

Innovation, South-North Trade and Manufacturing Industry Agglomeration*

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Abstract: Within the two department framework, this paper describes the factors influencing the manufacturing industry agglomeration in the South-North product cycle movement, and tries to identify whether the manufacturing industry agglomeration is department bias or factor bias. The opening of the economy promotes the formation of the developing country's manufacturing industry agglomeration. Then we analyze the influence mechanism of product innovation in the South-North product cycle movement on the structure and scale of manufacturing industry agglomeration, which not only is reflected on the changes in the number of product varieties, but also reflected on the term of North-South trade and the change of North-South relative wage of human capital. This is an important expansion path for innovation model in the North-South trade.

Key words: Innovation ; South-North trade; Manufacturing industry agglomeration; Product cycle

1 Introduction

The product innovation is decisive to one country's economic growth and international division according to endogenous growth theory (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1998; Gancia and Zilibotti, 2005). International trade have a positive impact on innovation and growth (Grossman and Helpman, 1991; Coe and Helpman, 1995; Coe, Helpman and Holfmaister, 1997; Eaton and Kortum,1999;Acemoglu,1998;Keller, 2002). Butler (1990) described the interaction mechanism among innovative and North-North intra-industry trade and product cycle. Placing the manufacturing industry agglomeration of the developing countries in the South-North trade and the world product cycle movement, the research of the nature and evolving rules of the developing country's manufacturing industry agglomeration is an important extension of the product innovation theory as well as the industry agglomeration theory. On one hand, this paper tries to identify whether the manufacturing industry agglomeration of the developing countries and the developed countries in South-North trade and product cycle is department bias or factor bias according to Gancia and Zilibotti (2005). The consequence of the development of South-North trade is the increase of the production varieties in developing countries; in other words, the opening of the economy promotes the formation of the developing countries' manufacturing industry agglomeration. On the other hand, within the framework of the two departments (the intermediate product department and the research and development department), this paper describes the influence mechanism of product innovation in the South-North product cycle movement on the structure and scale of manufacturing industry agglomeration according to Butler (1990) and Yin (2006).

2 Basic Model

The assumption is that the world consists of the North and the South, with the North representing the developed countries whose skilled labour (H) is affluent and the South representing the developing countries whose non-skilled labour (L) is affluent; the product cycle follows the model that the North innovates while the South imitates; the final products from both the North and the South use two mutual complementing intermediate products as the input factors: skilled labour intensive intermediate products (Y_H) and non-skilled labour intensive intermediate products (Y_L). The agglomeration of the manufacturing industry is reflected in the increase of the varieties of intermediate products.

The product functions of the intermediate products Y_L and Y_H are respectively as follows:

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$$Y_L = L^{1-\alpha} \int_0^{n_L} x_{Lj}^\alpha dj \tag{1}$$

$$Y_H = H^{1-\alpha} \int_0^{n_H} x_{Hj}^\alpha dj \tag{2}$$

Among them, n_L, n_H respectively represent the number of the varieties of the non-skilled labour and skilled labour (skills) intensive intermediate products.

For the production of the intermediate products, when the iso-elastic demand is the same and under the symmetry assumptions, there is

$$x_{Lj} = \left[\frac{\alpha p_L}{p_{Lj}} \right]^{\frac{1}{1-\alpha}} L \tag{3}$$

$$x_{Hj} = \left[\frac{\alpha p_H}{p_{Hj}} \right]^{\frac{1}{1-\alpha}} H \tag{4}$$

For the convenience of analysis, we treat w_{Hj}, w_{Lj} as the given variables. In the market structure where the intermediate products are in the monopolized competition, there is

$$p_{Lj} = 1/ Q_L \tag{5}$$

$$p_{Hj} = 1/ Q_H \tag{6}$$

In which Q_L, Q_H respectively represent the average quality of the machinery used in the non-skilled labour and skilled labour (skills) intensive departments. As such,

$$x_{Lj} = [\alpha Q_L p_L]^{\frac{1}{1-\alpha}} L \tag{7}$$

$$x_{Hj} = [\alpha Q_H p_H]^{\frac{1}{1-\alpha}} H \tag{8}$$

On basis of equations (7) and (8), the equations (1) and (2) under the symmetry assumption can be changed to

$$Y_L = n_L L \alpha^{\frac{\alpha}{1-\alpha}} p_L^{\frac{\alpha}{1-\alpha}} Q_L^{\frac{\alpha}{1-\alpha}} \tag{9}$$

$$Y_H = n_H H \alpha^{\frac{\alpha}{1-\alpha}} p_H^{\frac{\alpha}{1-\alpha}} Q_H^{\frac{\alpha}{1-\alpha}} \tag{10}$$

