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# MISMATCH OF LABOR SUPPLY AND DEMAND AND THE PATH OF INDUSTRIAL UPGRADING IN THE CONTEXT OF DIGITAL ECONOMY

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## Abstract

In the context of digital economy, this paper mainly studies the impact of China's labor supply and demand mismatch on industrial structure upgrading, and the path of digital economy to adjust labor supply and demand mismatch and industrial structure upgrading. This paper puts forward three hypotheses: first, the mismatch of labor supply and demand will inhibit the advancement and rationalization of industrial structure; second, the regulatory effect of digital economy can force human capital to improve the industrial structure and contribute to the upgrading of industrial structure; third, the digital economy can alleviate the negative impact of the rationalization of the mismatched industrial structure of labor supply and demand. The empirical results of this study show that, first of all, the mismatch of labor supply and demand in China has a direct inhibitory effect on the upgrading and rationalization of industrial structure; Second, China's digital economy has played an important role in adjusting the imbalance between labor supply and demand and improving the industrial structure. This paper is devoted to finding out how to effectively deal with the problem of labor supply and demand mismatch, promote the upgrading of industrial structure, and maintain the steady growth of national economy.

**Keywords:** Labor Supply-Demand Mismatch, Upgrading Industrial Structure, Digital Economics, Regulation Effect

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## Introduction

To promote the steady growth of the national economy, China's industries should maintain high-quality development and take industrial upgrading as the basic purpose. As one of the important ways to promote the transformation of economic and social development mode and the optimization of industrial structure, the upgrading of industrial structure has a direct bearing on national economic security and sustainable development. In this case, the upgrading of industrial structure is promoted, which has become a key part of China's economic development at this stage.

However, with the development of economy, more and more factors affecting the upgrading of industrial structure emerge. The low efficiency of labor resources allocation causes the mismatch of labor resources among regions, industries and departments, which is the main obstacle restricting the upgrading of China's industrial structure. The mismatch of labor resources can be divided into two parts: one is labor demand and the other is labor supply. As for the demand for labor force, China's employers always have a large shortage of talents. Facing the severe situation of mismatch of labor supply and demand in China, how to effectively deal with the mismatch of labor supply and demand, find a way out of this problem, achieve the goal of full employment, promote the upgrading of industrial structure, and maintain the stable growth of national economy are the current topics that China must solve as soon as possible.

## Literature Review

There are many factors affecting the upgrading of industrial structures. Chen et al. (2017). believe that foreign direct investment is a catalyst for industrial upgrading in the economy, and it is necessary to promote the establishment and development of joint ventures. Intarakumnerd et al. (2016) studied how Thailand's semiconductor industry transformed from low-added value to high-added value, and concluded that the lack of industrial policies limited industrial technology upgrading. Pipkin and Fuentes (2017) concluded that local institutions and policies are the key factors for regional industrial structure upgrading. Tian et al. (2019) provided influencing factors for industrial structure upgrading through factor analysis, including process upgrading, product upgrading, and skill upgrading.

Liu et al. (2022) come up with that as a booster of the high-quality development of the economy, the digital economy according to the "G20 Digital Economy Development and Cooperation Initiative" released at the G20 Summit in 2016, the digital economy refers to a series of economic activities with the use of digital knowledge and information as key production factors, modern information network as an important carrier and the effective use of information and communication technology as an important driving force for efficiency improvement and economic structure optimization has extended the industrial chain, spawned a series of new industries and upgraded industrial upgrading is defined as the process that nations, firms, and workers, as economic actors, move from low-value to relatively high-value activities in global production networks traditional industries.

Dai et al. (2022) sums up some ideas about the quantity of employment, some scholars have argued that industrial upgrading has inhibited the quantity of employment. Banerji found that in the 1950s-1970s, Taiwan's emphasis on the development of labor-intensive industries contributed to the rate of employment growth and economic development in Taiwan, while India's preference for capital-intensive industries hindered economic development and labor specialization.

Based on the above study, for the impact of the digital economy on industrial structure upgrading, first the digital economy creates new industries and new modes of production. Second, the digital economy empowers traditional industries. Third, the digital economy promotes industrial integration. Fourth, the digital economy resolves the contradiction of

information asymmetry. The sum of everything that's been staged so far, this thesis put forward Hypothesis 1: China's digital economy promotes upgrading industrial structure.

