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Abstract

The Dutch disease generates de-industrialization. This paper reconsiders the Dutch disease by using the monopolistic competition model. Matsuyama (1992a) insists that the advance in agricultural productivity leads to industrialization in the manufacturing sector in the closed economy. However, our result is opposed to it. We show that even in the closed economy, the advance in agricultural productivity brings about de-industrialization. This is because the agricultural sector absorbs labor employment, and manufacturing labor decreases, which decreases the number of firms producing specialized parts. Finally, we discuss the poverty trap and a prescription for the Dutch disease.

Key Words : *De-industrialization; Monopolistic Competition; Elasticity of Factor Substitution; Poverty Trap; Structural Change*

JEL classifications: O11 O14

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1 Introduction

Most of countries having bountiful energy resource or vast land suffer from the Dutch disease. That is, the manufacturing industry in the country blessed with natural resources tends to decline due to the booming sector such as energy or agricultural industries.

According Corden and Neary (1982), there are two main factors for de-industrialization. The first one is the *resource moving effect.* The economy is directly de-industrialized because the production factor such as labor moves from the manufacturing sector to the booming sector. The other one is the *pricing effect* (*or spending effect*). If the price of goods produced in the booming sector becomes higher and the price of manufacturing goods falls, then the economy produces less manufacturing goods. In their model, however, both booming sector and manufacturing sector have the constant return to scale technology and perfect competition markets.

Unlike Corden and Neary (1982), we emphasize on the number of firms producing the specialized parts (or component) for machine. We propose the third factor of de-industrialization. It is the *limited availability of specialized inputs.* When the number of firms producing specialized parts for machine is small, the small range of specialized parts forces the final manufacturing goods sector to use a labor intensive technology. The small market size induces the monopolistic firms producing specialized parts to exit from producing the specialized parts. Since the division of labor is limited by the market size, this circularity between the market size and the degree of specialization forces the economy to drop into poverty trap.

On the contrary, the productivity of manufacturing industry advances due to adoption of an even more roundabout way of production in the intermediate sector. Since the division of labor is generated by large market size, the circularity forces the economy to move toward the highly stable equilibrium, which leads to the more firms producing the specialized parts. When the number of firms which produce specialized parts for machine is enough large to be above a threshold, the larger market size enables for the economy to fulfill cumulative advance. The productivity growth of manufacturing sector is achieved through increasing availability of specialized parts and more indirect methods of production.

The entry of a firm increases the market share of other firms, at least for a certain range because the new firm contributes to an expanding variety of specialized parts. It generates demand for complementary products. The new firms add a variety of specialized parts, which induces the intermediate goods sector producing "machine" to adopt an even more roundabout way of production. It generates demand for other related industries.

In our model, there are four production sectors; (1) agricultural sector, (2) final manufacturing goods sector, (3) intermediate goods sector producing machine, and (4) specialized inputs (parts) sector. The market of specialized parts is monopolistic competition.

The prominence of our model is featured in labor markets where labor is employed in three sectors; the agricultural sector, the final manufacturing goods sector, and the specialized parts sector. Since we assume that labor moves freely across three sectors, labor earns the same wage. Especially, the final manufacturing goods sector employs labor as well as machine. When the elasticity of substitution between labor in final manufacturing goods sector and machine is more than the elasticity of substitution between parts, the model generates multiple equilibria. In this case, there are three equilibrium points as for the number of monopolistic firms producing specialized parts.

Matsuyama (1992a) insists that the advance in agricultural productivity leads to industrialization in the manufacturing sector in the closed economy. However, our result is opposed to it. We show that even in the closed economy, the advance in agricultural productivity brings about the de-industrialization. This is because the agricultural sector absorbs labor employment, and manufacturing labor decreases, which decreases the number of firms producing specialized parts. Note that Matsuyama (1992a) insists that the advance in agricultural productivity leads to the de-industrialization in the small open economy.

Murphy, Shleifer, and Vishny (1989) show that the larger propagation effect of macroeconomic demand gives rise to poverty trap. In their model, the firms choose either the constant return to scale technology or the increasing return to scale technology. What technology the firms adopt relies on the market size which depends on the purchasing power the labor has in the economy. The purchasing power depends on the degree of industrialization. The more firms which use the modern technologies, the more profitable. As the result of this, the complementarity of investment across industries brings about multiple equilibria. In the higher equilibrium, all industries adopt modern technology. On the contrary, in the lower equilibrium, the firms use the less modern technology. Matsuyama (1992b) discusses the possibility that Dixit and Stiglitz's (1977) type of monopolistic competition generates poverty trap. Rosenstein-Rodan (1943) discusses that the way to overcome poverty trap is economic development based on economic program.

