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Analysis of Drivers of China's Labor Productivity Change: Industry Decomposition with the LMDI Model

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Abstract

Enhancing labor productivity is essential for sustaining economic growth and improving living standards. This paper utilizes the Logarithmic Mean Divisia Index (LMDI) model to decompose the drivers of labor productivity growth in China from 2000 to 2022, focusing on the impact of intra-industry effects and labor structure effects. Findings indicate that China's primary productivity growth driver lies within intra-industry effects, with substantial contributions from the industrial and service sectors, while the impact of labor structure effects is relatively low. Although productivity growth slowed after the 2008 financial crisis, it has since stabilized. The agricultural sector's contribution has remained steady, while industrial and service sectors experienced significant fluctuations during the pandemic. Based on these findings, this paper recommends fostering productivity enhancement by improving worker skills and upgrading industry structures. Furthermore, it advocates for advancing technological innovation and optimizing resource allocation in the industrial and service sectors to drive high-quality economic development in China.

Keywords

LMDI, Labor Productivity Growth, Driver Analysis.

1. Introduction

Historically, social productivity and its growth have been crucial determinants of national progress. With limited potential for significant labor force expansion, China must prioritize productivity improvements to sustain healthy economic development and avoid the middle-income trap. As noted in the 2016 report "International Comparison Indicates Rapid Growth in China's Labor Productivity" by the National Bureau of Statistics [1], a strong correlation exists between labor productivity and economic growth. Globally, faster productivity growth is associated with accelerated economic expansion, while slower productivity growth can hinder economic growth. Labor productivity thus serves as a critical indicator of a nation's future economic potential. China's productivity has increased rapidly compared to other global economies, prompting an essential question: what has driven such remarkable growth in China's labor productivity?

To explore this, we apply the LMDI decomposition method, breaking down labor productivity growth into intra-industry and labor structure effects from 2000 to 2022 to determine the underlying drivers of China's rapid productivity growth.

2. LMDI Model Construction and Data Processing for Analyzing China's Labor Productivity

2.1. Model Construction

Index decomposition analysis is widely used in empirical studies on carbon emissions and energy economics, with two main types: Laspeyres and Divisia decomposition methods [2,3].

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The Divisia approach includes the Arithmetic Mean Divisia Index (AMDI) and Logarithmic Mean Divisia Index (LMDI). The LMDI method has advantages, such as eliminating residuals, handling zero values, simplicity in calculation, and interpretability [4], making it a popular choice for driver analysis. Meanwhile, the LMDI decomposition method also has certain applications in the field of macroeconomics.

To examine industry factors influencing China's productivity changes from 2000 to 2022, we use the LMDI approach to decompose national labor productivity, focusing on three sectors: agriculture, industry, and services.

The model is constructed as follows, where national labor productivity and the labor productivity of the three sectors can be expressed by the following identity:

$$y_t = \frac{Y_t}{L_t} = \frac{Y_t^1+Y_t^2+Y_t^3}{L_t} = \frac{Y_t^1}{L_t^1} \times \frac{L_t^1}{L_t} + \frac{Y_t^2}{L_t^2} \times \frac{L_t^2}{L_t} + \frac{Y_t^3}{L_t^3} \times \frac{L_t^3}{L_t} = y_t^1 s_t^1 + y_t^2 s_t^2 + y_t^3 s_t^3 \quad (1)$$

In the above formula, y_t, y_t^1, y_t^2, y_t^3 represent the labor productivity of the nation, agriculture, industry, and services, respectively. Meanwhile, Y_t, Y_t^1, Y_t^2, Y_t^3 represent the value-added output of the national economy, agriculture, industry, and services. Additionally, L_t, L_t^1, L_t^2, L_t^3 represent the labor force numbers in the national economy, agriculture, industry, and services, respectively, while s_t^1, s_t^2, s_t^3 indicate the proportion of the labor force in agriculture, industry, and services relative to the total labor force.

By decomposing the national labor productivity in period t into the sum of labor productivity within each sector and the structure of labor across sectors, the change in national labor productivity from period t−1 to period t can be expressed by the following formula.

$$\Delta y_t = y_t - y_{t-1} = \sum_{i=1}^{3}\left(y_t^i s_t^i\right) - \sum_{i=1}^{3}\left(y_{t-1}^i s_{t-1}^i\right) \quad (2)$$

To extract the intra-industry effect and the inter-industry labor structure effect from Δy_t, we apply the LMDI method to decompose the change in national labor productivity into two main parts: the intra-industry effect and the inter-industry labor structure effect. Furthermore, each of these effects can be broken down into the intra-industry and inter-industry labor structure effects for each of the three main sectors.

