European Research Studies Journal
Volume XXIII, Issue 4, 2020

pp. 865-872

Underdevelopment through Productivity Improvement Measures in an Advanced Region

Submitted 02/08/20, 1st revision 29/08/20, 2nd revision 22/09/20, accepted 20/10/20

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Abstract:

Purpose: *This paper analyzes how increasing economies of scale, higher productivity, and falling costs in an advanced region can lead to a relative reduction in progressiveness in an economically weaker region.*
Design/Methodology/Approach: *The author uses the core-peripheral model as a basis for this framework. The regional development model thus, consists of two sectors. Technological progress favors either the advanced or lagging regions.*
Findings: *Thus, optimization measures taken in the advanced region will lead to a steady slowdown in development. The effects of increasing economies of scale are reflected in falling marginal and fixed costs. This reduces costs and makes production more effective. The productivity of the advanced region increases. This increase in volume, however, means that agricultural production becomes more valuable. The relative price of industrial goods falls, and, as a result, the relative income differences decrease—the utility of both regions increases. However, the increasing economies of scale in the advanced region mean that the underdeveloped region's utility increases more strongly and reduces inequality.*
Practical Implications: *The analysis shows that optimization measures in an advanced region weaken the region as they lead to loss of development benefits.*
Originality: *The author analyzes the influence of rising economies of scale and declining costs on developing the advanced region and the underdeveloped region and relative inequality.*

Keywords: *Development advantage, economics of scale, core-peripheral model, regional transfers, regional policy.*

JEL: *R00, R10, R13, R15, R19, R20, O10, O11, F11, F19.*

Paper Type: *Research study.*

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1. Introduction

Many underdeveloped regions' problem lies in all forms of transfer between regions showing dissimilar levels of development. Wages go up without a corresponding increase in productivity, making a weaker region less competitive. In this paper, the author considers two regions, two sectors, and two products. The assumptions are based on publications: Brezis, Krugman, and Tsiddon (1993), Desmet (2002), Desmet and Ortín (2007), Gumpert (2019a), Gumpert (2019b), and Krugman (1991).

This paper introduces an idea of why measures for optimization taken in an advanced region, such as cost reductions, can nevertheless be a development disadvantage for that region. Despite reduce costs (factors), the advanced region will not improve compared to the underdeveloped region. To simplify, we consider two regions with as many sectors and goods. The agricultural sector has an important role to play here as a sector that produces agricultural goods. Furthermore, each region is assumed to be fully specialized. The agricultural sector is a static sector where less innovation is expected and where the input from the factor soil is rather rigid. The industrial sector is characterized by innovation and human capital.

The question arises as to how the underdeveloped East could converge - despite the advanced West solely reaping the benefits of optimization and innovation. The following analysis analyzes how optimization measures, innovations, and cost reductions in the advanced industrial sector positively affect the underdeveloped agricultural sector and how they help and strengthen the latter in its development. The author analyzes the influence of rising economies of scale and declining costs on developing the advanced region and the underdeveloped region and relative inequality.

The motivations for this following analysis are:

- Conscious model theoretical analysis is to be carried out. Authors have presented the phenomenon empirically. A sustainable model theoretical explanation is still lacking. The following paper is intended to contribute here (Felice, 2018).
- The extension of the core-peripheral model allows a more detailed and realistic analysis of the interactions between the regions and the individual input factors. The analysis of fixed costs, variable costs, and economies of scale illustrates both regions (Brezis *et al*., 1993; Desmet, 2002; Desmet and Ortín, 2007; Krugman, 1991).
- Monopolistic competition is assumed. Every company is a “minor” monopolist and can impose its own price premium. There are fixed costs, variable costs, marginal costs, and, as a result, the extension of the model leads to increasing economies of scale. This promotes optimization measures of market entry and market exit of individual companies (Krugman, 1991; Krugman and Venables, 1995).

2. The Model

The author uses the core-peripheral model as a basis for this framework (Desmet and Ortín, 2007; Gumpert, 2019a; Gumpert, 2019b; Krugman, 1991). The regional development model thus consists of two sectors. Technological progress favors either the advanced or lagging

regions (Boschma and Frenken, 2017; Fonseca, 2017). There is one unit of labor for the input factor.

$$L = L^* = 1 \tag{1}$$

T_M is levied on the industrial product $T_M > 1$. The relevant production functions in the underdeveloped East are defined by input factor and sectoral productivity Q_F^*.

