Excessive Agglomeration and Labor Crowding Effect: An Empirical Study of China's Manufacturing Industry

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Abstract: *Industrial agglomeration is an important phenomenon in modern economic development, however, both theory and practice prove that the relationship between industrial agglomeration and industry growth is not absolutely linear. Based on panel data of 20 China's manufacturing industries during 2001-2011, this paper verifies that the relationship between industrial agglomeration and industry growth is an inverted U-shape as a whole. From sub-industries, the further agglomeration of four industries, including textile, paper and paper products, general equipment manufacturing and electronic information manufacturing(EIM), presents negative effect to their growth. In particular, as a high-tech industry, the EIM demonstrates a "labor force crowding" effect in Guangdong province. For these excessive agglomeration industries, spatial transfer is an usual way to maintain development, while for EIM industry, the transfer of low-skilled labors from Guangdong to other provinces is necessary, but the more important thing is to break through technological bottleneck at the same time.*

Keywords: Industrial agglomeration, industry growth, excessive agglomeration, labor force crowding

1. Introduction

As an important phenomenon in modern economic development, industrial agglomeration has received a common concern among entrepreneurs, policy makers and theory researchers. For the overwhelming majority countries and regions, especially these in the developing areas, the government tried to speed up economic growth by guiding industrial agglomerating in specific locations. China's rapid development over the past thirty years has great relevant to its industry is highly concentrated in the eastern coastal areas, which can be seen as a model of promoting economic development through industrial agglomeration. However, a more interesting and controversial issues is whether the promotion effect of industrial agglomeration can be sustainable?

From the perspective of pure theory, Alfred Weber classified the factors that affect industrial location into "agglomerative" and "deglomerative" factors in 1909. He analyzed the influence of factor costs and transportation cost on industrial agglomeration and industrial deglomeration(Friedrich,1929). Weber's view demonstrated an idea of deglomerative factors were contained in the process of industrial agglomeration. Hoover &Giarratani(1971) clearly put forward such concepts as the most appropriate corporate scale and the most moderate agglomeration, and explored auto reinforcement and restriction of industry agglomeration. So their theories were called the "optimal scale theory of industry agglomeration". Krugman(1991) established a core-periphery model, and set forth the mechanism of economic agglomeration. According to his theory, the circular cumulative causation effect associated with demands and cost was an agglomeration force, whereas the competition for consumers between enterprises gathering in one region was a deglomeration force; both agglomeration and deglomeration in economy depended on magnitude of the two forces. Baldwin & Forslid(2000) went a step further by combining Krugman's core-periphery model with Romer's endogenous growth model, showing that growth is a powerful centripetal force, while knowledge spillover is a powerful centrifugal force. Above studies all indicate that agglomeration forces and deglomeration forces coexist in industry agglomeration, which means the promotion of industry agglomeration to its growth may be not sustainable.

On the basis of above theories, relevant empirical studies have verified, directly or indirectly, the industry agglomeration which is not always to promote its growth. Not a few scholars conducted studies in the effect of industry agglomeration on productivity, technical efficiency or economic growth, either supporting the industry agglomeration beneficial to lifting efficiency(Ciccone, 1996; Mitra & Sato, 2007; Brülhart & Mathys, 2008; Fan Jianyong, 2006; Chih-Hai Yang,et al.,2013) or positively promoting economic growth（Martin & Ottaviano,2001; Fujita & Thisse,2003; Luo. & Cao, 2005; Pan & Liu, 2012）. There also some studies drew the inconsistent or even opposite conclusions. Accetturo(2010) put forward the concept of "congestion costs", incorporated the concept into the industrial location and endogenous growth model, and combined it with knowledge spillover and income distribution. His study verified the negative influence of congestion costs to the long-term economic growth, and drew a conclusion of "Krugman-type catastrophic agglomeration", which was contrary to the center-periphery theory. Broersma, Oosterhaven(2009)and Rizov(2012) successively studied the influence of agglomeration on labor productivity and total factor productivity by using the data from 40 regions during 1990-2001 and the data from enterprises during 1997-2006 respectively in Holland, and they came to a conclusion of negative correlation of growth rate and agglomeration degree, verifying the existence of the crowding effect. Yan & Qiao(2010) studied the impact of industrial agglomeration's development on industry growth and the internal relation between such impact and industrial features, the result shows that a certain degree of "labor crowding effect" has been emerged in China's low-technology-intensive sectors and labor-intensive sectors with the development of industrial agglomeration.

