Industrial transfer and regional economy coordination based on multiple regression model

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Abstract

In the development of urban construction, regional economic differences have always been the focus of the government, society and academia. As an eastern coastal province in China, although Jiangsu has a relatively high level of economic development from an overall point of view, there is still a serious problem of regional economic disparity within it. Therefore, based on the development of local economic construction and the understanding of the phenomenon of industrial transfer, this paper uses a multiple regression model to study the regional economic coordination and thus puts forward appropriate solutions.

Keywords: Multiple regression, Industrial transfer, Regional economy, coordination.
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1 Introduction

1.1 Industrial transformation

Simple speaking, refers to the enterprise as the main body of industry transformation of the economic activity, belongs to a country or region in order to promote the industry innovation, factors such as the condition of resource supply or demand change, part in the mature industry, innovation, or recession stage of development from one country or area to another country or region of a kind of economic behaviour. The specific mechanism is shown in the figure below:
Based on the framework of neoclassical ideas, the corresponding mathematical model analysis shows that suppose there are only two countries in the world, namely country A and country B and labour as the only factor of production, there are only two kinds of products, namely product 1 and product 2. Within the country, the products produced by all enterprises have the same production function, and the markets of each country are perfectly competitive. In the case of clear production function $F$, the production quantity of product I in country $J$ is $Y_{ij}$, and the input quantity of labour is $L_{ij}$, then we can get [1]:

$$Y_{ij} = F_{ij}(L_{ij}) (i = 1, 2; j = a, b)$$

Also

$$F'_{ij}(L_{ij}) = F_{ij}(L_{ij}) / L_{ij}$$

Combined with the analysis shown in Figure 2, in the context of long-run equilibrium, the marginal output or marginal revenue of each sector in each country is equal to its average output and average income. $L_{ij}$ represents the minimum cost and labour input of the product’s production in each country, which can be calculated as $L_{ij0}$. Consider that the total output of product I produced in country $J$ can be regarded as $Z_{ij}$, and the consumption propensity and production function of the two countries are the same, then the Douglas production function can be defined [2].

In the case of the same propensity to consume products, it is assumed that the income of product I in country $J$ is $I_{j}$ and the actual demand of product I is $X_{ij}$, then we can get:

$$N_{ij} = a_{ij} (L_{j} / L_{ij0})$$

According to the analysis of the above formula, the sum of the number of enterprises in the industry I in
country $J$ can use the ratio of the expenditure propensity of the I industry product and the minimum input labour cost of the product I in the total amount of labour input.

1.2 Economic status

According to the analysis of the economic development situation of the north and south of Jiangsu area at present, due to its regional advantages, in the process of industrial innovation and continuous expansion of industrial scale, enterprises in the southern region have gradually gathered. In this way, they can not only obtain more professional products and services but also build a shared labour market. Although the northern region has also achieved certain economic benefits, the overall development level has decreased significantly compared with the southern region. Especially after entering into the 1990s, the economic differences between the north and the south became more and more obvious and gradually formed a ladder development situation from the south to the north. Such unbalanced development has led to serious imbalances in infrastructure, medical investment and education levels in both regions. Nowadays, the land cost and labour force in people’s areas are increasing with the economic development, and the overall consumption level is also increasing. Moreover, with the expansion of the industrial scale, development problems such as environmental pollution and resource shortage are gradually introduced. In this context, transferring some industries to the northern region and sharing them with the southern economic development can not only solve the problems of the current industrial economic development but also promote the pace of economic construction and innovation in the northern region \[3\].

By studying the strength of the economic connection between the two regions, it can be seen that the degree of economic connection between the two regions is directly proportional to the mass of the two regions and inversely proportional to the distance between the centres of the two regions. Consider building a model as shown below:

$$R_t = \sqrt{\frac{P_n V_n}{P_S V_S}} / D^2$$

Among them, $R_t$ represents the maximum possible strength of the economic connection between the two places. $P_n$ is the total population of northern Jiangsu, in 10,000 people; $P_S$ represents the total population in the south of Jiangsu in 10,000; $V_n$ represents the total industrial output in northern Jiangsu Province, in units of 100 million yuan; $V_S$ represents the total industrial output in the south of Jiangsu Province, and the unit is 100 million yuan.