For the impact of the mismatch of labor supply and demand on industrial structure upgrading, labor has always been an important production factor in the production process and a sufficient condition for industrial and economic development. Firstly, the labor supply and demand mismatch will reduce the industrial production efficiency and inhibit upgrading the industrial structure. Secondly, the mismatch of labor supply and demand inhibits the utilization efficiency of human capital and the upgrading of industrial structure. Thirdly, the mismatch of labor supply and demand hinders the knowledge spillover effect, thus inhibiting the upgrading of the industrial structure. The sum of everything that's been staged so far, this thesis put forward Hypothesis 2: China's labor mismatch inhibits upgrading the industrial structure.

For the interactive effects of the digital economy and labor mismatch on industrial structure upgrading, first the digital economy aggravates the mismatch of labor supply and demand, forcing the improvement of human capital, compensating for the loss of human capital utilization efficiency. Second, the mismatch of labor supply and demand leads to the substitution of capital for labor, the development of a digital economy, and the upgrading of industrial structure. Third, the creative effect of the digital economy and the improvement of human resource allocation efficiency have alleviated the mismatch between labor supply and demand and promoted the upgrading of industrial structure. The sum of everything that's been staged so far, this thesis put forward Hypothesis 3: The interactive effect of the digital economy and the mismatch of labor supply and demand plays a positive role in promoting upgrading industrial structure.

## Research Methodology

### Design of Model

This paper incorporates the digital economy and the labor supply and demand mismatch into the industrial structure upgrading analytical framework. After the Hausmann test, the paper selects the time and individual two-way fixed effect model for estimation, and the benchmark regression model is constructed as follows:

$$TS_{i,t} = \alpha_0 + \alpha_1 \ln S_{i,t} + \alpha_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

$$TL_{i,t} = \beta_0 + \beta_1 \ln S_{i,t} + \beta_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (2)$$

In equations,  $TS_{i,t}$  represents the high level of upgrading of industrial structure in the city  $i$  in period  $t$ .  $TL_{i,t}$  represents the general level of industrial structure rationalization and upgrading of the city  $i$  in period  $t$ .  $S_{i,t}$  represents the mismatch index of labor supply and demand for the city  $i$  in period  $t$ . The vector  $Z_{i,t}$  represents a set of control variables.  $\mu_i$  represents the individual fixed effect of the  $i$ th city that does not change with time;  $\delta_t$  represents the fixed effect of control time;  $\varepsilon_{i,t}$  represents the random disturbance term.

To further analyze the impact of the interaction between the digital economy and the mismatch of labor supply and demand on the upgrading of industrial structure, this paper introduces the interaction terms of the two based on the benchmark regression model:

$$TS_{i,t} = a_0 + a_1 \ln S_{i,t} + a_2 \ln Dige_{i,t} + a_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (3)$$

$$TS_{i,t} = b_0 + b_1 \ln S_{i,t} + b_2 \ln Dige_{i,t} + b_3 \ln S_{i,t} \times \ln Dige_{i,t} + b_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (4)$$

$$TL_{i,t} = c_0 + c_1 \ln S_{i,t} + c_2 \ln Dige_{i,t} + c_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (5)$$

$$TL_{i,t} = d_0 + d_1 \ln S_{i,t} + d_2 \ln Dige_{i,t} + d_3 \ln S_{i,t} \times \ln Dige_{i,t} + d_c Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \quad (6)$$

To avoid the multicollinearity problem after the interaction term is introduced into the model, this paper first conducted centralized processing on the two variables of labor supply and

demand mismatch ( $\ln S$ ) and digital economy ( $\ln Dige$ ) and then multiplied to obtain the interaction term ( $\ln S \times \ln Dige$ ).

### Data Collection and Analysis

In this paper, Chinese cities were selected as research samples. Due to the availability and completeness of data, 277 cities at the prefecture level and above were selected as research samples in the last nine years, from 2011 to 2019, with 2,472 observations or more. From the point of view of data sources, all data from the "China City Statistical Yearbook".