Quite a few scholars also examined Williamson Hypothesis[1]. Brülhart and Sbergami(2009) applied the global samples (data from 150 countries during 1960-2000) and EU samples (data from 16 countries during 1975-2000) at the same time to analyze the relation of industry agglomeration and its economic growth. The results showed that before the GDP per capita was up to the critical level ($10,000 estimated), the industry agglomeration could promote economic growth. The economic growth effect from manufacturing agglomeration could go down gradually with the national revenues, while the growth effect from agglomeration in financial service sector could go up with national revenues. Xu et al. (2011)verified the Williamson Hypothesis by employing the 1978-2008 panel data from 30 provinces in China, and the conclusions demonstrated this hypothesis significantly existed in China. Based on the panel data from 85 countries in the world in recent ten years, Sun et al. (2011) also supported the Williamson Hypothesis. Liu (2012) held by an empirical study on the data from China's prefecture-level cities, the conclusion indicated that agglomeration had a significant positive promotion to increases of GDP per capita and productivity, but after economy developed to a certain degree, the growth effect of agglomeration was changed into a significant negative direction. Zhou and Zhu (2013) made an empirical analysis on the influence of the crowding effect on total factor productivity (TFP) by using the 1999-2007 data from 60 industrial cities nationwide, believing there was an "inverted-U" relation between agglomeration degree and TFP, and finding the year 2003 was an inflection point.

Apparently, theory and practice both prove that industry agglomeration can't always facilitate its growth. In other words, industry agglomeration has an appropriate degree, and once up to this degree, the further agglomeration goes against the sustainable industrial growth. The related core issues are which industries are excessive agglomeration? why does excessive agglomeration occur? How to address these issues to keep the sustainable industrial development? These issues were less answered definitely in current studies. This paper applies the industry-classified panel data from China's manufacturing, as well as the approach of measuring the relation of industry agglomeration and its growth, and the method of evaluating specific excessive agglomerating industries. The study tries to make clear the relation of industry agglomeration and its growth in China's manufacturing, and gives the more in-depth analysis on possible excessive agglomeration industries, so as to find out the direction to maintain and promote industrial development.

[1] Williamson considered that in the early stage of economic development when the infrastructure lagged behind, the spatial agglomeration could exert a significant effect on industrial growth. However, with infrastructure improving and market expanding, the negative externality of agglomeration appeared gradually with economic development, so that the negative externality enabled economic activity to tend to dispersion to a certain extent. These ideas were called Williamson Hypothesis.

2. Models and Variables

In a new standard classic growth model, the industrial output is the function of capital and labor force. Assuming this function is a Cobb-Douglas production function with constant returns to scale, then, the output of the specific industries can be expressed by the following function:

$$Y = AK^{\alpha}L^{\beta} \qquad (1)$$

Where, Y is the actual output of an industry, K is the input capital, L is the labor forces used, and A is total factor productivity.
Take the natural logarithm at two sides of Formula (1), and gain the following formula (2):

$$LnY = LnA_0 + \alpha \cdot LnK + \beta \cdot LnL + \gamma \cdot H \qquad (2)$$

On the basis of above model, industry agglomeration needs to be introduced and as a core variable. Here EG index is used to evaluate the industry agglomeration degree. Based on the theories and related empirical studies, this paper assumes that there is a non-traditional relation between industry agglomeration and economic growth. In order to verify the non-linear assumption, industry agglomeration index (EG) and its quadratic component (EG^2) are introduced to Formula (2).