Combined with the investigation and analysis of the strength of the regional economic connection between the two sides in recent years, we can see that it has been showing a gradual upward trend. This also proves the importance of industrial transfer in economic development and industrial upgrading.

2 Empirical analysis

2.1 Problem summary

The classical multiple regression model is shown as follows:

$$Y = a_0 + a_1 x_1 + a_2 x_2 + \ldots + a_p x_p + \epsilon$$

It can visually present the predictor $Y$ and factors $x_1, x_2...$. The linear relationship between.

Since there are few cases of a linear relationship between predictors and factors in actual data and most of them are non-linear, in order to expand the application range of the model, factors will be transformed based on several forms of function transformation and then selected by means of stepwise regression. The details are as follows:

First of all, it is necessary to define the function conversion form that can be selected based on the physical background of the data:

Linear function: $y = A + Bx$

Hyperbolic function: $y = x / (Ax + B)$

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Power function: \( y = Ax^B \)

Logarithmic function: \( y = A + B \log x \)

Exponential function: \( y = A \exp(Bx) \)

Fractional exponential function: \( y = A \exp\left(\frac{B}{x}\right) \)

Second, for \( y \) and \( x_i \) \((i = 1, 2, 3 \ldots, p)\), construct six unary regression models, as shown above, compare the value of \( F \) and select the regression model corresponding to the maximum value of \( F \) as the function transformation form of \( x_i \), and get:

\[ y_i = f_i(x_i), i = 1, 2, \ldots, p \]

And finally, we want \( y \) to be equal to \( y_1, y_2, y_3 \ldots \) YP implements stepwise regression and builds \( x_1, x_2, x_3 \ldots \) The nonlinear multiple regression model of XP.

In this method, only 6p unary regression is needed to select the function transformation form of the factors.

2.2 Model derivation

In the derivation of model establishment, the southern and northern parts of Jiangsu were taken as the whole regional economy for in-depth discussion and the production function equation as shown below can be obtained, respectively:

\[ S_t = S(L_s, K_s) \]
\[ B_t = B(L_B, K_B, S^*_t) \]
\[ Y_t = S_t + B_t \]

In the above formula, \( S_t \) represents the total production value of the southern region in the period of \( t \), while \( B_t \) represents the total production value of the northern region in the period of \( t \). \( L_s \) represents the size of the labour force in the southern region at the time \( t \) and \( L_B \) represents the size of the labour force in the northern region at the time of \( t \); \( K_s \) represents the investment level of fixed assets in the southern region in the period \( t \); \( K_B \) represents the investment level of fixed assets in the northern region in the period \( t \); \( S^*_t \) represents the total industrial production value in the southern region in the period \( t \).

At the same time, since the externalities of industrial transfer in both regions can only be reflected after a period of time, the formula can be obtained as follows:

\[ S^*_t = \theta S_t + (1 - \theta) S^*_{t-1} \]

In the above formula, \( 0 < \theta \leq 1 \), it is proved that the externality of industrial transfer in the southern region meets the following conditions: First, the externality of total output quantity \( S_t \) to the northern region is 1, and meets the condition of \( \theta \sum_{i=0}^{m} (1-\theta)^i = 1 \). In this case, the essence of the adaptive expectation model is to assume that the externality of industrial transfer from the south to the north should conform to the geometric lag condition. Second, the externality coefficient \( a_j \) of industrial transfer will decrease with time. Combined with the above formula analysis, it can be seen that the externality coefficient of the total output quantity of the southern region in the lag stage will show a geometric decreasing trend according to the ratio of \( (1-\theta) \).

Thus, the production function of the two regions is substituted into the formula to obtain the total differential, and the following can be obtained:

\[ dY_t = S_L dL_s + S_K dK_s + B_L dL_B + B_K dK_B + B_{S^*} dS^* \]

At this point, it is assumed that the marginal elements of the two regions are different, so it can be concluded that:

\[ \frac{S_L}{B_L} = \frac{S_K}{B_K} = 1 + \delta \]
Substituting the above two formulas into the analysis, we can get:

\[ dY_t = (1 + \delta) B_L dL_t + (1 + \delta) B_K dK_t + B_L dL_{B_t} + B_K dK_{B_t} + B_S dS^* \]

\[ = B_L dL_t + B_K dK_t + B_S dS^* + \delta \left( B_L dL_{S_t} + B_K dK_{S_t} \right) \]

\[ = B_L dL_t + B_K dK_t + B_S dS_t + \frac{\delta}{1 + \delta} dS_t \]

