 | 2.641 | 1.941 | 0.290 | 8.8 | 3.4 | 24.0 | 2.2 | 6.0 | 19.6 | 14.4 | 2.2 |

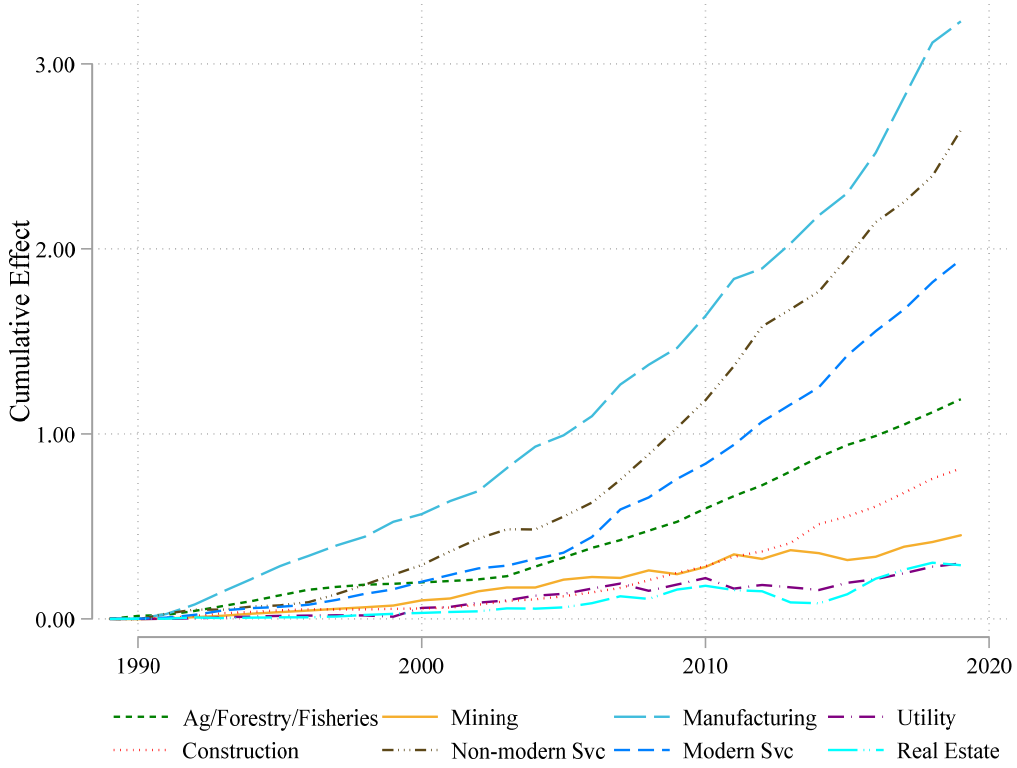


**Figure 5.** Cumulative labor productivity effect by sector (1989–2019). Note: The data are obtained from the statistical yearbooks of China and its provinces and are calculated by the authors.

#### 5.3.2. The Secondary Industry and Its Sub-Sectors

The productivity effect of the secondary industry has promoted China's economic growth by 4.79 times accumulatively and contributed 35.6% to economic growth (Table 8). However, there are significant differences in the labor productivity effect within the secondary industry. Manufacturing is the sector with the fastest increase in productivity effect. From 1989 to 2019, it has promoted economic growth by 3.23 times, accounting for 67.4% of the labor productivity effect in the secondary industry and contributing up to 27% of the economic growth rate. It can be seen from Figure 5 that the labor productivity effect in manufacturing has accelerated after 2003. In contrast to manufacturing, in the secondary industry, the labor productivity effect growth of the mining, utility, and construction is relatively slow (Figure 5), which promotes the economic growth by 0.45 times, 0.30 times, and 0.81 times during the research period, with contribution rates of only 3.4%, 2.2%, and 6.0% respectively (Table 8). The total contribution of the three is less than half of that of manufacturing, accounting for only 32.6% of the contribution rate of the productivity effect of the secondary industry. With the same analysis method as that of agriculture, manufacturing seems to have maintained its technological progress all the time (its change curve is closer to the exponential change), while the technological progress speed of other industries in recent years is not satisfactory. The post-2015 change in construction is similar to that in agriculture (Figure 5).