$$Q_F^* = L_F^* \tag{2}$$

In the industrial sector, there are monopolistic competition and transportation costs. Each company produces an individual industrial commodity. For further analysis, increasing returns to scale are defined. The author defines the individual decreasing, increasing, or unchanging variables with MOD and respective signs (↓ ↑ or →). Each company produces its own goods. These factors in product variants, although the companies are identical. The industrial sector has a monopolistic competition à la Chamberlain (Dixit and Stiglitz, 1977; Hanusch et al., 2002; Pindyck and Rubinfeld, 2003; Samuelson and Nordhaus, 2005). Every company has fixed and marginal costs. The fixed costs are defined with FM, MOD (↓)> 0, and the marginal costs are defined with cM, MOD (↓) < 1 to ensure increasing internal economies of scale. The costs are marked with MOD and (↓or ↑) to indicate the increasing efficiency by decreasing costs and rising economies of scale. The substitution elasticity is defined with σ> 1. The industrial output of a company in the advanced region is defined by equation (3). The individual output quantity of a company does not depend on productivity and the labor factor but the elasticity of substitution, marginal costs cM, MOD (↓), and fixed costs FM, MOD (↓). Due to the relationship between fixed costs and marginal costs, the increasing economies of scale lead to an equal or increase in the individual industrial output volume. There is no impact on the agricultural sector because the sector is only characterized by perfect competition.

$$q_{M,MOD}(\uparrow) = (\sigma - 1) \cdot \frac{F_{M,MOD}(\downarrow)}{c_{M,MOD}(\downarrow)} \tag{3}$$

The factor demand function is defined by industrial labor l_M.

$$l_{M,MOD}(\downarrow) = F_{M,MOD}(\downarrow) + c_{M,MOD}(\downarrow) \cdot Q_M \tag{4}$$

After inserting the output quantity, the following results can be obtained:

$$l_{M,MOD}(\downarrow) = F_{M,MOD}(\downarrow) + c_{M,MOD}(\downarrow) \cdot (\sigma - 1) \cdot \frac{F_{M,MOD}(\downarrow)}{c_{M,MOD}(\downarrow)} = \sigma \cdot F_{M,MOD}(\downarrow) \tag{5}$$

Industrial work is reduced by decreasing fixed costs. The labor factor and the technology component influence the output quantity of the entire region. An artificial factor of industrial labor is introduced and compared with the production function to calculate the number of companies. The declining fixed costs make it easier and more attractive for new companies to get started, increasing the number of companies.

$$n_{M,MOD}\left(\uparrow\right)=\frac{A\cdot L_M}{\sigma\cdot F_{M,MOD}\left(\downarrow\right)} \tag{6}$$

This phenomenon has three consequences for individual companies:

1. The industrial output of a single company increases.
2. The decreasing fixed costs make it easier for new companies to enter, and the number of companies' increases.
3. The new companies will increase competition in the advanced West, increasing the overall output of the region.

These measures also lead to the agricultural sector, becoming more valuable than the industrial sector because the relative production volume decreases. The higher production volume in the advanced West will cause the underdeveloped East's industrial workers to migrate to the West. This, too, will continue to lead to an absolute reduction in agricultural output. The labor factor is partially mobile between regions and within sectors. Wages are similar in two sectors within a given region, and the industrial M and M* sector across regions.

$$w_{M,MOD}=w^{*}_{M,MOD}=w_F \tag{7}$$

$$w^{*}_{M,MOD}=w_{M,MOD}=w^{*}_F \tag{8}$$

The cost function results from wages and the required industrial labor. The total costs in the advanced West are decreasing.

$$CO_{M,MOD}\left(\downarrow\right)=\left(F_{M,MOD}\left(\downarrow\right)+c_{M,MOD}\left(\downarrow\right)\cdot Q_M\right)\cdot w_M \tag{9}$$

The Cobb-Douglas function is

$$U\left(C_M,C_F\right)=\upsilon\left(C_M^{\mu}\cdot C_F^{1-\mu}\right)\cdot \tag{10}$$

The Cobb-Douglas function in equation (10) is concave due to the diminishing marginal rate of substitution. Variables C_M and C_F denote the consumption of industrial and agricultural products. The utility function has the characteristic that a larger number of variations (product variety i) increase the utility. Consumers thus maximize the utilities while considering the budget constraints (Ehrenfeld, 2004; Krugman, 1991). Equation (11) illustrates that due to the decreasing marginal costs, the inequality between the regions is decreasing, and the developmental characteristics are converging.

$$\mu>\frac{1}{\frac{L^{*}_F}{L_M}\cdot\frac{\sigma}{\sigma-1}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M+1} \tag{11}$$

3. Impacts on Regions

In the case of complete specialization, an industrial goods' price according to equation (12) is available.