The production function representing the final products is

$$Y = [Y_H^\sigma + \varphi Y_L^\sigma]^{\frac{1}{\sigma}} \tag{11}$$

In which φ is the importance degree of the non-skilled labour intensive intermediate products against the final products, and $0 < \sigma \leq 1$. when Y is maximized under the circumstance of resource constraint, there is

$$\frac{p_H}{p_L} = \varphi^{-1} \left(\frac{Y_L}{Y_H} \right)^{1-\sigma} \tag{12}$$

In which p_H, p_L are the prices of Y_H and Y_L respectively.

According to equations (9) and (10), there is

$$\frac{p_H}{p_L} = \varphi^{\frac{1-\alpha}{1-\alpha\sigma}} \left(\frac{H}{L} \right)^{\frac{(1-\alpha)(\sigma-1)}{1-\alpha\sigma}} \left(\frac{n_H}{n_L} \right)^{\frac{(1-\alpha)(\sigma-1)}{1-\alpha\sigma}} \left(\frac{Q_H}{Q_L} \right)^{\frac{\alpha(\sigma-1)}{1-\alpha\sigma}} \tag{13}$$

According to equations (9) and (10), the relative salary of the skilled labour against non-skilled Labour is

$$\frac{w_H}{w_L} = \left(\frac{n_H}{n_L} \right) \left(\frac{Q_H}{Q_L} \right)^{\frac{\alpha}{1-\alpha}} \left(\frac{p_H}{p_L} \right)^{\frac{\alpha}{1-\alpha}} \tag{14}$$

Assuming that the factor market is fully competitive, and if

$$p_H = \frac{w_H}{\lambda Q_H} \tag{15}$$

$$p_L = \frac{w_L}{\lambda Q_L} \tag{16}$$

there is

$$\frac{w_H}{w_L} = \frac{p_H Q_H}{p_L Q_L} \tag{17}$$

Putting equation (17) into (14), there is

$$\left(\frac{Q_H}{Q_L}\right) = \left(\frac{n_H}{n_L}\right)^{\frac{1-\alpha}{1-2\alpha}} \left(\frac{p_H}{p_L}\right)^{-1} \tag{18}$$

Putting equation (18) into (13), there is

$$\frac{p_H}{p_L} = \varphi^{-1} \left(\frac{H}{L}\right)^{\sigma-1} \left(\frac{n_H}{n_L}\right)^{\frac{(1-\alpha)(\sigma-1)}{1-2\alpha}} \tag{19}$$

Equation (19) reflects the situation where the trade is not opened. Accordingly, where the trade is opened, there is

$$\left(\frac{p_H}{p_L}\right)^T = \varphi^{-1} \left(\frac{H^w}{L^w}\right)^{\sigma-1} \left[\left(\frac{n_H}{n_L}\right)^T\right]^{\frac{(1-\alpha)(\sigma-1)}{1-2\alpha}} \tag{20}$$

In it, $(n_H/n_L)^T$ is the number of the relative product variety of the skilled labour intensive department after a country's trade is opened; H^w/L^w is the relative ratio of the world skilled labour against non-skilled labour.

Because $\frac{H^w}{L^w} = \nu \frac{H}{L}$, $\left(\frac{p_H}{p_L}\right)^T = \frac{p_H}{p_L}$ on basis of equations (19) and (20), there is

$$\frac{(n_H/n_L)^T}{n_H/n_L} = \nu^{-(1-\frac{\alpha}{1-\alpha})} \tag{21}$$

When $\nu > 1$, it reflects the situation of the developing countries; here, if $1 > \alpha > \frac{1}{2}$,

then $\left(\frac{n_H}{n_L}\right)^T > \frac{n_H}{n_L}$. When $0 < \nu < 1$, it reflects the situation of the developed countries; here,

if $\frac{1}{2} > \alpha > 0$, then $\left(\frac{n_H}{n_L}\right)^T > \frac{n_H}{n_L}$.

Proposition 1: During the South-North product cycle movement, the manufacturing industry agglomeration in the developing countries is characterized with the labour intensive intermediate product department bias, while the manufacturing industry agglomeration in the developed countries is characterized with the skills (factors) bias.