#### 5.3.3. The Tertiary Industry and Its Sub-Sectors

During the study period, the labor productivity effect of the tertiary industry promoted China's economic growth by 4.87 times, contributing 36.2% to economic growth (Table 8), slightly higher than that of the secondary industry. In the tertiary industry, the labor productivity effect of non-modern service has cumulatively promoted China's economic growth by 2.64 times, and the labor productivity effect of modern service has cumulatively promoted China's economic growth by 1.94 times, both of which have maintained a good growth momentum during the research period (Figure 5). Real estate is the sector with

slower growth of labor productivity effect among all sectors (Figure 5), with the highest cumulative growth rate of 30.3% in 2018, contributing 2.2% to economic growth. In the tertiary industry, the non-modern service seems to maintain a good rate of technological progress, perhaps related to the development of information technology in China in recent years. In contrast, the technological progress of modern service seems to have taken place in some time points, such as 2006 and 2014, with piecewise changes in the slope of the curve (Figure 5).

## 6. Discussion

China's economic growth is closely related to the change in population structure. From the decomposition result of economic growth, the depletion of demographic dividend, which shows that the labor input effect tends to zero and becomes negative, is a fundamental reason for China's economic growth slowdown, which is also an essential basis for judging whether China's economic growth is cyclical or not. If the research period from 1989 to 2019 is divided into two 15 years, the first 15 years, due to the continuous increase of labor force, labor input will promote China's economic growth by about 1% per year. In the second 15 years, the labor input effect can only promote China's economic growth by 0.3% per year on average, which is consistent with China's demographic changes. As China experienced a period of baby boomers after 1963 [48], from the middle and late 1980s to the beginning of the 20th century, the population grew into a new labor force to participate in social production, which was the reason for the high labor input effect in the first 15 years in the research period. However, in the 1980s, China began to implement the one-child policy and the change of people's conception of childbirth [48], the impact on the number of labor force appeared more than 20 years later, that is, the number of the newly added labor force in China dropped rapidly after 2005, which was the reason for the sharp drop in labor force input effect in the second 15 years. The change of labor input effect in China revealed by this research can be mutually confirmed with the discussion on Lewis turning point in the research of labor supply in China [9,27,33].

For the labor reallocation effect, although the average has decreased to 0.45% in the past five years, it has promoted China's economic growth by 1.45% on average every year from 1989 to 2019. It cannot be denied that it is vital to China's economic growth, which is consistent with the research results of [28,31,35]. On the changing trend of labor reallocation effect, this study tested the rationality of the research conclusion of [36] and supplemented the change after 2011. As for the significant decrease in the contribution rate of labor reallocation to economic growth after 2013, our view is consistent with that of most studies [49–51], and we believe that this change is related to the increase in the cost of factors of production in China and the intensification of Sino–US trade confrontation. China's employment structure has been in the process of continuous optimization. The employment share of some sub-sectors in manufacturing declined as early as before 2010 [52], but the sudden increase in speed after 2013 is not due to the normal development process. Because of the sudden and severe decline in the effect of labor reallocation, we conclude that there may be a close relationship with China's industrial policy in addition to the reasons above. When separated from the industrial sector, the per capita income level of China's labor force is much lower than the corresponding level of the booming economies in East Asia [53,54]. Since in 2019 China still had more than 450 million people living in rural areas and more than 190 million labor force engaged in the primary industry (Table 9), we believe that this change does not fully follow the development strategy of comparative advantage [55], nor is it due to the development stage, and is likely to be the result of external intervention.