In order to deter de-industrialization, we propose some prescriptions for the Dutch disease. That is the decrease in entry cost or initial setup cost, which raises the number of firms producing specialized parts for machine, and increases output of the economy.

The remainder of the paper is organized as follows. Section 2 presents our model, Section 3 characterizes the equilibrium, Section 4 considers the Dutch disease, and Section 5 concludes our analyses.

2 The Model

2.1 Final Manufacturing Goods Sector

We assume that the final goods sector produces homogeneous manufacturing goods under constant return to scale technology and that its production function is given by

$$Y=F(M,\ L_y)=\left[vM^{\frac{\varepsilon-1}{\varepsilon}}+(1-v)L_y^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where M is the composite intermediate goods or what is called machine, and L_y is labor who engages in the final goods sector. The parameter $\varepsilon(>1)$ is the elasticity of substitution between machine and labor in final goods sector. $v\in(0,\ 1)$ is the parameter weighted on machine input. The final goods market is assumed to be perfect competition. We assume that the price of final manufacturing goods is normalized to be one. The profit of final manufacturing goods sector is given by

$$\pi^f=Y-wL_y-PM,$$

where w and P are the wage rate and the price of machine which represents the wholesale price index or what we call "WPI," respectively.

According to the profit maximization conditions, the technical rate of substitution is computed by

$$\frac{vM^{\frac{-1}{\varepsilon}}}{(1-v)L_y^{\frac{-1}{\varepsilon}}}=\frac{P}{w}.$$

This is the relative marginal products of machine and labor in the final manufacturing goods sector, which must be equal to the relative factor prices. Therefore, we obtain the relative demand for labor in final goods sector to machine as

$$\frac{L_y}{M}=\left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{P}{w}\right)^{\varepsilon}, \tag{1}$$

which depends positively on the inverse of wage rate in terms of "machine".

2.2 Intermediate Goods Sector

Each intermediate goods sector assembles parts of $m(j)$ into a machine M. This sector produces and sales "machine" to the final manufacturing goods sector. Denote a monopolistic firm producing parts by index of $j \in [0, n]$. There exist n monopolistic firms which produce parts of machine. We assume that the machine consists of n parts. The production function of machine is given by

$$M = \left[\int_{j=0}^{n} m(j)^{\frac{\sigma-1}{\sigma}} dj \right]^{\frac{\sigma}{\sigma-1}}, \tag{2}$$

where $m(j)$ is a part which each monopolistic firm $j \in [0, n]$ produces. $\sigma > 1$ is the elasticity of substitution between parts. Denote the expenditure to machine by $E = PM$. Given the expenditure E, the intermediate goods sector chooses optimal demand for parts subject to

$$\int_{j=0}^{n} p(j) m(j) dj = E.$$

The optimal demand for parts of j is computed by

$$m(j) = M \left(\frac{p(j)}{P} \right)^{-\sigma}, \tag{3}$$

where $M = \frac{E}{P}$. The price of machine or WPI is defined by

$$P \equiv \left[\int_{j=0}^{n} p(j)^{1-\sigma} dj \right]^{\frac{1}{1-\sigma}}. \tag{4}$$

2.3 Monopolistic Firms Producing Parts

We assume that the parts market is monopolistic competition. The monopolistic firms j produce parts $m(j)$ by increasing return to scale technology, which involves fixed costs as well as variable costs. The production of parts uses only labor. Producing parts requires not only fixed labor $F > 0$ but also variable labor $\theta > 0$ in order to produce one unit part of $m(j)$. Therefore, the monopolistic firm j employs

$$l_j = \theta m(j) + F.$$

The profit of a monopolistic firm j is given by

$$\pi_j = p(j)m(j) - w[\theta m(j) + F],$$

where w is wage rate. According to the mark-up pricing, the monopolistic price is set to

$$p(j) = \left(\frac{\sigma}{\sigma - 1}\right) w\theta,$$

where the monopolistic price $p(j) = p$ does not depend on j. From the optimal demand for parts（３）, σ is the elasticity of demand with respect to price of parts. Each differentiated goods（parts）producer faces a downward sloping demand with the constant price elasticity σ. Then, the profit is

$$\pi_j = \frac{1}{\sigma - 1} w\theta m(j) - wF.$$

Because of the free entry condition $\pi_j = 0$, we obtain

$$m(j) = \frac{(\sigma - 1)F}{\theta}.$$

From the equation above we find $m(j) = m$ is independent of j, and so is $\pi_j = \pi$.