**Table 1** The results of descriptive statistics

Variable	Number of observations	Mean	Variance	Min	Median	Max
TS	2502	6.5188	0.346	5.52	6.50	7.84
TL	2511	0.2745	0.196	0.00	0.24	1.72
$\ln S$	2472	3.1966	0.951	0.87	3.11	6.95
$\ln Dige$	2510	-2.4756	0.484	-4.58	-2.46	-0.20
gov	2511	0.1991	0.101	0.04	0.17	0.92
hum	2502	1.7524	2.029	0.01	1.03	12.76
invest	2506	0.0001	0.000	0.00	0.00	0.01
infra	2511	17.2205	7.179	0.00	15.79	60.07
fin	2511	1.4308	0.711	0.37	1.29	20.10
grow	2509	8.6478	4.211	-19.38	8.30	109.00
FDI	2511	0.0212	0.060	0.00	0.01	1.28

### Research Results

Table 2 reports the estimation results of the upgrading and rationalization of the industrial structure of labor supply and demand mismatch. The regression results before and after adding control variables are listed respectively. It can be seen that the mismatch coefficient of labor supply and demand is relatively significant before and after the addition of control variables. Moreover, the labor supply and demand mismatch industrial structure upgrading coefficient is significantly negative, indicating that the labor supply and demand mismatch industrial structure upgrading has a restraining effect. However, the rationalization coefficient of industrial structure is significantly positive when the mismatch of labor supply and demand is mismatched. Since the Thiel index of industrial structure rationalization in this paper is a negative indicator, when the rationalization coefficient of industrial structure is positive, it indicates that the mismatch of labor supply and demand significantly inhibits the rationalization of industrial structure. The above verifies hypothesis 1 in this paper.

**Table 2** The estimation result of labor supply and demand mismatch of industrial structure is advanced and rationalized

	(1)	(2)
$\ln S$	-0.0173*** (-2.6548)	-0.0164** (-2.5149)
grow	-0.0003 (-0.5805)	-0.0001 (-0.2359)
FDI	0.0540 (0.6028)	-0.0877** (-1.9871)
hum	0.0010 (0.1630)	0.0061* (1.6749)
gov	0.0951 (0.8936)	0.3246*** (4.6710)
invest	1.6282	4.0075

		(1)		(2)
		(0.1534)		(1.2895)
fin		0.0066		0.0161***
		(1.4777)		(5.0752)
Infra		0.0016		-0.0007
		(1.6430)		(-1.2202)
_cons	6.4193***	6.3697***	-0.1842***	-0.2607***
	(302.1542)	(196.6101)	(-6.5432)	(-8.3573)
Urban fixed	YES	YES	YES	YES
Time fixed	YES	YES	YES	YES
Number of cities	2463	2458	2472	2467
Number of periods	9	9	9	9
R <sup>2</sup>	0.741	0.743	0.488	0.513

Note: What is reported in brackets in the table is robust standard error. \*\*\*, \*\* and \* respectively indicate that the regression results pass the significance test at 1%, 5% and 10% confidence level.

Table 3 reports the estimated results of the moderating effect of digital economy on the influence of labor supply and demand mismatch on the upgrading of industrial structure. It can be seen that after adding the digital economy as an instrumental variable, the mismatch coefficient of labor supply and demand is still obvious and does not change much. After further addition of the two interaction terms, it can be seen that the mismatch of labor supply and demand is still significantly negative, and the coefficient of the interaction term is significantly positive, and the coefficient of the interaction term is opposite to the mismatch coefficient of labor supply and demand, and the  $R^2$  is significantly increased, which explains the influence of digital economy on the mismatch of labor supply and demand and the upgrading of industrial structure, and plays a regulating role in weakening the inhibition effect of the mismatch of labor supply and demand. That is, hypothesis 2 of this study is verified.

**Table 3** The results of estimating the adjustment effect of digital economy on the upgrading of industrial structure

	(1) TS	(3) TS	(4) TS
lnS	-0.0164** (-2.5149)	-0.0173*** (-2.6786)	-0.0401*** (-4.5124)
lnDige		-0.2288** (-2.2013)	-0.2912*** (-2.8529)
lnS×lnDige			0.0039*** (3.7093)
grow	-0.0003 (-0.5805)	-0.0002 (-0.5158)	-0.0002 (-0.4422)
FDI	0.0540 (0.6028)	0.0510 (0.5814)	0.0732 (0.7407)
hum	0.0010 (0.1630)	0.0009 (0.1365)	0.0002 (0.0250)
gov	0.0951 (0.8936)	0.0799 (0.7476)	0.0821 (0.7841)
invest	1.6282 (0.1534)	0.6690 (0.0638)	0.9592 (0.0922)

	(1) TS	(3) TS	(4) TS
fin	0.0066 (1.4777)	0.0061 (1.4365)	0.0059 (1.4900)
infra	0.0016 (1.6430)	0.0015 (1.5728)	0.0015 (1.6135)
_cons	6.3697*** (196.6101)	6.3879*** (190.4565)	6.4572*** (170.1177)
Urban fixed	YES	YES	YES
Time fixed	YES	YES	YES
Number of cities	2458	2458	2458
Number of periods	9	9	9
$R^2$	0.743	0.744	0.748

Note: What is reported in brackets in the table is robust standard error. \*\*\*, \*\* and \* respectively indicate that the regression results pass the significance test at 1%, 5% and 10% confidence level.