At this point, let \( dS_t^* = \theta \mu_t dS_t \)

In the above formula, \( \theta \) represents the multiplier of the external impact factor of industrial transfer, and \( \mu_t \) represents the proportion of the total GDP of the industrial sector in the local GDP. Continuing into the above formula, we can get:

\[ dY_t = B_L dL_t + B_K dK_t + B_S \theta \mu_t dS_t + \frac{\delta}{1 + \delta} dS_t \]

If there is a linear relationship between the marginal production efficiency of labour and the per capita production within the scope of the overall economy, then we can get:

\[ B_L = \beta \cdot \left( Y / L_B \right) \]

Substituting it into the above formula and dividing both sides of the equation by \( Y_t \), and you get:

\[ \frac{dY_t}{Y_t} = \frac{B_L dL_t}{Y_t} + \frac{B_K dK_t}{Y_t} + \left( B_S \theta \mu_t + \frac{\delta}{1 + \delta} \right) \frac{dS_t}{S_t} \cdot \frac{S_t}{Y_t} \]

Combined with the production function formula analysis of the southern region, the influence of the externality of local output transfer on the total production quantity in the northern region conforms to the following conditions:

\[ B_t = B \left( L_{B_t}, K_{B_t}, S_t^* \right) = (S_t^*)^0 \varphi \left( L_{B_t}, K_{B_t} \right) \]

By continuing to deduce and analyse the above formula, the marginal production efficiency of the external influencing factor can be determined. The specific formula is as follows:

Putting the above formula into the linear relationship between the marginal productivity of labour and the scope of the overall economy, we can get:

\[ \frac{dY_t}{Y_t} = BL \frac{dL_t}{Y_t} + B_K \frac{dK_t}{Y_t} + \frac{\delta}{1 + \delta} \frac{dS_t}{S_t} \cdot \frac{S_t}{Y_t} + \omega \theta \mu_t \frac{B_t}{S_t^*} \frac{dS_t}{S_t^*} \cdot \frac{S_t}{Y_t} \]

Further recursive iteration processing is carried out for the external impact factor, and the following can be obtained:

The above formula satisfies the condition of \( \theta \sum_{i=0}^{\infty} (1 - \theta)^i = 1 \), so in essence, can be regarded as the weighted average value of the total production quantity of the southern region at the present and previous stages. Combined with the above formula analysis, it is further verified that there is an equivalent relationship between the adaptive expectation process and the Loyck geometric lag model. Thus, the above formula can be transformed into:

It represents the basic dynamic externality model studied in this paper.

### 2.3 Model analysis

According to the analysis of the basic dynamic externality model, multiplying both sides of it by \( Y_t \), we can get:

\[ Y_t = 2 \theta B_t + \theta \frac{\delta}{1 + \delta} S_t + \omega \theta \mu_t B_t LnS_t + (1 - \theta) Y_{t-1} LnY_{t-1} \]

In the above formula, \( \theta \) analyses the distribution of the externality of the industrial output value of the southern region in the lag region, \( W \) analyses the externality elasticity of the industrial output value of the
southern region on the northern region and \( \sigma \) evaluates the difference change of the editorial factor productivity between the southern region and the northern region. Combined with the analysis of the derivation results of the above models, an empirical model is built for the spillover effect of technology externalities in the southern region as shown below:

\[
Y_t = a_1 B_t + a_2 S_t + a_3 B_t \ln S_t + a_4 Y_t \ln Y_{t-1} + \epsilon_t
\]

3 Results

In this study, Eviews5.0 software was used to conduct regression processing on all local data information from 1990 to 2020. Table 1 shows the GDP ranking results of 13 cities in Jiangsu Province in 2020. By evaluating the development experience of the two places, the externality of industrial transfer from the south to the north is analysed, and the final results are as follows:

\[
Y_t = 0.527221 + 0.463383 B_t + 0.593668 S_t + 0.050253 B_t \ln S_t + 0.7683085 LNY_{t-1}
\]

\[
(2.243647) (3.488722) (8.457762) (-2.373962) (2.098330)
\]

\[R^2 = 0.999994, DW = 1.330634, F = 527676.3\]

