Labor Costs Rising and the Behavior of Enterprises: Transfer or Innovate?

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Abstract

Recently, China's labour costs were rising fast, the enterprises were facing the choice that moving to lower cost regions or innovating. In order to analyse the impact of labour cost rising on enterprise innovation behaviour, by establishing a model with innovation arbitrage, this paper makes an empirical analysis using provincial panel data in Chinese industrial department from 2000 to 2011. The study shows that the rising labour costs had a stimulating role on the enterprise's R&D input, and the output of innovation also increased, but the patents couldn't be effectively transformed into market products. The profound analysis by different regions shows that the innovation inputs and outputs of eastern enterprises are better than the central and western.

Keywords: *Labour costs rising; Transfer; Innovation; Market transformation; Regional differences*

1.INTRODUCTION

Abundant and cheap labour resources have always been the sustainable driving force of China's economic development. However, in recent years, the low fertility and aging of China's population have led to the reduction of the new working age population, resulting in the shortage of labour force and a rapid rise in wages. The advantage of labor costs in some parts of China has gradually been lost. Many enterprises in the eastern region have migrated to the central and western regions or Southeast Asian countries in order to reduce costs, and the trend of this migration is accelerating. It could be seen that if the cost of rising labor prices cannot be offset by technological progress, capital will withdraw from the eastern region, resulting in a "crowding out effect" on population and industry, and may even lead to "de industrialization".

In the short term, in order to avoid high labor costs, enterprises move their factories to low-cost areas, which can prolong the survival time and maintain the profit space based on low cost. In the long run, when the rising trend of labor costs is inevitable, the development of enterprises depends on the improvement of productivity and technological progress. However, the reality of China's economic development is that enterprises lack sufficient motivation to innovate actively, that is, without exogenous pressure, enterprises will not take the initiative to undertake innovation activities (Madsen, 2001). Under the pressure of rising labor costs, will Chinese industrial enterprises actively innovate based on local market advantages, so as to promote industrial structural transformation?

About the relationship between labor costs change and enterprise innovation, neoclassical growth theory and endogenous growth theory paid attention to the relationship earlier. Neoclassical economic growth theory supported the view that rising labor costs promote enterprise innovation. Solow (1957) believed that lower wages would delay the upgrading of enterprises' machinery and equipment, because low wages still have profit space and enterprises have no motivation for innovation. Endogenous growth theory put more emphasis on the role of high wages in enterprise innovation, and believed that the rise of labor costs will induce enterprises to carry out endogenous innovation. Romor (1987), a representative, believed that raising wages is a mechanism to induce enterprises to innovate, and the innovation ability of enterprises will decline with the reduction of labor remuneration.

In terms of empirical research, most of the research support the conclusion of "high labor costs - high innovation". Among them, kleinkrecht (1998) investigated Dutch enterprises and found that low wage level enabled low productivity enterprises to survive, hindered the process of "creative destruction", and

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plunged the Netherlands into the dilemma of "low wage-low innovation". Van Reenen (2007) found that there was a substitution effect between wages and technological innovation through the study of British enterprises.

However, the previous literature on the innovation behavior of Chinese enterprises from the perspective of rising labor costs was slightly insufficient. What was groundbreaking is that, Zhang Qingchang and Li Ping (2011) Based on the research on the total factor productivity of Chinese industrial enterprises pointed out that the rise of wages promoted the improvement of enterprise productivity, but there was a threshold effect; Yao Xianguo and Zeng Guohua (2012) believe that labor costs were a positive cost. The rise of labor cost from 1999 to 2007 has promoted the improvement of labor productivity, and the incentive function of labor costs was obvious in the acceleration stage.

From the above literature review, it can be seen that there were still few studies on the innovation behavior of Chinese enterprises from the perspective of rising labor costs. Based on the current trend of China's adjustment of economic structure and industrial transfer, this paper analyzes the impact of changes in labor costs on enterprises innovation behavior.

2.MATHEMATICAL MODEL CONSTRUCTION

Based on Aghion (2009) and Dai Jing et al. (2013), this paper establishes a concise two manufacturer innovation model with rising labor costs, and analyzes the impact of rising labor costs on manufacturers' innovation arbitrage conditions and innovation input and output. The basic assumption of the model is that every manufacturer has the ability to innovate, and the utility of innovation is the decline of production cost.