**Table 9.** Employment and value-added by sector in China for selected years, and labor productivity by sector in 2019.

| Year | Ag | Min | Man | Ut | Con | N-Mod | Mod | Est |
|---|---|---|---|---|---|---|---|---|
| 1990 | 389.1 | 10.0 | 97.8 | 3.3 | 27.5 | 25.2 | 94.2 | 0.4 |
| | (2.2) | (0.2) | (1.8) | (0.1) | (0.3) | (0.8) | (0.9) | (0.2) |
| 2000 | 360.4 | 7.7 | 104.1 | 4.4 | 46.0 | 30.7 | 163.1 | 1.0 |
| | (3.2) | (0.7) | (5.4) | (0.5) | (0.9) | (2.3) | (3.6) | (0.7) |
| 2013 | 241.7 | 9.0 | 147.6 | 5.3 | 75.1 | 38.5 | 247.5 | 3.7 |
| | (5.3) | (2.6) | (18.4) | (1.5) | (4.1) | (9.3) | (15.2) | (3.6) |
| 2019 | 194.5 | 5.2 | 133.2 | 4.8 | 69.8 | 44.1 | 318.6 | 5.1 |
| | (6.6) | (2.1) | (23.8) | (2.2) | (6.4) | (15.7) | (26.1) | (6.3) |
| Productivity | 34 | 410 | 178 | 447 | 91 | 82 | 356 | 1242 |

Note: The number after the year is the employment in millions of units, and the number in brackets is the added value in trillions of units. The 2013 data were selected because the value-added manufacturing share of GDP in China peaked in that year (the share of employment peaked in 2014, but was only 0.2% different from 2013). The last line in the table is the sector labor productivity in 2019, with the unit of 1000 yuan. The value-added data are constant in 2015 and denominated in CNY.

The labor reallocation effect in different sectors, separated from the economic growth rate, has inspired us to deconstruct the causes of China's economic slowdown. Judging that the negative effect of agricultural labor reallocation continues to increase and has not slowed down in recent years (Figure 5), the critical mechanism of China's economic slowdown cannot be explained by the transfer of agricultural labor to non-agricultural sectors. We believe that the slowdown in China's economic growth is due to the disappearance of the demographic dividend and the sharp decrease in the labor reallocation effect. As shown in Table 9, the employment share of China's agriculture, manufacturing, and non-modern service is much higher than that of other sectors, while the productivity of manufacturing is more than twice that of non-modern service. After 2013, on the one hand, China's labor force has directly transferred from agriculture to non-modern service. On the other hand, there has been a rapid and massive movement from higher productivity sectors to lower productivity sectors, especially in the movement of labor from manufacturing to non-modern service (Figure 4). In the past six years, about 47 million workers have been transferred from agriculture and 14 million from manufacturing, while about 71 million workers have been absorbed by non-modern service. This pattern of transfer explains the sharp decrease in the labor reallocation effect and is also the reason for the significant decline in economic growth.

Another cause of economic slowdown that has been widely concerned—technological progress—can be reflected in this paper by the labor productivity effect of various sectors, as shown in Figure 5, where most sectors are on an upward trajectory. However, if an industry makes technological progress at the same rate every year, its labor productivity effect curve should conform to exponential growth. However, at present, except for manufacturing and non-modern service, the labor productivity effect in China seems to conform to this characteristic, and other industries do not meet this characteristic, especially after 2010. In other words, in recent years, other sectors, including agriculture, which accounts for a large proportion of employment, have failed to drive China's economic growth through technological progress, which is also one of the reasons for China's economic slowdown. Due to the high initial technology intensity sectors characteristics, the low technological progress in utilities and mining is understandable. However, the ineffectiveness of technological progress in sectors such as agriculture and modern service indicates the more profound problems facing development.

According to the forecast in this paper, the pressure on China's economic growth will be tremendous in the future. On the one hand, as the demographic dividend disappears, labor input will remain negative for a long time. This situation will not change unless an effective population policy is implemented. On the other hand, the labor reallocation effect will continue to weaken. China's manufacturing labor force has been flowing out for six

consecutive years, valid for other industrial sectors. The labor reallocation effect of the secondary industry will continue to be negative in the future. In addition, the Sino–US trade confrontation has made it more difficult for China to undertake the technology transfer from advanced countries and restricted the space for China to realize economic growth by taking advantage of its backwardness. However, the effect of independent research and development to realize technological progress is hardly apparent in the short term.

Some landmark indicators can evaluate the feasibility of China's economic development goals. According to the experience of booming economies in East Asia, including Japan and South Korea, the proportion of agricultural employment in China may eventually remain at around 5%, and the target value of output ratio may be about 1.5%. The proportion of agricultural employment in China is about 25.1%, and the proportion of output is about 7.4%. Reckoning from recent development facts, it will take about 14 years for the proportion of agricultural employment to decrease by 20% and the proportion of output to decrease by 6%.