Besides above basic variables, the industrial development is affected by international capital inflow and international trade to a great extent in the open economic. Thus, the foreign direct investment (FDI) and the open to the outside should be added as control variables in the model. So, the following measurement model is obtained:

$$\begin{aligned} LnY_{it} = LnA_{0it} + \alpha LnK_{it} + \beta LnL_{it} + \varphi_1 EG + \varphi_2 EG^2 \\ + \varphi_3 FDI + \varphi_4 Open + \varepsilon_{it} \end{aligned} \qquad (3)$$

Where, LnY is an explained variable, expressed by total industrial output value and taken in logarithm; K represents capital, expressed by the sum of fixed and floating capitals, and taken in logarithm; L is labor force, expressed by annual average number of employees, and taken in logarithm; EG and EG^2 represent respectively EG index and quadratic component of industry agglomeration; FDI is the proportion of foreign direct investment; as the FDI of industries are not issued by the National Bureau of Statistics of China, the FDI proportion is the partof the sum of investment from Hong Kong, Macao and Taiwan and foreign investment in paid-in capital. The investments from Hong Kong, Macao and Taiwan and foreign investment are converted into Renminbi yuan in terms of the current exchange rate between Renminbi yuan and US dollar; Open represents the degree of open to the outside, expressed by export delivery value, which is converted into RMB in a similar way in terms of the corresponding year exchange rate between Renminbi and US dollar and also taken in logarithm; the subscript i means the i -th industry; t represents year, and ε_{it} is a random disturbing term.

3. Date and Methods

3.1 Sources of data

The data used by the empirical study includes 20 China's manufacturing industries during 2001-2011. All original data for above variables are from the *Statistical Yearbook of Chinese Industrial Economy* and the *Chinese Statistical Yearbook*. In order to eliminate the influence of price factors, the variables such as total industrial output value, capital and export delivery value are converted into the constant prices in 2000 using ex-factory price indices of industrial products (EFPI), price indices of fixed capital investment and export indices of the prices of export goods separately.

3.2 EG index calculation method

The calculation method and data for EG index should be specially explained in this paper. The EG index is calculated by the following formula based on Ellision & Glaeser (1997):

$$EG = \frac{G_i - (1 - \sum_{j=1}^{r} x_j^2) \cdot H_i}{(1 - \sum_{j=1}^{r} x_j^2)(1 - H_i)} \qquad (4)$$

$$G_i = \sum_{j=1}^{r} (x_j - s_{ij})^2, \quad H_i = \sum_{k=1}^{N} z_k^2 \qquad (5)$$

Where, i, j, k stand for industry, region and enterprise respectively; x_j represents the proportion of gross output of all industries in j region in gross output of all industries throughout the country; s_{ij} denotes the proportion of i-industry output in j region in the output of this industry throughout the country; z_k means the proportion of k-enterprise output in total i-industry output value. In addition, G_i is the spatial Gini coefficient of i industry. The bigger the G_i value is, the higher the agglomeration degree in geography for i industry is. H_i is Herfindahl coefficient of i industry, and it reflects enterprise scale and distribution in industries; the greater this coefficient, the higher the degree of market monopoly of the industry. EG index is involved in industrial and enterprise distributions, and it can provide a referenced unified measuring standard.

Nevertheless, as the detailed data at the corporate level are obtained difficultly, it is impossible to calculate through above formula. For this reason, it is necessary to improve the formula. According to Wu and Li (2009), supposing all i-industry enterprises in each region have the same total industrial output, then, the Herfindahl index formula is available as follows:

$$H_i = \sum_{j=1}^{r} n_{ij} \left(\frac{output_{ij} / n_{ij}}{output_i}\right)^2 = \sum_{j=1}^{r} \frac{1}{n_{ij}} \left(\frac{output_{ij}}{output_i}\right)^2 = \sum_{j=1}^{r} \frac{1}{n_{ij}} s_{ij}^{\ 2} \qquad (6)$$

Where, *i, j, r and s* have the same meanings as above mentioned. n_{ij} is the enterprise number in i industry in j region; $output_i$ is total national output value of i industry, and $output_{ij}$ is total national output of i industry in j region. The EG is available as follows:

$$EG = \frac{\sum_{j=1}^{r}(x_j - s_{ij})^2 - (1 - \sum_{j=1}^{r} x_j^{\ 2}) \cdot \sum_{j=1}^{r} \frac{1}{n_{ij}} s_{ij}^{\ 2}}{(1 - \sum_{j=1}^{r} x_j^{\ 2})(1 - \sum_{j=1}^{r} \frac{1}{n_{ij}} s_{ij}^{\ 2})} \qquad (7)$$

Although the EG index calculated by Formula (7) is not more accurate than the formula given by Ellision & Glaeser (1997), it reflects the core idea in EG index constructing procedure, and the similar processing is available for all industries. So this doesn't hamper at all evaluation and comparison of industry agglomeration. Table 1 shows EG indices of 20 main industries of China's manufacturing during 2001-2011 worked out based on this formula.