3 Innovation, Product Cycle and Manufacturing Industry Agglomeration

The agglomeration of the manufacturing industry is reflected in the increase of the varieties of intermediate products, while the product varieties will not increase if there is no production innovation. Therefore, equation (13) can be understood as the relative price of the intermediate products of the North against that of the South, i.e.

$$\frac{p_N}{p_S} = \varphi^{\frac{1-\alpha}{1-\alpha\sigma}} \left(\frac{H_{Np}}{H_S} \right)^{\frac{(1-\alpha)(\sigma-1)}{1-\alpha\sigma}} \left(\frac{n_N}{n_S} \right)^{\frac{(1-\alpha)(\sigma-1)}{1-\alpha\sigma}} \left(\frac{a_{Np}}{a_S} \right)^{\frac{\alpha(\sigma-1)}{1-\alpha\sigma}} \quad (22)$$

In it, H_{Np} is the quantity of human capital invested by Northern countries in the intermediate product department. For the Northern manufacturers, their human capital is used in the research and development department and the differentiated product production department at the same time. H_S is the quantity of human capital invested by Southern countries in the intermediate product department. n_N, n_S are respectively the varieties of the Northern and Southern intermediate products. a_{Np}, a_S are respectively the labour productivity of the product department of the Northern and Southern intermediate products.

According to equation (14), there is

$$\frac{\partial(p_N / p_S)}{\partial H_{Np}} < 0 \quad \frac{\partial(p_N / p_S)}{\partial H_S} > 0 \quad (23)$$

$$\frac{\partial(p_N / p_S)}{\partial n_N} < 0 \quad \frac{\partial(p_N / p_S)}{\partial n_S} > 0 \quad (24)$$

$$\frac{\partial(p_N / p_S)}{\partial a_{Np}} < 0 \quad \frac{\partial(p_N / p_S)}{\partial a_S} > 0 \quad (25)$$

Equations (23) to (25) can be summarized as proposition 2.

Proposition 2: With the increase of the relative human capital scale, production varieties and the relative labour productivity in the Northern and Southern intermediate product department, the relative price of the Northern and Southern intermediate product department will fall.

Putting equation (13) into (14) and according to the meaning of equation (22), there will be the relative pay w_N/w_S of the Northern and Southern human capital i.e.,

$$\frac{w_N}{w_S} = \varphi^{\frac{\alpha}{1-\alpha\sigma}} \left(\frac{H_{Np}}{H_S} \right)^{\frac{\alpha(\sigma-1)}{1-\alpha\sigma}} \left(\frac{n_N}{n_S} \right)^{\frac{1-\alpha}{1-\alpha\sigma}} \left(\frac{a_{Np}}{a_S} \right)^{\frac{\alpha}{1-\alpha\sigma}} \quad (26)$$

According to equation (26), there are

$$\frac{\partial(w_N / w_S)}{\partial H_{Np}} < 0 \quad \frac{\partial(w_N / w_S)}{\partial H_S} > 0 \quad (27)$$

$$\frac{\partial(w_N / w_S)}{\partial n_N} > 0 \quad \frac{\partial(w_N / w_S)}{\partial n_S} < 0 \quad (28)$$

$$\frac{\partial(w_N / w_S)}{\partial a_{Np}} > 0 \quad \frac{\partial(w_N / w_S)}{\partial a_S} < 0 \quad (29)$$

Proposition 3 can be summarized on basis of equations (27) to (29).

Proposition 3: The relative human capital price of the South and the North influences the agglomeration of the intermediate product departments. The relative pay of the Northern human capital will fall with the increase of the relative human capital scale in the Northern intermediate product department, and will increase with the increase of the relative product varieties as well as the relative labour productivity of the intermediate product department in the North.

4 Conclusions

Within the two department framework, this article describes the factors influencing the manufacturing industry agglomeration in the South-North product cycle movement. The manufacturing industry agglomeration of the developing countries is characterized with the labour intensive intermediate product department bias, while the manufacturing industry agglomeration in the developed countries is characterized with the skills (factors) bias. When the relative skilled labour (skills) in the developing countries increases, the manufacturing centre will shift from the department bias to the factor (skills) bias. With the increase of the relative human resource capital scale, product varieties and the relative labour productivity in the Northern intermediate product department, the relative price of the

intermediate product department in the North and the South will fall. The agglomeration of the intermediate product department depends on the input of the human capital, product varieties as well as the department labour productivity. The change of the human resource pay also has an important influence on the agglomeration of the intermediate product department. The relative price of the Northern human capital will fall with the increase of the relative human capital scale in the Northern intermediate product department, and will increase with the increase of the relative product varieties as well as the relative labour productivity of the intermediate product department in the North.

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