2.1. Producer Analysis

Suppose: the market is completely competitive, the return to scale remains unchanged, there are only one department of economy and society, two manufacturers A and B, and the product X produced by the manufacturer is homogeneous, so the price is P_x under the competitive equilibrium. At the same time, it is assumed that only labor factors are used for production without considering other input factors.

2.2. Consumer Analysis

Suppose there are consumers with quantity L, each consumer has a unit of labor endowment, and the labor price is ω, and there is no elastic supply of labor. At the same time, in order to simplify the analysis, it is assumed that half of the products purchased by consumers come from manufacturer A and half from manufacturer B. The utility of consumers depends on the number of products consumed, X_t represents the total amount of products purchased by all consumers, then the budget constraint of each consumer is: $1 \cdot \omega = \frac{X_t}{L} \cdot P_x$. The market demand of available product X is $X_t = \frac{\omega L}{P_x}$.

2.3. Analysis of R&D Investment under the Condition of Innovation Arbitrage

Assumption: every enterprise has the opportunity to innovate, and the innovation investment is a certain proportion of the product sales value R_i, Before innovation, it is assumed that the productivity of the two manufacturers is 1, and the productivity of the manufacturer after successful innovation is φ_i. The manufacturer's production cost is in direct proportion to the labor price ω.

Enterprises need certain investment for innovation. The more investment in R&D, the higher possibility succeed in innovation, that is, the probability of successful innovation q_i is positively depend on the level of investment in scientific research activities R_i. Then the innovation equation can be expressed as: $q_i = f(R_i) = \alpha_i (R_i)^{\rho}$, Where R_i is the proportion of enterprise R&D investment in product sales value, $0 \le R_i \le 1$; α_i is the R&D efficiency parameter of the R&D department, $0 \le \alpha_i \le 1$; ρ is the output elasticity of R&D input, $0 \le \rho_i \le 1$.Then the profits before and after innovation are:

$$\pi_0 = \frac{1}{2}\omega L - \frac{\delta_i \omega^2 L}{2P_x} \tag{1}$$

$$\pi_1 = \frac{1}{2}\omega L - \frac{\delta_i \omega^2 L}{2P_x(1+\varphi)} \tag{2}$$

Then the expected profit of the manufacturer's R&D activities is:

$$\pi_i = \pi_0 \cdot (1 - q_i) + \pi_1 \cdot q_i - \frac{1}{2} X_t P_x \cdot \left(\frac{q_i}{\alpha_i}\right)^{\frac{1}{\rho}}, \quad i = A \text{ or } B$$

$$= \left(\frac{1}{2}\omega L - \frac{\delta_i \omega^2 L}{2P_x}\right) \cdot (1 - q_i) + \left[\frac{1}{2}\omega L - \frac{\delta_i \omega^2 L}{2P_x(1+\varphi)}\right] \cdot q_i - \frac{1}{2}\omega L \left(\frac{q_i}{\alpha_i}\right)^{\frac{1}{\rho}} \tag{3}$$

According to the principle of profit maximization, the optimal innovation R&D investment derived is:

$$R_i = \left[\frac{\rho_i \alpha_i \delta_i \omega}{P_x}\left(1 - \frac{1}{1+\varphi_i}\right)\right]^{\frac{1}{1-\rho_i}} \tag{4}$$

It can be seen from equation (4) that the optimal R&D investment R_i has a positive relationship with wage level ω, innovation income φ and innovation efficiencyα_i. It shows that when labor costs rise, manufacturers increase the R&D investment level in order to digest the pressure of rising costs and obtain the excess profits brought by innovation.