Table 1 GDP ranking results of 13 cities in Jiangsu Province in 2020

| Serial number | City     | Total GDP (100 million yuan) | GDP growth (%) |
|---------------|----------|-------------------------------|----------------|
| 1             | Suzhou   | 20170.50                      | 3.40           |
| 2             | Nanjing  | 14817.95                      | 4.60           |
| 3             | Wuxi     | 12370.48                      | 3.70           |
| 4             | Nantong  | 10036.31                      | 4.70           |
| 5             | Changzhou| 7805.30                       | 4.50           |
| 6             | Xuzhou   | 7319.77                       | 3.40           |
| 7             | Yangzhou | Breakthrough 6000            | 3.50           |
| 8             | Yancheng | 5953.38                       | 3.50           |
| 9             | Taizhou  | 5312.77                       | 3.60           |
| 10            | Zhenjiang| 4220.09                       | 3.50           |
| 11            | Huaiian  | Breakthrough 4000            | 3.00           |
| 12            | Lianyungang| 3277.07                    | 3.00           |
| 13            | Suqian   | 3262.37                       | 4.50           |

Combined with the above formula analysis, it can be seen that the equation fits well, and the goodness of fit can reach 0.999994, and the \( F \) test has been completed. In addition, the final \( DW \) statistical value proves that there is no series-related problem in the equation, and all variables have passed the \( t \)-test. It is proved that the derived equation in this paper can accurately verify the problem to be studied, and finally, the results of various variables in the external model can be determined, where \( \theta = 0.463383/2 = 0.231692, W = 0.216896 \) and \( \delta = 2.857539 \).

The final result shows that the industrial development in the southern region has a low impact on the economic development in the northern region based on the industrial agglomeration phenomenon, so the industrial transfer is not coordinated now. At the same time, the labour productivity constituted by the two is also the main reason for the differences in industrial development. Based on the analysis of practical data, taking the GDP growth rates of the two places in 2018, 2019 and 2020 as examples, the overall development level of all regions has been improved under the influence of the concept of industrial transfer. In this background, the civil labour productivity ratio reached 4:1; in other words, the south region of labour costs three times up to that of
the north region. Hence for the rapid development of the economy, the north area can never rely on the south region economic externality and should make full use of its advantages, the development of the practice development breakthrough of the blind spot. At the same time, the northern region should correctly understand the importance of industrial transfer and pay attention to fully show the flexibility of production factors in practice and exploration, so as to promote the coordination of regional economic development faster.

Table 2  Comparison of GDP increment in the first half of 2018 and the first half of 2019 (100 million yuan)

| No | Area     | The first half of 2019 | The first half of 2018 | Incremental | Nominal growth rate (%) |
|----|-----------|------------------------|------------------------|-------------|--------------------------|
| 1  | Nanjing   | 6742.59                | 6201.08                | 541.51      | 8.73                     |
| 2  | Wuxi      | 5962.51                | 5535.66                | 426.85      | 7.71                     |
| 3  | Xuzhou    | 3540.76                | 3318.09                | 222.67      | 6.71                     |
| 4  | Changzhou | 3765.6                 | 3506.7                 | 258.9       | 7.38                     |
| 5  | Suzhou    | 8548.27                | 9109.71                | 438.56      | 4.81                     |
| 6  | Nantong   | 4580.11                | 4262.8                 | 317.31      | 7.44                     |
| 7  | Lianyungang | 1446.89                | 1398.67                | 48.22       | 3.45                     |
| 8  | Huai'an   | 1956.1                 | 1845.7                 | 110.39      | 5.98                     |
| 9  | Yancheng  | 2885.11                | 2721.13                | 163.98      | 6.03                     |
| 10 | Yangzhou  | 2804.57                | 2642.48                | 162.09      | 6.13                     |
| 11 | Zhenjiang | 2216.3                 | 2118.95                | 97.35       | 4.59                     |
| 12 | Taizhou   | 2732.15                | 2507.57                | 224.58      | 8.96                     |
| 13 | Suqian    | 1408.56                | 1304.88                | 103.68      | 7.59                     |