According to the current development plan of the Chinese government, if the income in 2035 reaches the level of a moderately developed country, we take the constant price of US$ 20,000–25,000 in 2015 as the threshold, and 1.4 billion as the population estimate, i.e., the total economic volume of China in 2035 is US$ 28–35 trillion. The total economic volume of China in 2019 is 14.3 trillion, which means that China's average annual economic growth rate will be at least 4.3% to 5.8% before 2035 to achieve the planned target. Maintaining this pace requires slowing down the decline in the labor reallocation effect as much as possible while increasing investment in research and development.

## 7. Conclusions and Policy Implications

This paper uses the index method to decompose the covariant effect according to the influence of factors to separate the labor input effect, labor reallocation effect, and labor productivity effect from China's economic growth from 1989 to 2019. The results show that the labor input effect has a downward trend throughout the study period and has begun to drag down China's economic growth in recent years. The effect of labor reallocation once promoted China's economic growth by more than 2% per year on average from 2004 to 2014 but entered a recession after 2014. The labor productivity effect has always been an essential contributor to China's economic growth, with an annual contribution rate of 80%. China's economy grew 13.46 times from 1989 to 2019 at constant prices in terms of cumulative economic growth. Labor input contributed 4.1%, labor reallocation contributed 15.4%, and labor productivity contributed 80.6%. The three effects contributed to China's economic growth annually by 0.39%, 1.45%, and 7.58%.

Our analysis found that the critical mechanism for China's downward economic growth is the change from positive to negative of new labor input, the weakening of labor reallocation effect, and the decline in the rate of technological progress in some industries. If we take the average annual economic growth rate of 9.4% from 1989 to 2019 as the average level, and the slowed-down rate is 6.7% (the average economic growth rate in the past five years), labor reallocation can explain 37% of China's economic slowdown, labor input, and labor reallocation together can explain 50% of China's economic slowdown, and technological progress can explain 50%. The key mechanism for weakening the labor reallocation effect lies in: (i) many laborers skipped industry and directly transferred from agriculture to non-modern service and (ii) labor separated from high-productivity sectors (usually manufacturing) and transferred to low-productivity sectors (usually non-modern service). This mechanism provides a new perspective to understand the weakening effect of labor reallocation in China in recent years and further reveals the structural problems of China's economic slowdown. The slow technological progress in sectors dramatically impacts China's economic growth in terms of the labor productivity effect. Manufacturing and non-modern service maintain a relatively steady rate of technological progress and have made significant contributions to economic growth. However, China's agricultural and modern services have experienced slow or even stopped technological progress, which

is an issue worthy of concentration, and the labor productivity effect of these sectors needs to be further explored.

The findings of this study have important policy implications for promoting the transformation of industrial and employment structure and promoting sustained and stable economic growth in China. In order to achieve the planned goal of reaching the income level of moderately developed countries in 2035, China's future average annual economic growth rate must be maintained at least above 4.3–5.8%. Based on the findings of this paper, we believe that in the long run, the healthy and sustainable growth of China's economy requires continuous technological innovation. However, the easiest and most effective development strategy in the short run is to correct the existing policy distortions, optimize the rational allocation of labor resources, and maximize the benefits it creates. We believe that, first of all, policymakers should pay more attention to the development of the manufacturing's ability to absorb employment, and re-examine some existing development policies and eliminate policy distortions, such as avoiding one-size-fits-all environmental review system [56] and reasonably promoting the industrial robot strategy [57]. Implementing these policies has weakened the manufacturing's ability to absorb employment to a certain extent. Secondly, the marketization reform of labor force elements is not perfect, and structural factors such as household registration system, rural land property right system, and education system hinder the exertion of labor resource advantages to a certain extent [58–60]. The government should create a more favorable institutional environment for labor force mobility and reduce the cross-sectoral, cross-regional, and cross-industry employment barriers. In addition, it is also crucial for the long-term goal of economic growth to increase investment in research and development to promote technological progress in various sectors, and actively formulate and implement supporting policies to encourage childbearing.

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