2.4. Innovation Output

In this paper, the Cobb Douglas form is used to construct the innovation output function. If only labor input and innovation input are considered, the innovation output function can be simplified as:

$$Y_i = (\alpha_i l_i)^{1-\beta} R_i^{\beta}, \qquad 0 \le \beta \le 1 \tag{5}$$

From the optimal R&D input (4), the optimal innovation output can be deduced as:

$$Y_i = {\alpha_i}^{\tau} {l_i}^{1-\beta} \left[\frac{\rho_i \delta_i \omega}{P_x}\left(1 - \frac{1}{1+\varphi_i}\right)\right]^{\vartheta},$$

$$\tau = 1 + \frac{\rho\beta}{1-\rho},\ \vartheta = \frac{\beta}{1-\rho} \tag{6}$$

It can be seen from (6) that under the competitive equilibrium, the optimal innovation output of manufacturers is determined by factors such as labor costs ω, labor quantity l_i, innovation income φ and innovation efficiency α_i. Among them, the innovation output of Y_i has a positive relationship with labor price ω, which shows that the innovation output efficiency increases with the rise of labor costs when other factors remain unchanged.

From the analysis of the above theories and mathematical models, we can draw the following hypothesis: the rise of labor costs will induce enterprises to increase R&D investment intensity and promote enterprises to improve innovation output efficiency. Compared with the central and western regions, enterprises in eastern China should be more innovative.

3.EMPIRICAL ANALYSIS

3.1. Empirical Model Setting

This paper selects large and medium-sized industrial enterprises at the provincial level in China as the research sample, which includes 29 provinces and municipalities directly under the central government. However, Tibet and Hainan provinces are not included in the sample due to the lack of data in some years. The sample data is from 2000 to 2011. The dynamic panel model set in this paper is as follows:

$$Y_{it} = \alpha_0 + \alpha_1 Y_{it-1} + \beta_1 lnWage_{it} + \rho X_{it} + \varepsilon_{it} \tag{7}$$

Among them, Y_{it} is the explained variable and Y_{it-1} is the lag period to control the cumulative dynamic effect of innovation. $lnWage_{it}$ is the core explanatory variable: logarithm of wage level; X_{it} represents other control variables, including other factors affecting enterprise innovation; α_0 is the intercept item, ε_{it} represents the error term.

3.2. Variable Definition

This paper uses the number of patent applications to measure innovation output. The average wage of large and medium-sized industrial enterprises in the region is expressed by $Wage_{it}$. The total wage of large and medium-sized enterprises in mining, manufacturing, power, gas and water production and supply industries is divided by all employees.

X_{it} represents other control variables. This paper selects the land price, enterprise scale, enterprise performance, and technology introduction level, the number of employees of all enterprises, the level of foreign capital utilization and the level of financial development reflecting the regional economic characteristics as the control variables.

Table 1 Statistical Characteristics of variables

Variables	mean	Standard error	Min	Max
Newb	0.143	0.087	0.010	0.448
lnPatent	6.701	1.536	3.296	10.68
RD	0.023	0.009	0.006	0.052
lnWage	9.664	0.413	8.803	10.73
lnLand	5.506	0.918	2.589	8.590
lnWorker	4.495	0.883	2.216	6.815
lnScale	1.479	0.512	0.115	2.750
Debt	59.233	5.529	32.150	72.50
Techb	28.326	27.325	0.091	199.6
FDI	0.028	0.025	0.001	0.147
Finance	2.427	0.833	1.279	6.662

The data of this paper mainly comes from China Statistical Yearbook, China Science and technology statistical yearbook, China Industrial Economy Statistical Yearbook, China land and resources statistical yearbook and financial statistical yearbook from 2000 to 2011.

3.3. Estimation method

In this paper, GMM for Dynamic Panel Data estimation method is used to estimate the regression equation. Compared with static panel estimation, dynamic panel GMM can not only control the time fixed effect and individual effect, but also solve the endogenous problem of explanatory variables by using the lag term of explanatory variables as instrumental variables.

In this study, because wages are endogenous, in order to effectively avoid the error caused by endogenous, $Wage_{it}$ is set as an endogenous explanatory variable. GMM estimation includes differential GMM and System GMM. Compared with differential, System GMM estimation can improve the efficiency of estimation. Therefore, System GMM is used for estimation in this paper. At the same time, in order to solve the problem of

over identification and possible bias caused by too many tool variables, this paper limits the maximum use of first-order or second-order lag variables as tool variables according to the method of Roodman (2009).