$$P_{M,MOD}(\downarrow)=\left(\frac{\sigma}{\sigma-1}\right)^{2}\cdot\frac{\mu}{1-\mu}\cdot\frac{L_{F}^{*}}{A_{M}\cdot L_{M}}\cdot c_{M,MOD}^{2}(\downarrow)\cdot T_{M} \tag{12}$$

In the East, only the immovable labor force of the agricultural sector is located. The falling marginal costs will cause the relative price of industrial goods to fall. As a result, the relative price of agricultural goods becomes indirectly more important and increases. The scarcity of agricultural production and the expansion of industrial production is also reducing the prices of industrial goods. The reduction in agricultural products directly reduces the industrial prices because the former are becoming scarcer. Equation (13) shows that input factor, productivity, and expenditure share influence industrial goods prices and substitution elasticity and cost function. In equation (13), the marginal and fixed costs are reduced. The marginal costs' square sum has a stronger effect on this reduction—consequently, the individual industrial goods' prices of a company decrease. In principle, individual companies must adapt to the overall market situation and reduce their prices.

$$ps_{M,MOD}(\downarrow)=\frac{\sigma}{\sigma-1}\cdot\frac{\mu}{1-\mu}\cdot\frac{1\cdot L_{F}^{*}}{(\sigma-1)\cdot F_{M,MOD}(\downarrow)}\cdot c_{M,MOD}(\downarrow)\cdot T_{M} \tag{13}$$

Equation *(14)* must apply to full specialization of the East.

$$\frac{A_{M}}{A_{F}^{*}}>\left(\frac{\sigma}{\sigma-1}\right)^{2}\cdot\frac{\mu}{1-\mu}\cdot\frac{L_{F}^{*}}{L_{M}}\cdot c_{M,MOD}^{2}(\downarrow)\cdot T_{M} \tag{14}$$

The transformation curve is concave due to the two inputs. The comparative advantage will be lower, and the regions will converge in the future. The Eastern production function is defined:

$$Q_{F}^{*}=1\cdot L_{F}^{*} \tag{15}$$

The industrial output of a company in the advanced region is defined by equation (16). The individual output quantity of a company does not depend on productivity and the labor factor but on the elasticity of substitution, marginal costs $c_{M,MOD}$ (↓), and fixed costs $F_{M,MOD}$ (↓).

$$q_{M,MOD}(\uparrow or\rightarrow)=(\sigma-1)\cdot\frac{F_{M,MOD}(\downarrow)}{c_{M,MOD}(\downarrow)} \tag{16}$$

Industrial work is reduced by decreasing fixed costs. The labor factor and the technology component influence the output quantity of the entire region. An artificial factor of industrial labor is introduced and compared with the production function to calculate enterprises' number. Equation (17) indicates the number of companies.

$$n_{M,MOD}\left(\uparrow\right)=\frac{A_M\cdot L_M}{\sigma\cdot F_{M,MOD}\left(\downarrow\right)} \tag{17}$$

The declining fixed costs make it easier and more attractive for new companies to get started, increasing the number of companies. Total productivity is also increasing.

$$Q_{M,MOD}\left(\uparrow\right)=q_{M,MOD}\left(\uparrow or\rightarrow\right)\cdot n_{M,MOD}\left(\uparrow\right) \tag{18}$$

This leads to an increase in overall production, but the growing number of companies also increases innovation capacity. Only innovative companies survive in the market. Equations (19) and (20) define wages in the industrial West and the agricultural East. By reducing marginal costs, the advanced West's wages will decrease moderately [equation (19)]. The pressure to reduce wages in the West comes from a steady reduction in industrial goods` prices across regions according to equation (13). As a result, wages in the West will fall. In the underdeveloped East, wages are not influenced by the cost structure [equation (20)]. That is, wages remain unchanged in the underdeveloped East. In relation, the West becomes increasingly poorer.

$$w_{M,MOD}\left(\downarrow\right)=\frac{\sigma}{\sigma-1}\cdot\frac{\mu}{1-\mu}\cdot L_F^*\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M \tag{19}$$

$$w_F^*=L_F^* \tag{20}$$

$$\frac{EK_{MOD}}{EK_{MOD}^*}\left(\downarrow\right)=\psi\left(\downarrow\right)=\frac{\sigma}{\sigma-1}\cdot\frac{\mu}{1-\mu}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M \tag{21}$$

The income of the West, according to equation (22), depends on monopolistic competition, the region's share of spending on consumer goods, the input factor of the underdeveloped East, falling marginal costs and transportation costs. The first complex is lower due to the higher production volumes of industrial goods and the lower prices. Lower wages and workers of the East are deducted from this complex. The second complex represents the payments made by the West to the East. A lower wage is paid to the East; however, wages in the industrial sector are still higher than in the agricultural sector. In the West, everyone gets a lower wage in the industrial sector. The industrial workers in the advanced West work entirely in the industrial sector. Consequently, a wage reduction affects all industrial workers in the West.