The optimal employment of a monopolistic firm j is given by

$$l_j = F\sigma.$$

The total manufacturing labor producing intermediate goods is

$$L_m = nl_j = n[\theta m + F]. \qquad (5)$$

From the production function of machine（２）and $m(j) = m$, we obtain

$$M = mn^{\frac{\sigma}{\sigma - 1}}. \qquad (6)$$

Substituting $p(j) = p = \left(\frac{\sigma}{\sigma - 1}\right) w\theta$ into WPI（４）, we obtain WPI as follows:

$$P = \left(\frac{\sigma}{\sigma - 1}\right) \theta w n^{\frac{1}{1 - \sigma}}.$$

Therefore, the inverse of wage rate in terms of machine is computed by

$$\frac{P}{w}=\left(\frac{\sigma}{\sigma-1}\right)\theta n^{\frac{1}{1-\sigma}}. \qquad (7)$$

2.4 Agricultural Sector

We assume that the market of agricultural goods is perfect competition. The production function of agricultural sector is assumed to be

$$Y_A=ZL_A^{\alpha},$$

where $Z(>0)$ is the agricultural productivity which is given exogenously, L_A is labor who engages in producing agricultural goods, and $\alpha\in(0,\ 1)$ is a parameter. Denote the price of agricultural goods by p_A. The profit maximization condition of

$$w=p_A Z\alpha L_A^{\alpha-1},$$

determines the optimal employment of agricultural labor, which is given by

$$L_A=\left(\frac{p_A Z\alpha}{w}\right)^{\frac{1}{1-\alpha}}. \qquad (8)$$

3 The Equilibrium

3.1 Labor Market Equilibrium

Having analyzed the behavior of each agent, we consider the equilibrium of the economy. We assume that total population is given exogenously by $\bar{L}$ for simplicity. We also assume that labor moves freely between industries, which means that all labor earns the same wage.

The labor market equilibrium is given by

$$L_y+L_m=\bar{L}-L_A, \qquad (9)$$

where the left-hand side is the manufacturing labor of final and intermediate goods sector.

From (1) (6) and (7), the manufacturing labor in final goods sector is given by

$$L_y = \left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{P}{w}\right)^{\varepsilon} M = \left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{\sigma}{\sigma-1}\right)^{\varepsilon}\theta^{\varepsilon} n^{\frac{\sigma-\varepsilon}{\sigma-1}} m.$$

By using the manufacturing labor in producing intermediate goods $L_m = n\theta m + nF$ (5), the labor market equilibrium is expressed as

$$\left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{\sigma}{\sigma-1}\right)^{\varepsilon}\theta^{\varepsilon} n^{\frac{\sigma-\varepsilon}{\sigma-1}} m + n\theta m + nF = \bar{L} - L_A.$$

Thus the optimal demand of parts is determined by

$$m = \frac{\bar{L} - L_A - nF}{n\theta + \left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{\sigma}{\sigma-1}\right)^{\varepsilon}\theta^{\varepsilon} n^{\frac{\sigma-\varepsilon}{\sigma-1}}}.$$

3.2 Free Entry and Numbers of Monopolistic Firms

Next, we consider the number of firms in the equilibrium. The free entry condition is that the profit of monopolistic firm becomes zero, that is

$$\pi = \frac{1}{\sigma-1} w\theta m - wF = 0. \tag{10}$$

The number of monopolistic firms n is determined endogenously. For convenience, we define the gross profit as

$$\pi^{gross} \equiv \frac{1}{\sigma-1} w\theta m. \tag{11}$$

By substituting the optimal demand of parts (10) into (11), we obtain the gross profit of a monopolistic firm which is computed by

$$\pi^{gross} = \frac{w\theta}{\sigma-1}\left[\frac{\bar{L} - \left(\frac{p_A Z\alpha}{w}\right)^{\frac{1}{1-\alpha}} - nF}{n\theta + \left(\frac{v}{1-v}\right)^{-\varepsilon}\left(\frac{\sigma}{\sigma-1}\right)^{\varepsilon}\theta^{\varepsilon} n^{\frac{\sigma-\varepsilon}{\sigma-1}}}\right], \tag{12}$$

where we use the optimal agricultural labor (8).