4.REGRESSION RESULT ANALYSIS

In this part, GMM for dynamic panel data estimation method is used to estimate the regression equation. As shown in the empirical test results in Table 2-3, when the control variables are fully considered, the regression results with R&D investment intensity and the number of patent applications as the explained variables are very significant, and the results of Sargan and AR (2) statistics show that there is no over identification of instrumental variables and second-order sequence related problems.

4.1. Impact of Rising Labour Costs on R&D Investment

Taking the R&D investment intensity RD of various provinces and cities as the explanatory variable, L_1RD represents the corresponding value of the first lag period. The empirical results are shown in the regression (1) - (2) of Table 2.

The results of regression (2) show that in addition to other influencing factors, the core variable that wage level（lnWage）has a positive significant relationship with R&D investment intensity (RD). At the significant level of 1%, the R&D investment intensity increases by about 0.431% for every 1% increase in wages. This shows that the rise of wages can significantly promote the R&D investment of enterprises, which is consistent with our hypothesis. Like the wage level, land price can promote the intensity of R&D investment, but it is not significant. This is likely that various regions intend to lower the price of industrial land to attract investment and develop industry. Therefore, industrial enterprises are not sensitive to the change of land price.

Table 2 Impact of rising labour costs on RD

variables	(1)	(2)
	RD	RD
L1	0.623*** (0.01)	0.372*** (0.042)
lnWage	0.076*** (0.006)	0.431*** (0.043)
lnLand		0.008 (0.012)
lnScale		-0.256*** (0.032)
Techb		0.0006** (0.0003)
Debt		0.003 (0.002)
lnWorker		0.039 (0.038)
FDI		4.291** (1.752)
Finance		0.087 *** (0.013)
Constant term	-0.448*** (0.056)	-3.685*** (0.382)
AR (2)	0.271	0.613
Sargan	0.993	0.998

Note: the figures in brackets are standard deviation, *, * *, * * * respectively indicate significant at the level of 10%, 5% and 1%; Sargan is the p value of sargan test statistic for over identification of instrumental variables; AR (2) is the p value of Arellano bond test statistic related to the existence of second-order sequence in the model.

4.2. Impact of Rising Factor Prices on Innovation Output

Taking the logarithm of patent applications of large and medium-sized industrial enterprises in various provinces and cities (lnPatent) as the explanatory variable, the empirical results are shown in the regression (3) - (4) in Table 3.

As the regression result (4) shows, after controlling the cumulative effect of patent applications in various regions and other influencing factors, there is a positive and significant relationship between the wage level （lnWage） and the number of patent applications. For every 1% increase in wages, the number of patent applications increases by about 0.72%, which shows that the rise in wages has a great effect on the innovation output of enterprises. Enterprises are facing rising labor costs, which not only increase the investment in R&D, but also improve the efficiency of innovation output.

Table 3 Impact of rising labor costs on innovation output

variables	(3)	(4)
	lnPatent	lnPatent
L1	0.677*** (0.02)	0.367*** (0.130)
lnWage	0.696*** (0.06)	0.720** (0.336)

lnLand		0.059** (0.027)
lnScale		0.269** (0.134)
RD		0.450** (0.233)
Techb		0.002*** (0.0008)
Debt		-0.006 (0.007)
lnWorker		0.714*** (0.200)
FDI		5.763 (6.506)
Finance		0.011 (0.077)
Constant term	-4.352*** (0.467)	-6.720*** (1.962)
AR (2)	0.075	0.528
Sargan	0.998	0.999

Note: Same as table 2.

4.3. Robustness Test

In order to test whether the changes of model samples affect the measurement results, this paper further uses the output value rate of new products (the ratio of sales revenue of new products to total output value of enterprises) to test the robustness.

In Table4, the regression results with the logarithm of new product output value rate (lnNewb) as the dependent variable show that at the significant level of 1%, the coefficient of the core explanatory variable lnWage is 0.012, indicating that the rise of wage level plays a significant positive role on promoting the output value rate of new products, which is consistent with the previous regression results.