Table 3  Comparison of GDP increment in the first half of 2019 and the first half of 2020 (100 million yuan)

| No | Area     | Gross GDP in the first half of 2020 (unit: 100 million yuan) | Gross GDP in the first half of 2019 (unit: 100 million yuan) | Increments (unit: 100 million yuan) | Nominal growth (%) |
|----|-----------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------|-------------------|
| 1  | Suzhou    | 9050.24                                                     | 9548.27                                                     | -498.03                             | -5.22             |
| 2  | Nanjing   | 6612.35                                                     | 6742.59                                                     | -130.24                             | -1.93             |
| 3  | Wuxi      | 5516.32                                                     | 5962.51                                                     | -446.19                             | -7.48             |
| 4  | Nantong   | 4664.35                                                     | 4580.11                                                     | 84.24                               | 1.84              |
| 5  | Changzhou | 3471.01                                                     | 3765.60                                                     | -294.59                             | -7.82             |
| 6  | Xuzhou    | 3074.05                                                     | 3540.76                                                     | -466.71                             | -13.18            |
| 7  | Yancheng  | 2686.02                                                     | 2885.11                                                     | -199.09                             | -6.90             |
| 8  | Yangzhou  | 2653.80                                                     | 2804.57                                                     | -150.77                             | -5.38             |
| 9  | Taizhou   | 2401.73                                                     | 2732.15                                                     | -330.42                             | -12.09            |
| 10 | Zhenjiang | 2026.61                                                     | 2216.30                                                     | -189.69                             | -8.56             |
| 11 | Huai'an   | 1849.43                                                     | 1956.10                                                     | -106.67                             | -5.45             |
| 12 | Lianyungang | 1417.69                                                     | 1446.89                                                     | -29.2                               | -2.02             |
| 13 | Suqian    | 1399.40                                                     | 1408.56                                                     | -9.16                               | -0.65             |
4 Countermeasures

Generally speaking, the coordinated development of regional economy between the north and south of Jiangsu refers to mutual assistance and coordination between regions, which conforms to the principle of comprehensive interests. According to the analysis of the research results outlined in this paper, the following work should be done well in the coordinated development of industrial transfer in the northern region of Jiangsu Province: first, continuously optimise the labour production efficiency in the less developed regions. Due to the imbalance in the level of market development between the north and the south, the production factors such as talent information and technology funds will concentrate in the south. Once the flow effect reaches a certain level, it will be difficult for the less developed regions to change the situation. Therefore, in the context of the new era, it is necessary to break through the development restrictions between the two places and pay attention to the construction of a unified regional development of the big market to ensure that the production factors can be flexibly used and the industrial transfer within the region. On the one hand, we can use the coercive cooperative relationship to promote the rectification; on the other hand, we should actively participate in the economic radiation and fully grasp the change rules of the market economy so as to ensure the full integration of the factors of production in the north and the south. Second, make full use of regional advantages to develop new industries. The land and labour resources in the northern region are very rich, and the prices of actual production factors are relatively low, which can provide convenient conditions for the industrial transfer and the development of labour-intensive industries. At the same time, the northern region also has more mineral resources, biological resources, Marine resources, etc., which also plays a positive role in the development of the resource-processing industry. Third, the government should put forward preferential support policies. On the one hand, we should provide conditions for some returning migrant workers, pay attention to increasing the types of industries of local enterprises and provide necessary services for their industrial transfer. On the other hand, we should break through administrative restrictions and build a unified market environment. Only in this way can we ensure the free flow of various factors within the market. At the same time, the construction level of the local soft environment should be optimised. For example, paying attention to the construction of strict law enforcement and a fair and equitable legal environment, creating equality, mutual benefit, harmonious and friendly policy environment can provide a basic guarantee for professional transfer [4, 5].

5 Conclusion

To sum up, although based on the multiple regression model of industry transfer and regional economic coordination, the research has obtained certain results, because of the economic development and the market environment’s instability contains the influence of many factors, the practice research is still at the primary stage, which requires relevant researchers to continue to explore in practice development and analysis. At the same time, based on the construction and development needs of the new era, it is necessary to vigorously cultivate excellent technical talents, rationally use the modern technology concept and pay attention to improving the control strength inside and outside the market. Only in this way can it provide an effective basis for the practice of industrial transfer [6, 7].

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