3.3 Two-stage GMM estimation method

In empirical exploration of the relation between China's manufacturing agglomeration and its growth, a possible issue is the endogeneity between industry agglomeration and its growth and other explaining variables. Just as most studies on industry agglomeration point out, this endogenous issue should be specially taken into account in these studies (Fan, 2006; Zhang & Liu, 2007). For this, we need to hunt for a panel data estimation approach which can overcome the endogeneity. Currently a common approach is the system generalized method of moments (SYS-GMM).

This estimation method applies the first-order lag term of the explaining variable as an instrumental variable of GMM estimation, and employs the P values in AR(1) & AR(2) test and Sargan test for over-identification to judge reasonability of model setup and effectiveness of instrumental variable. If the P value corresponding to AR(1) test is less than 0.1, then P value of AR(2) is greater than 0.1, indicating the instrumental variable is selected reasonably; the P value corresponding to Sargan over-identification test is greater than 0.1, indicating no over-identification occurs, and the model is set more reasonably. As the two-stage estimation result is generally more effective than the one-stage one, the two-stage system GMM estimation is used in this paper, which is realized by STATA12.0.

4. GMM estimation results and analysis

Two-stage system GMM estimation method is used to examine the relationship between agglomeration and industry growth, and the specific estimation results are given in Table 2. Model A shows the regression results of the traditional economic growth model; K and L coefficients are significant, indicating that it conforms to the traditional economic growth theory; the sum of K and L coefficients is greater than 1, indicating an increasing return to scale, but lagging-stage total industrial output value (L.LnY) presents a negative coefficient, which goes against the economic common sense.

Model B is added with industry agglomeration and its square term on the basis of Model A; all indices are significant, and the lagging-stage total industrial output value becomes positive, indicating the industry agglomeration must be taken into account to explain the influencing factors in economic growth. Model C and Model D present the estimation results of adding the two control variables—Open to the outside and FDI. It is found from the results that labor force coefficient becomes negative after adding control variables, demonstrating the “labor force crowding effect” has started to occur; the labor force coefficient becomes negative significantly when the Open as a control variable is only considered, but it is not significant when the model is added with FDI, indicating FDI relieves the crowding effect to some extent. Nevertheless, this relief is limited, so that this phenomenon is unable to be changed fundamentally.

In the above models, Models A and B have passed Sargan and AR (1) tests, but not passed AR (2) test. Models C and D have passed the tests, too. As Model D can comprehensively reflect all variables influencing industrial growth, we focus on analyzing the regression results of it. The following conclusions are made from Model D oftable 2:

1) The regression coefficient is positive but not significant in the lagging-stage industrial growth, which indicate that the last-stage industrial growth situations exerting a certain influence on current industrial growth, but this influence is not significant.
2) There is a positive correlation between capital and industrial growth, with an output elasticity of 0.946, indicating the capital increasing by a percent can result in an increase of 0.946 percent point in industrial output value. This means that China’s manufacturing industries are investment-driven growth, where the increase of capital input will bring rapid industrial growth. On the other hand, this exhibits there is a larger marginal output in capital, and the manufacturing industries are most labor intensive ones.
3) The output elasticity is -0.0579 for labor force, it means that the one percent point increase of labor force can result in a decrease of 0.0579 percent point in industrial output. Though this result is not significant at a level of 10%, it means the “labor force crowding” effect appear in China’s manufacturing to a certain extent. This effect is not enough to exert a substantial influence on industrial growth, but it should be a matter of concern as well. This conclusion is in agreement with the findings by Yan and Qiao (2010).
4) Industry agglomeration (EG) is significant at a level of 5%, with a positive monomial coefficient and a negative square term coefficient, it indicates an “inverted-U” relation of industry agglomeration and growth, that is, the increase of industry agglomeration degree at a low level can accelerate industrial growth significantly, but when the agglomeration degree comes to a certain extent, further increase can inhibit the industrial growth on the contrary. Why this phenomenon is happen? On the condition of a low degree of industrial agglomeration, the increase of concentration degree can speed up the industrial growth by promoting external economy and productivity on the one hand; on the other hand, it can accelerate industrial growth due to the external economy triggering technology diffusion. After the industry agglomeration degree is up to a certain level, the marginal benefits of agglomeration will decrease progressively while the marginal cost increases progressively, thus the “crowding effect” appears. In this situation, the agglomeration may cause the slowdown of industrial growth and even industrial decline.
5) There is a significant positive correlation between Open and economic growth, which is in line with the traditional economic theory. On one hand, open to the outside improves output and sales volume of domestic products by enhancing foreign trades, on the other hand, it can raise domestic productivity by introducing foreign advanced technology, which further accelerate the industrial growth. FDI exert a positive but not significant influence, which may be caused by the offset of its positive and negative effects on industrial growth. On the one hand, different FDI features can affect its effect degree on industrial growth directly, even its effect direction. On the other hand, FDI can facilitate the industrial growth by improving the dual effect of production and technical efficiency and accelerating domestic technological advance, but it can also occupy domestic capital, squeezing and suppressing domestic enterprises by monopoly position, and imposing restrictions on domestic enterprise growth, thus exerts an adverse impact on industrial growth.

5 Identify of excessive agglomeration industries

The above dynamic GMM model can well reflect the relation between industry agglomeration and its growth, but it can’t reflect which industries have a positive correlation with industry agglomeration, and which industries have a negative correlation with it. For this reason, we are intended to apply the variable coefficient fixed effect model in panel data models for a further analysis.

According to the constraint degree to variables, the panel data models are mainly classified into mixed data model, fixed effect model and variable coefficient model. It is assumed that all variables have the same effect, i.e. $\alpha_1 = \alpha_2 \cdots = \alpha_n, \beta_1 = \beta_2 \cdots = \beta_n$; the constraint to the intercept term is reduced in the fixed effect model, and there isdifference among individuals for the intercept term, i.e. $\beta_1 = \beta_2 \cdots = \beta_n$; the constraint to variables is further reduced for the variable coefficient model, and there is an individual difference for all variables; the model coefficients α_i and β_i may all be different. In panel data estimation, the incorrect model setting may cause a deviation of estimation result. Thus, the corresponding tests should be done before determining which model will be applied. The covariance analysis test is used in test method, where, supposing:

$$H_1 : \beta_1 = \beta_2 \cdots = \beta_N$$

$$H_2 : \alpha 1 = \alpha 2 \cdots \alpha_N \quad \beta_1 = \beta_2 \cdots = \beta_N$$

Constructing F statistics, and conforming to F distribution:

$$F_1 = \frac{(S_2 - S_1)/[(N-1)k]}{S_1 \big/ (NT - N(k+1))} \sim F[(N-1)k, N(T-k-1)]$$

$$F_2 = \frac{(S_3 - S_1)/[(N-1)(k+1)]}{S_1 \big/ (NT - N(k+1))} \sim F[(N-1)(k+1), N(T-k-1)]$$

, S_1, S_2 and S_3 are the residual sums of squares of variable coefficient model, variable intercept model and mixed model respectively. At the given significant level, if F_2 is less than the corresponding critical value in the given confidence degree, then Hypothesis H_2 is accepted, indicating the mixed model is required; otherwise, the F statistics is still used to test H_1. If F_1 is less than critical value, then, the original H_1 is accepted, indicating the variable intercept model is used; otherwise, the variable coefficient model should be applied. The measurement model corresponding to this section is set as follows:

$$LnY_{it} = \alpha \cdot LnK_{it} + \beta \cdot LnL_{it} + \gamma \cdot EG_{it} + \varepsilon_{it} \qquad (9)$$

For formula (9):

$$N = 20, k = 3, T = 11, \ S_1 = 2.8421, \ S_2 = 10.7728, \ S_3 = 28.0166$$

Two statistics can be got by above formulas:

$$F_1 = 33.81, \qquad F_2 = 7.02$$

Based on F distribution table, the corresponding critical values below the significant level at 5% are available as follows:

$$F(76,140) = 1.43, \qquad F(57,7) = 3.08$$

$H_1$is rejected if $F_2 > 1.43$, and H_1 is rejected as well if $F_1 > 3.08$, Thus, the variable coefficient fixed effect model can be applied. The regression results see Table 3.