$$\Delta y_t = y_t - y_{t-1} = \Delta y_{in} + \Delta y_{ls} = \Delta y_{in}^1 + \Delta y_{in}^2 + \Delta y_{in}^3 + \Delta y_{ls}^1 + \Delta y_{ls}^2 + \Delta y_{ls}^3 \quad (3)$$

In the formula above, Δy_{in} denotes the intra-industry effect, and Δy_{ls} represents the inter-industry labor structure effect. The superscript on each effect indicates the specific industry sector (e.g., agriculture, industry, or services). Based on the LMDI method, the calculation for each of these effects is as follows.

$$\Delta y_{in} = \sum_{i=1}^{3}\left(w_i \times ln\frac{y_t^i}{y_{t-1}^i}\right) \quad (4)$$

$$\Delta y_{ls} = \sum_{i=1}^{3}\left(w_i \times ln\frac{s_t^i}{s_{t-1}^i}\right) \quad (5)$$

$$w_i = \frac{y_t^i s_t^i - y_{t-1}^i s_{t-1}^i}{ln(y_t^i s_t^i) - ln(y_{t-1}^i s_{t-1}^i)} \quad (6)$$

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Through the above analysis, we have decomposed the change in national labor productivity into the intra-industry effect and the inter-industry labor structure effect across the three main sectors. By dividing both sides of the equation by the absolute value of labor productivity, we obtain the decomposed results for the national labor productivity growth rate.

In terms of economic significance, using agriculture as an example, the contribution of agriculture to the national labor productivity growth rate can be split into the contributions from the within-agriculture effect and the agricultural labor structure effect. Both effects carry equal weight; however, the distinction lies in the fact that the within-agriculture effect is solely related to changes in agricultural labor productivity (y_t^1/y_{t-1}^1) and is independent of changes in labor structure (s_t^1/s_{t-1}^1). Conversely, the agricultural labor structure effect is influenced by changes in labor structure (s_t^1/s_{t-1}^1) and is not related to changes in labor productivity (y_t^1/y_{t-1}^1).

For the intra-industry effect, we can analyze it for each individual industry or as an aggregate across all industries. The internal effects between different industries are independent and do not influence each other.

For the labor structure effect, analyzing a single industry in isolation is less meaningful. From an overall labor structure perspective, the sum of labor structure effects across agriculture, industry, and services has a particular economic implication: it reflects the contribution to the national labor productivity growth rate from differences in the labor share of each sector between the current and previous periods. If the total labor structure effect across the three sectors is positive, this indicates that the current labor structure changes are conducive to improving the national labor productivity growth rate, primarily through an increased share of labor in high-productivity sectors and a decreased share in low-productivity sectors. Conversely, if the total is negative, it suggests that the current labor structure changes are detrimental to the national labor productivity growth rate, as evidenced by a decrease in the labor share of high-productivity sectors and an increase in the share of lower-productivity sectors.

2.2. Data Processing

This study uses data on value-added and employment for each sector in each province from 2000 to 2022. Adjustments to constant 2020 prices are made to account for price variations, using value-added indices from the National Bureau of Statistics [5]. Employment data is sourced from provincial statistical yearbooks.

3. Decomposition Results by Industry Perspective

Using the LMDI model, we decomposed labor productivity growth in China from 2000 to 2022 by intra-industry and labor structure effects. The results are presented in the table below.

We find that the decomposition results of China's labor productivity exhibit the following three main characteristics:

First, China’s labor productivity growth rate exhibited an overall upward trend before the 2008 financial crisis, followed by a gradual decline. Since 2000, the average annual growth rate of labor productivity in China has been relatively high at 8.69%. In particular, from 2002 to 2012, the growth rate consistently remained above 9%, though a slight decrease occurred thereafter. Given the current high baseline of labor productivity, maintaining around a 5% growth rate is acceptable.

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Table 1. Growth Rate of Labor Productivity, Industry-Specific Effects, and Structural Effects in China