Table 4 Robustness Test

variables	(5)	(6)
	Newb	Newb
L1	0.506*** (0.028)	0.265*** (0.078)
lnWage	0.016*** (0.002)	0.012** (0.007)
lnLand		-0.0003 (0.002)
lnScale		0.004 (0.006)
RD		0.070*** (0.011)
Techb		-0.0001 (0.001)
Debt		-0.001*** (0.0003)
lnWorker		-0.003 (0.008)
FDI		0.712*** (0.246)
Finance		0.001 (0.004)
Constant term	-0.088*** (0.019)	-0.001 (0.057)
AR (2)	0.306	0.197
Sargan	0.999	1.000

Note: Same as table 2.

4.4. Regional Difference Test

Through the previous regression analysis at the national level, we verified the conclusion that the rise of labor costs will promote enterprise innovation. However, China is a country with large regional differences. There are certain differences in wage level, enterprise scale and economic and social development level. Therefore, it is necessary to make a more in-depth analysis at the regional level. Therefore, this paper carries out the regression of the same control variables for 29 provinces and cities according to the eastern (10 provinces and cities) and central and Western (19 provinces and cities), and the test results are shown in Table 5.

From the regression results in Table 5-6, sargan and AR (2) statistics show that there is no over identification of instrumental variables and second-order sequence correlation. The impact of rising labor costs on the innovation behavior of large and medium-sized enterprises in the East and the central and western regions has obvious regional differences.

Table 5 Sub regional empirical results

variables	Eastern Region	
	RD	lnPatent
L1	0.185 (0.345)	0.424 (0.522)
lnWage	0.633* (0.378)	3.963** (2.051)
Constant term	-3.734* (1.988)	-22.635* (12.147)

AR (2)	0.366	0.164
Sargan	0.998	0.803

The regression results of other control variables are omitted.

For enterprise innovation investment (RD), for every 1% increase in labor costs, the R&D investment intensity of enterprises in the eastern region will increase by 0.633%, and that in the central and western regions will increase by about 0.50%. It can be seen that enterprises in the eastern region will increase more in R&D investment in the face of rising labor costs. For innovation output, for every 1% increase in labor costs, the innovation output of the eastern region will increase by 3.963% and that of the central and western regions will increase by 1.108%. It can be seen that the innovation output of the eastern region under the pressure of rising labor costs is more than three times that of the central and western regions. This shows that in recent years, the rising range of labor costs in the eastern region is greater than that in the central and western regions, and the cost rising pressure of eastern enterprises is greater, so the innovation power and innovation output efficiency are also higher.

Table 6 Central and Western Regions

variables	RD	lnPatent
L1	0.311** (0.160)	0.300 (0.207)
lnWage	0.500*** (0.106)	1.108 * (0.670)
Constant term	-4.143*** (0.881)	-7.278* (4.039)
AR (2)	0.972	0.223
Sargan	0.937	1.000

The regression results of other control variables are omitted.

5.CONCLUSIONS

Based on the analysis of mathematical model, using the panel data of large and medium-sized enterprises in 29 provinces and cities in China from 2000 to 2011, under the influence of controlling land price, enterprise scale, enterprise asset liability ratio, foreign technology introduction level and regional economic characteristics, this paper analyzes the impact of regional labour costs changes on enterprise innovation input intensity and enterprise innovation output. Looking at the full text, we draw the following conclusions.

Firstly, in order to cope with the pressure of rising labor costs, while low value-added enterprises migrate to low-cost areas, the retained enterprises increase the R&D input intensity and improve the R&D output efficiency, indicating that the appropriate increase of labor costs is conducive to get rid of the traditional economic growth mode relying on low-cost factor input, so as to contribute to the adjustment of economic structure.

Secondly, the market docking and transformation ability of patent achievements of enterprise innovation is insufficient. The enterprise did not conduct research and development based on the market demand, and the patent achievements could not be effectively transformed into the products required by the market. As a result, the enterprise did not give full play to the advantage in the number of patent output when developing the market.

Finally, facing the pressure of rising costs, enterprises in the East, central and western regions show significantly different in innovative behaviors. Compared with the central and western regions, eastern enterprises facing greater pressure of rising labor costs show greater innovation.

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