It is seen from Table 3 that R^2=0.992, indicating the equation is of high degrees of fitting and explanation, and F value and D-W value satisfy the statistical requirement of econometrics, demonstrating both design and estimation method are more reasonable for this model. Thus we conduct analyses based on this.

Among 20 industries studied in this study, agglomeration of the four industries goes against their industrial growth. They are textile, paper and paper products, general equipment manufacturing and electronic information manufacturing(EIM) industry, which are all in a high agglomeration degree. The agglomeration degrees of these industries are 0.05842, 0.02223, 0.03152 and 0.10187 respectively during 2001-2011. The results indicate that there is no definite criterion on appropriate agglomeration degree in different industries though the suitable agglomeration can really facilitate industrial growth. For example, for paper and paper products, its agglomeration degree (0.02223) is far below the instrument & meter and office machine manufacturing(0.07399), but thisagglomeration degree has take an adverse effect on the industry itself.

6 Further analyses of labor force crowding effect

It is found through further observation that the industries of excessive agglomeration are mostly labor intensive ones. However, though EIM is generally recognized as skill-intensive industry, the further increase of agglomeration degree would do harm to its growth. To explain this phenomenon, the underlying reason should be further explored more deeply.

On the one hand, this is related to the characteristic of China's EIM industry. Different form the enterprises in developed countries and regions, many enterprises in the industry currently have no technological-intensive features thoroughly, and most of them are mostly engaged in processing and manufacturing with relatively lower technology contents, and quite a number of them are the original equipment manufacturers.

On the other hand, this is also associated with geographic location of the industry. It is mostly distributed in the Pearl River Delta and the Yangtze River Delta. According to Tables 4 and 5, employees engaged in both electronic and communication devices manufacturing and computer & office equipment manufacturing occupy 50% of the whole eastern region; the production value doesn't take up a corresponding portion, but is significantly lower. Especially since 2009, the proportion of national product value of computer & office equipment manufacturing is 12 percent points lower than that of employees in Guangdong, revealing an evident "labor crowding" in the two manufacturing industries. From this, a judgment may be made that the excessive agglomeration of China's EIM industry is due to its excessive concentration in Guangdong.

7. Concluding Remarks

In this paper, panel data of 20 China's manufacturing industries during 2001-2011 are studied, and the study results show that China's manufacturing still presents a typical "investment-driven" feature, and "labor force crowding" effect is appears to a certain extent. Industry agglomeration doesn't really facilitate industrial growth all the time. Four industries present over-agglomeration, and they are either labor-intensive industries or skill-intensive EIM industry. The economic meanings for the conclusions are that the policy-making department should fully take into account the special industry agglomeration status and its relation with industrial growth. For excessive agglomeration industries, the industrial spatial layout should be optimized and adjusted timely, and the dynamic monitoring should be conducted to explore the industry agglomeration and promote the balanced and sustainable industry development.

For Guangdong, what is important is to break through the bottleneck of constraining high tech industries by R&D innovation and human capital accumulation, and crack the "labor force crowding" problem of industry development. Guangdong's EIM industry presents an evident "labor force crowding" as a whole, indicating its high-tech industry still develop at a lower level that mostly relies on labor force input to drive its industrial growth. This also reflects that China's industrial technical level still fall behind. Even Guangdong, which enjoys the highest agglomeration degree of China's high-tech industry, only participate in the low-to mid-ends of global value chain to a greater extent, and depends on a great many laborers for its industrial development. The main pathways for driving Guangdong's high-tech industrial transformation development are R&D innovation and human capital accumulating, whereas the core of the two pathways is a matter of talents, including generalized talents as well as special talents with professional skills, especially high-level talents with innovation abilities. Thus, Guangdong should optimize the structure of the existing industries especially the "labor force crowding" ones by shifting relatively lower-end segments into the other regions. More importantly, in order to provide a talents guarantee for a more higher-lever development in its high-tech industries, it should pay attention to attracting and retaining talents by a rational policy design, introducing all kinds of talented people who can support high-tech industry for innovation.