Year	Labor Productivity (10,000 RMB per person)	Labor Productivity Change (%)	Intra-industry effects (%)				Labor structure effects (%)
			Total	Agriculture	Industry	Services	
2001	26708	8.73	86.27	11.67	35.77	38.83	13.73
2002	29098	8.95	81.08	12.68	33.41	35.00	18.92
2003	31849	9.46	81.10	9.96	27.79	43.34	18.90
2004	34839	9.39	73.29	16.44	33.31	23.54	26.71
2005	38296	9.92	87.44	9.39	33.08	44.97	12.56
2006	42276	10.39	78.27	10.08	34.32	33.87	21.73
2007	47450	12.24	87.28	6.88	30.62	49.78	12.72
2008	52066	9.73	85.42	9.12	35.53	40.77	14.58
2009	56767	9.03	83.92	7.84	29.65	46.43	16.08
2010	62739	10.52	86.04	7.36	39.46	39.22	13.96
2011	69672	11.05	84.12	8.46	34.77	40.89	15.88
2012	76806	10.24	84.52	9.10	41.02	34.41	15.48
2013	83518	8.74	82.30	8.59	37.23	36.48	17.70
2014	89948	7.70	79.31	9.52	46.12	23.66	20.69
2015	97554	8.46	83.63	8.92	36.82	37.89	16.37
2016	105159	7.80	79.03	9.83	36.38	32.82	20.97
2017	113167	7.62	80.30	10.04	38.26	32.00	19.70
2018	121424	7.30	83.51	9.31	41.12	33.08	16.49
2019	129502	6.65	84.96	8.86	38.73	37.37	15.04
2020	136135	5.12	48.73	25.55	9.45	13.72	51.27
2021	146313	7.48	88.50	11.01	38.33	39.17	11.50
2022	153164	4.68	122.75	0.59	42.06	80.10	-22.75

Second, since 2000, the primary driving force behind China's labor productivity growth has been the intra-industry effect. Except for 2019-2020, the contribution rate of intra-industry effects has remained above 70%, with an average annual rate as high as 84.91%. For the period from 2000 to 2022, the average contribution rate of intra-industry effects was 83.26%, while the contribution rate of labor structure effects averaged only 16.74%. This demonstrates that the nationwide labor productivity growth mainly relies on the intra-industry labor productivity effect. Notably, during 2021-2022, labor structure effects showed a negative value for the first time, indicating that the labor structure in 2022 did not adjust in a way that supports productivity growth compared to 2021.

Third, from 2000 to 2022, the intra-industry effects show that agriculture's internal effect remained relatively stable, fluctuating around 10%, with an average value of 10.05%. In contrast, the contribution rates for industry and services were 35.15% and 38.06%, respectively, totaling 73.21%, with relatively large fluctuations. Notably, during the COVID-19 pandemic, the contribution from industry and services initially saw a significant decline, followed by a recovery.

4. Conclusion and Policy Recommendations

This paper primarily summarizes and analyzes changes in the labor productivity growth rate in China at the macro level. Firstly, it summarizes the characteristics of China's labor productivity from 2000 to 2022. Then, using the LMDI decomposition method, it performs an index decomposition of the growth rate of China's labor productivity to explain the changes in national labor productivity growth from 2000 to 2022 through the intra-industry effect and

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labor structure effect. Based on these findings, we propose the following policy recommendations.

Accelerating the development of new types of productivity is essential to enhance labor productivity effectively. A modern workforce is necessary, comprising both strategic talent capable of creating new productivity and applied talent proficient in managing new production resources. Utilizing advanced production tools, particularly in mastering core technologies, can empower the growth of emerging industries. Creating production relations that accommodate new productivity is also crucial. Through reform and opening, efforts should be made to remove bottlenecks that constrain the development of this new productivity, ensuring that various advanced and high-quality production factors can flow smoothly and be efficiently allocated toward new productivity growth.

In the industrial sector, it is essential to fully implement high-quality development actions within key manufacturing industry chains. This includes coordinating the promotion of core technology research projects, industrial foundation reconstruction projects, and major technical equipment projects, accelerating breakthroughs and the application of research achievements. Such efforts should foster a shift from isolated achievements to a cohesive and interconnected industrial network. To enhance the sector’s technological innovation capacity, it is important to deeply integrate scientific innovation with industrial innovation.

In the service sector, it is crucial to promote the development of productive manufacturing. Focusing on the needs of industrial transformation and upgrading, efforts should be directed at core aspects of the industry value chain and critical areas of resource allocation. Promoting high-quality development in sectors such as R&D and design, business consulting, human resources, supply chain finance, and data services is essential. Enhancing technological, managerial, and business model innovation can help deepen the integration of modern service industries with advanced manufacturing and modern agriculture.

References

[1] Information on https://www.gov.cn/xinwen/2016-09/01/content_5104470.htm

[2] Ang B W. The LMDI approach to decomposition analysis: a practical guide, Energy policy, vol. 33 (2005), 867-871.

[3] Ang B W. LMDI decomposition approach: A guide for implementation, Energy Policy, vol. 86 (2015), 233-238.

[4] Liu L C, Fan Y, Wu G, Wei Y M. Using LMDI method to analyze the change of China's industrial CO2 emissions from final fuel use: An empirical analysis, Energy Policy, vol. 35 (2007), 5892-5900.

[5] Information on https://www.stats.gov.cn/sj/