The range of specialized inputs (the number of parts) available determines the stage of development. In highly developed stage, a large number of specialist firms producing parts are active and meet the needs of intermediate goods industry producing machine. The presence of the vast network of auxiliary industries make the intermediate goods sector producing machine adopt a more roundabout way of production and rely on the varieties of parts.

On the contrary, in the stage of underdevelopment, the limited availability of specialized inputs (parts) forces the final manufacturing goods producers to use a more labor intensive technology.

The case of $\varepsilon < \sigma$

The gross profit decreases with the number of monopolistic firms n and the gross profit curve is downward-sloping in the case of $\varepsilon < \sigma$. (See Figure 1) This case is that the elasticity of substitution between labor in final goods sector and machine is less than that between parts. If the production function of final goods sector is

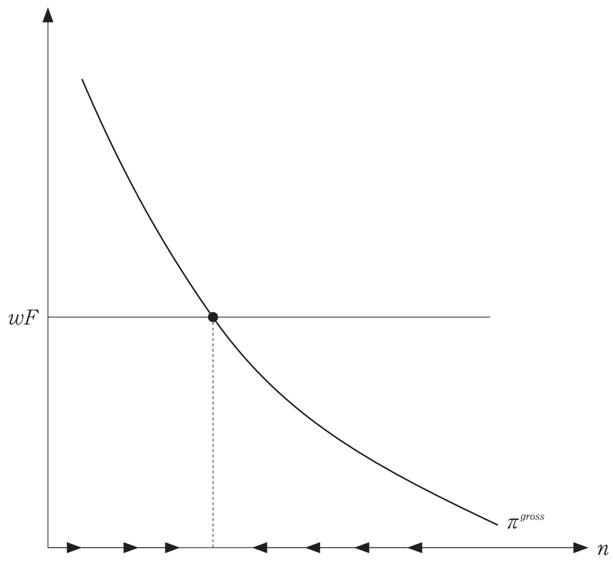

Figure 1: The case of $\varepsilon < \sigma$

Cobb-Douglas type, this case would be always valid.

The case of $\varepsilon > \sigma$

On the contrary, if $\varepsilon > \sigma$, then the gross profit curve becomes the "bell curve."（See Figure 2）This case is that the elasticity of substitution between labor in final goods sector and machine is more than that between parts. The free entry condition（10）determines the number of monopolistic firms producing parts, which generates multiple equilibria. In this case of $\varepsilon > \sigma$, there are three equilibrium points as for the number of monopolistic firms. They are the origin, n_L, and n_H. The equilibrium n_L is unstable, and n_H and the origin are stable.

The entry of firm increases the market share of other firms, at least for a certain range because the new firm contributes to an expanding variety of parts, and generates demand for complementary products. New firms add a variety of parts, which induces the intermediate goods sector producing machine to adopt an even more roundabout way of production. This generates demand for other related industries.

The unstable equilibrium point $n = n_L$ can be thought of as a threshold level. Below the threshold, the limited availability of specialized inputs（parts）forces the final manufacturing goods sector to use a labor intensive technology. The small market size induces monopolistic firms to exit from producing parts. Since the division of labor is limited by the market size, this circularity between the market size and the degree of specialization forces the economy to move toward $n = 0$.

Above the threshold, however, the larger market size enables for the economy to fulfill cumulative advance. The productivity growth of manufacturing sector is achieved through increasing availability of specialized inputs（parts）and more indirect methods of production. Since the division of labor is generated by enough market size, the circularity forces the economy to move toward the highly stable equilibrium $n = n_H$.

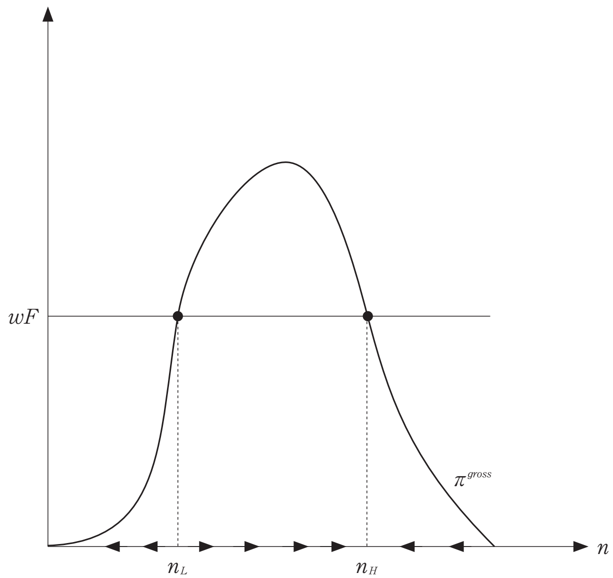

Figure 2: The case of $\varepsilon > \sigma$

The intuitive reason why the economy has multiple equilibria is as follows. The firms producing new parts cannot gain the whole profits of the advent of new parts. The wide availability of specialized parts introduced by new entrants forces the final goods sector to use more machine intensive technology. As a result, the demands of the other parts also increase. The firms of intermediate goods sector, however, may not recognize the effects of these pecuniary externalities.