Table 4 reports the estimated results of the moderating effect of digital economy on the rationalization of labor supply and demand mismatch of industrial structure. It can be seen that it is similar to Table 6, before and after the addition of digital economy variables, the mismatch coefficient of labor supply and demand does not change significantly, and is significantly positive. After the two interaction terms are added, their  $R^2$  increases significantly, and the coefficient of the interaction term is opposite to the mismatch coefficient of labor supply and demand, indicating that the digital economy also significantly weakens the mismatch of labor supply and demand and inhibits the rationalization of industrial structure, that is, hypothesis 3 of this study is verified.

**Table 4** The results of estimating the regulatory effect of digital economy on the rationalization of industrial structure

	(2) TL	(5) TL	(6) TL
lnS	0.1443*** (15.4453)	0.1451*** (15.6473)	0.1597*** (12.3764)
lnDige		0.2188*** (3.0012)	0.2589*** (3.6279)
lnS×lnDige			-0.0025** (-1.9998)
grow	-0.0001 (-0.2359)	-0.0002 (-0.3095)	-0.0002 (-0.3600)
FDI	-0.0877** (-1.9871)	-0.0848** (-2.0230)	-0.0990** (-2.2090)
hum	0.0061* (1.6749)	0.0062* (1.7186)	0.0067* (1.9151)
gov	0.3246*** (4.6710)	0.3390*** (4.8059)	0.3376*** (4.7324)
invest	4.0075 (1.2895)	4.9233 (1.6214)	4.7388 (1.5988)
fin	0.0161*** (5.0752)	0.0165*** (4.8925)	0.0166*** (4.6094)

	(2) TL	(5) TL	(6) TL
infra	-0.0007 (-1.2202)	-0.0006 (-1.0790)	-0.0007 (-1.1095)
cons	-0.2607*** (-8.3573)	-0.2780*** (-8.6114)	-0.3225*** (-7.7927)
Urban fixed	YES	YES	YES
Time fixed	YES	YES	YES
Number of cities	2467	2467	2467
Number of periods	9	9	9
$R^2$	0.513	0.516	0.521

Note: What is reported in brackets in the table is robust standard error. \*\*\*, \*\* and \* respectively indicate that the regression results pass the significance test at 1%, 5% and 10% confidence level.

## Conclusion

First, the advantages of labor resource endowment should be given full play, which hinders the improvement of industrial productivity, affects the normal economic activities among industries, and harms the industrial structure upgrading. On the other hand, the mismatch of labor supply and demand also significantly inhibits the rationalization of industrial structure. The mismatch of labor resources inhibits the accumulation of human capital, thus inhibiting the generation of knowledge spillover effect. The mismatch of labor impedes the free flow of labor, widening the distance between the knowledge spillover receiving place and the knowledge spillover place. Thus, the knowledge spillover effect is hindered, labor resources need to be fully utilized, and the industry harms the rationalization of industrial structure.

Second, the development of China's digital economy has played an indispensable role in promoting the upgrading industrial structure. On the one hand, the digital economy has a direct role in promoting the advanced industrial structure. The penetration of the digital economy in terms of coverage and high efficiency effectively enhances production efficiency and reduces production costs, promoting the advanced industrial structure. On the other hand, the digital economy has no apparent direct impact on rationalizing industrial structure, but it has a significant moderating effect. By integrating resources and improving the efficiency of resource allocation, the digital economy effectively weakens the inhibiting effect of labor supply and demand mismatch on industrial structure upgrading.

Third, the interactive effect of China's digital economy and labor supply and demand positively impacts promoting industrial structure upgrading. On the one hand, the interaction effect between the digital economy and labor supply and demand has a significant positive effect on industrial structure upgrading, which strengthens the promotion effect of the digital economy on industrial structure upgrading and weakens the inhibiting effect of labor supply and demand mismatch on industrial structure upgrading. On the other hand, the interaction effect of the digital economy and labor supply and demand significantly inhibits the rationalization of industrial structure, which significantly weakens the influence of labor supply and demand mismatch on the rationalization of an industrial structure under the regulation of the digital economy.

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**Data Availability Statement:** The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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