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Table 1 EG indices of 20 main industries in China's manufacturing during 2001-2011

Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	annual avg.
M13	0.026	0.030	0.034	0.037	0.044	0.043	0.041	0.034	0.034	0.028	0.024	0.034
M14	0.011	0.011	0.010	0.011	0.015	0.017	0.020	0.019	0.020	0.016	0.015	0.015
M15	0.008	0.008	0.008	0.006	0.010	0.011	0.012	0.012	0.014	0.018	0.021	0.012
M16	0.067	0.060	0.054	0.047	0.048	0.044	0.043	0.038	0.037	0.034	0.034	0.046
M17	0.049	0.056	0.055	0.067	0.066	0.066	0.065	0.062	0.058	0.052	0.046	0.058
M22	0.016	0.019	0.024	0.028	0.028	0.027	0.025	0.022	0.021	0.018	0.017	0.022
M25	0.023	0.025	0.025	0.024	0.022	0.022	0.020	0.020	0.019	0.024	0.016	0.022
M26	0.014	0.014	0.013	0.015	0.018	0.020	0.019	0.020	0.024	0.020	0.020	0.018
M27	0.006	0.006	0.005	0.004	0.007	0.006	0.007	0.007	0.008	0.007	0.009	0.007
M28	0.066	0.077	0.115	0.143	0.160	0.177	0.168	0.184	0.185	0.187	0.198	0.151
M31	0.005	0.006	0.009	0.009	0.014	0.014	0.015	0.014	0.015	0.012	0.013	0.011
M32	0.025	0.023	0.025	0.026	0.028	0.028	0.028	0.031	0.032	0.030	0.030	0.028
M33	0.011	0.011	0.010	0.009	0.011	0.012	0.013	0.015	0.014	0.014	0.017	0.013
M34	0.038	0.040	0.042	0.041	0.032	0.033	0.032	0.027	0.029	0.023	0.019	0.032
M35	0.037	0.038	0.037	0.034	0.032	0.032	0.030	0.028	0.029	0.026	0.023	0.032
M36	0.027	0.025	0.018	0.013	0.013	0.012	0.011	0.012	0.013	0.014	0.016	0.016
M37	0.028	0.027	0.028	0.020	0.015	0.015	0.014	0.013	0.012	0.012	0.013	0.018
M40	0.042	0.043	0.047	0.048	0.043	0.041	0.040	0.037	0.032	0.033	0.035	0.040
M41	0.094	0.103	0.112	0.114	0.104	0.099	0.094	0.102	0.103	0.103	0.094	0.102
M42	0.089	0.090	0.098	0.093	0.074	0.064	0.063	0.059	0.053	0.057	0.074	0.074
Avg.	**0.034**	**0.036**	**0.038**	**0.039**	**0.039**	**0.039**	**0.038**	**0.038**	**0.038**	**0.036**	**0.037**	**0.037**

Note:M13:Food processing;M14:Food Manufacturing;M15:Beverage manufacturing; M16:Tobacco manufacturing; M17:Textile manufacturing; M22:Paper and Paper Products manufacturing; M25: Petroleum, Coking, Processing of Nuclear Fuel processing; M26:Chemical Raw Materials manufacturing; M27: Medicines manufacturing;M28:Chemical Fiber manufacturing;M31: Nonmetallic Mineral Products manufacturing; M32: Smelting of Ferrous Metals and Manufacture of Alloys M33: Smelting of Non-Ferrous Metals and Manufacture of Alloys; M34:Metal Products manufacturing; M35: General Purpose Machinery manufacturing; M36:Special Purpose Machinery manufacturing; M37: Transport Equipment manufacturing; M40:Electrical Machinery and Equipment manufacturing; M41: Electronic Information manufacturing; M42: Measuring Instrument and Machinery for Cultural Activity & Office Work manufacturing.