The problem discussed above can be solved if every firm can enter the intermediate goods market simultaneously. Then the economy can jump to the stable point, $n = n_H$, from anywhere. This can be possible only in the static model. In the dynamic model, however, the economy has to move some resource from the incumbent to the entrant in order to produce new parts. Therefore, the economy cannot gain the whole profits from the productivity advance just after the advent of new parts.

The main force to impede the economic growth is that a complicated productive technology needs a lot of parts and services which are produced in the adjoining area. In the developing countries, for instance, the economy can use only simple technology because she has few basic industries, which means that the specialized parts market is very small. The shortage of demands prevents the economy from establishing network of the basic industries which support the output in the area. Hence, there exist two main factors impeding the economic growth: the *shortage of demands* and the *undeveloped basic industries,* both of which are interdependent. In other words, in the one hand, the division of labor is subject to the market size, and the other hand, the market size is also subject to the degree of specialization. This recursive dependence generates the trap of economic development.

If an economy establishes a considerable size of base industries, then the recursive dependence is a virtuous cycle. In the economy, the division of labor becomes very higher, the production process becomes more circuitous, and the specialized parts firms produce more specialized parts. These accumulative processes enhance productivity and increase the income. That is, a success brings about another success, whereas poverty is a cause of poverty per se.

Since there is substitutability between labor intensive technology and machine intensive technology, the parts have complementarities mutually, which exists even if the elasticity of substitution is high.

4 The Dutch Disease and De-Industrialization

4.1 A Rise in Agricultural Productivity

Now, we are ready to discuss the Dutch disease in this economy. First we consider the effects of an increase in the agricultural productivity on the economy where $\varepsilon < \sigma$. An increase in Z shifts the gross profit curve downwardly, but shifts the wF line upwardly. (See Figure 3)

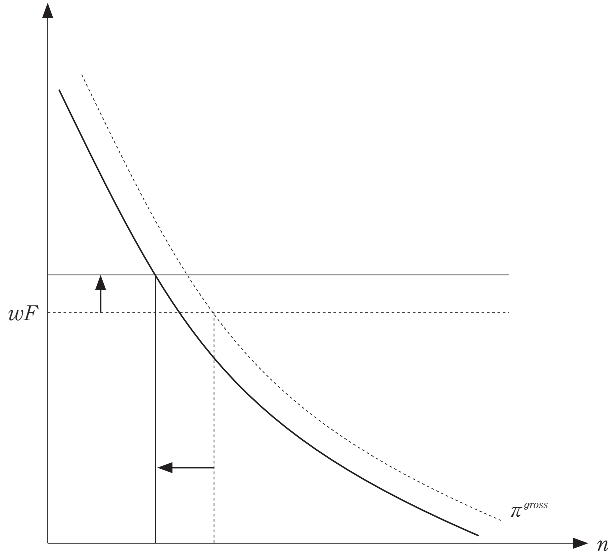

Figure 3: The effects of a rise in Z ($\varepsilon > \sigma$)

Next we move to the case in which $\varepsilon > \sigma$. As in the case above, a rise in Z shifts down the gross profit curve but up fixed cost. (See Figure 4) These shifts increase n_L and decrease n_H.

In any case, we find that the number of firms producing parts decreases, which leads *de-industrialization.*

Matsuyama (1992a) insists that the advance in agricultural productivity leads to industrialization in the manufacturing sector in the closed economy but leads to de-industrialization in the small open economy.

Contrary to Matsuyama (1992a), we show that even in the closed economy, the advance in agricultural productivity brings about the de-industrialization. This is because the agricultural sector absorbs labor employment, and labor who works for the manufacturing sector decreases, which decreases the number of firms producing specialized parts.

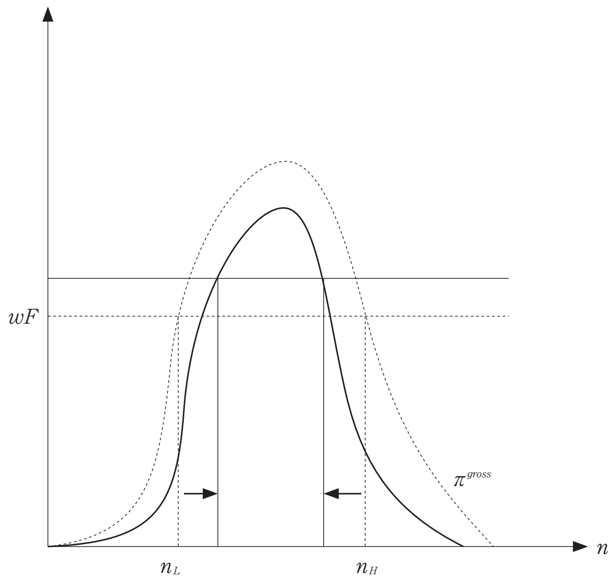

Figure 4: The effects of a rise in Z ($\varepsilon < \sigma$)

4.2 Prescription for the Dutch Disease

Having found the cause of the Dutch disease in the economy, we consider the solution of the problem here. We analyze the effect of a subsidy. If the government makes a grant to the entrant for a fixed cost F, then some new firms may decide to enter the intermediate goods market. This policy shifts wF locus downwardly, which means that the number of firms producing parts increases. Therefore, the subsidy can prevent the economy from de-industrializing.

5 Concluding Remarks

The Dutch disease is one of the most important economic problems which both developing and developed countries have to solve. In his seminal paper, Matsuyama (1992a) finds that whether the economy suffers from the Dutch disease or not depends on the openness of the economy. That is, only in a small open economy, an

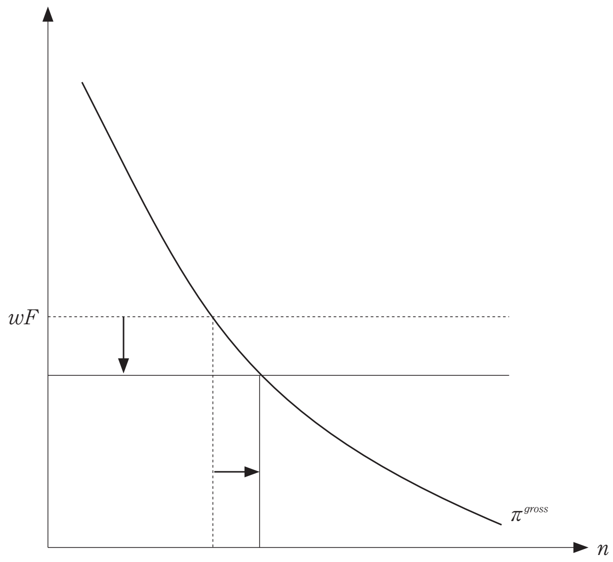

Figure 5: The effect of a subsidy ($\varepsilon > \sigma$)

increase in agricultural productivity de-industrializes the economy.

In this paper, however, we have considered the same effect of an advance in agricultural productivity on the economy whose intermediate goods sector is monopolistic competitive, and find that the economy suffers from de-industrialization even in the closed economy. If an agricultural technology makes progress, the wage rate rises. This increase in the wage rate also raises the initial setup cost for the entrant in the parts market. Therefore, the number of firms producing specialized parts falls. As a result, the output of the economy decreases, which means de-industrialization occurs in the economy.

A subsidy for the entrant can deter de-industrialization. If the government subsidizes the entrants in the intermediate goods market for the setup cost, then the number of firms producing specialized parts increases. Making a grant is a most simple prescription for the Dutch disease.

The problems and solutions in a static model may be different from those in a dynamic model. The budget constraint of the government is not considered in this paper. In addition, there exist a lot of other policies to prevent the economy from de-industrializing; *multilateralization of industries,* which increases the number of firms producing specialized parts for machine, and gives rise to an even more roundabout ways of production, or *corporate tax cut* to welcome new enterprise, and so on. In our paper, the labor market is perfectly competitive while the goods market is imperfect competition. Blanchard and Giavazzi (2003) studies the effects of deregulation in the goods markets and labor markets in the monopolistic competition model with labor bargaining. We are interested in the relationship between deregulation of markets, poverty trap, and the Dutch disease. We leave all these extensions for future research.

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