Table 2 GMM regression results

Variables	Model A	Model B	Model C	Model D
L. lnY	-0.01395**(0.018)	0.0629***(0.000)	0.0019(0.774)	0.0316(0.432)
LNK	0.9115***(0.000)	0.9387***(0.000)	0.9436***(0.000)	0.9459***(0.000)
LNL	0.1211***(0.000)	0.1259***(0.000)	-0.0389**(0.021)	-0.0578(0.111)
LQ		5.2858***(0.000)	2.5141***(0.007)	4.6945**(0.016)
LQ^2		-20.8898***(0.000)	-11.1421**(0.030)	-23.8778**(0.032)
FDI			0.1203***(0.000)	0.1205(0.579)
Open				0.1167(0.431)
Constant term	0.4194***(0.000)	-0.7016***(0.000)	-0.0758(0.424)	-0.3871***（0.000）
Sargan test	1.000	1.000	1.000	1.000
AR(1)	0.0016	0.0042	0.0059	0.0216
AR(2)	0.0045	0.0063	0.1647	0.3616

Note: * p<0.05,** p<0.01, *** p<0.001

Table 3 Regression results of variable coefficient fixed effect model

Variables	Coefficient	P	Variables	Coefficient	P
Ln K	1.096	0.0000	LQ_M28	1.185	0.1038
Ln L	-0.013	0.8787	LQ_M31	33.705	0.0053
Open	0.226	0.0000	LQ_M32	5.744	0.1810
FDI	-0.266	0.3192	LQ_M33	16.542	0.5090
Constant term	-2.192	0.0000	LQ_M34	0.085	0.9891
LQ_M13	0.232	0.9672	LQ_M35	-4.480	0.6331
LQ_M14	7.987	0.3774	LQ_M36	5.494	0.3951
LQ_M15	15.360	0.0576	LQ_M37	15.880	0.0035
LQ_M16	2.327	0.4716	LQ_M40	14.758	0.1439
LQ_M17	-8.066	0.1691	LQ_M41	-8.297	0.2148
LQ_M22	-3.021	0.7771	LQ_M42	3.180	0.1825
LQ_M25	0.852	0.9280	R^2	0.992	
LQ_M26	11.598	0.2172	F	494.705	0.000
LQ_M27	62.911	0.0344	DW	1.132	

Table 4 Regional distribution of jobholders in industries

Industries		2004	2005	2006	2007	2008	2009	2010	2011
Electronic & Communication Equipment Manufacturing	East	90.01	90.63	90.68	90.28	90.10	88.62	88.44	85.49
	Guang Dong	45.00	44.64	43.82	41.62	42.26	42.41	41.58	39.33
	Midland	4.23	4.18	4.58	5.03	5.62	6.46	7.59	10.79
	West	5.75	5.19	4.74	4.69	4.28	4.92	3.96	3.71
Computer & Office Work Equipment Manufacturing	East	97.06	96.99	97.60	97.54	96.48	95.60	95.01	88.81
	Guang Dong	48.46	48.23	47.34	47.98	43.52	45.03	43.92	44.44
	Midland	1.86	2.20	2.04	1.94	2.80	3.08	2.60	3.30
	West	1.08	0.81	0.36	0.52	0.72	1.32	2.39	7.89

Table 5 Regional distribution of total production value in industries

Industries	East	2004	2005	2006	2007	2008	2009	2010	2011
Electronic & Communication Equipment Manufacturing	GuangDong	93.61	93.86	94.05	93.33	92.57	90.73	90.18	87.55
	Midland	36.12	34.65	34.31	32.91	36.06	38.02	36.54	34.70
	West	3.29	3.17	3.08	3.31	3.87	4.35	5.38	8.12
	East	3.09	2.97	2.87	3.37	3.56	4.92	4.44	4.33
Computer & Office Work Equipment Manufacturing	GuangDong	98.84	98.56	98.15	98.14	97.75	97.04	97.12	91.39
	Midland	37.67	39.86	39.53	36.99	34.13	31.10	32.97	32.57
	West	0.70	1.23	1.73	1.60	1.85	2.19	1.70	2.11
	East	0.45	0.21	0.12	0.25	0.40	0.77	1.18	6.50