$$EK_{MOD}\left(\downarrow\downarrow\right)=\frac{\sigma}{\sigma-1}\cdot\frac{\mu}{1-\mu}\cdot L_F^*\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M-w_{M,MOD}\left(\downarrow\right)\cdot\left(1-L_F^*\right)-\tilde{z} \tag{22}$$

The Eastern income depends on the agricultural workers and the normalized price. To this end are added the incomes of the agricultural workers who have retrained and are receiving wages in the industrial sector in the West. This wage is lower for a proportion of workers, so there is less income for this section of the population. However, falling prices for industrial goods means paying less; therefore, less wages are required. Additionally, all other inhabitants of the East can now buy cheaper industrial products. Considering the financial

transfers, the overall effect of the reduction is less pronounced in the underdeveloped East than in the advanced West.

$$EK^{*}_{MOD}\left(\downarrow\right) = L^{*}_{F} + w_{M,MOD}\left(\downarrow\right)\cdot\left(1 - L^{*}_{F}\right) + z^{*} \tag{23}$$

The regions have balanced budgets: The variable "z equals z*" defines the connection between the two regions. The incomes of the West and the East are given by equations (24) and (25). The income levels are presented as functions that depend on the value ψ.

If the variables $L_F^* = 0.99$, $L_M = 1.01$, $\sigma = 2.00$, $c_{M,MOD} = 0.50$, and $T_M = 1.00$ are selected, the parameter μ must be greater than 0.60, according to equation (21). With this assumption, the value $\psi = 2.3334$ results from equation (24). If the variables L_F^*, L_M, σ, $c_{M,MOD}$, and T_M and the values $\mu = 0.60$ and $\psi = 1.50$ are used in equations (26) and (27), then there is utility for the advanced West EK_{MOD} with 1.5150 and utility for the underdeveloped East EK_{MOD}^* with 1.0100. Because of increasing economies of scale (falling marginal costs) in the advanced West, progress will decrease there, but the East will increase its level of development. In the West, income increases by 1.42 times while that in the East increases by 1.78 times.

$$EK_{MOD}\left(\downarrow\downarrow\right) = \frac{1}{1-\mu}\cdot L^{*}_{F}\cdot\left(1+\mu\cdot\left(\frac{\sigma}{\sigma-1}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M - 1\right)\right)\cdot\frac{\psi}{1+\psi} \tag{24}$$

$$EK^{*}_{MOD}\left(\downarrow\right) = \frac{1}{1-\mu}\cdot L^{*}_{F}\cdot\left(1+\mu\cdot\left(\frac{\sigma}{\sigma-1}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M - 1\right)\right)\cdot\frac{1}{1+\psi} \tag{25}$$

Utility in the advanced West, according to equation (26), is equal to $U_{1,MOD} = 0.6012$ under the variables $L_F^* = 0.99$, $L_M = 1.01$, $\sigma = 2.00$, $c_{M,MOD} = 0.50$, $T_M = 1.00$, $A_M = 1.00$, $\mu = 0.60$, and $\psi = 1.50$. The usefulness of the underdeveloped East is $U_{1,MOD}^* = 0.4008$. If the marginal costs $c_{M,MOD}$ are reduced from 0.50 to 0.40, the utility level increases in both regions. The utility level in the West U_{MOD} increases from 0.6012 to 0.6286 (1.05 times) while that for the underdeveloped East U_{MOD}^* increases much more, from 0.4008 to 0.5238 (1.31 times).

$$U_{MOD}\left(\psi\right)\left(\uparrow\right) = \upsilon\left(\frac{\psi}{1+\psi}\cdot L^{*}_{F}\cdot\left(1+\mu\cdot\left(\frac{\sigma}{\sigma-1}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M - 1\right)\right)\cdot\left(\frac{A_M\cdot L_M}{L^{*}_{F}}\cdot\left(\frac{\sigma-1}{\sigma}\right)^{2}\cdot\frac{1}{c^{2}_{M,MOD}\left(\downarrow\right)}\cdot\frac{1}{T_M}\right)^{\mu}\right) \tag{27}$$

$$U^{*}_{MOD}\left(\psi\right)\left(\uparrow\uparrow\right) = \upsilon\left(\frac{1}{1+\psi}\cdot L^{*}_{F}\cdot\left(1+\mu\cdot\left(\frac{\sigma}{\sigma-1}\cdot c_{M,MOD}\left(\downarrow\right)\cdot T_M - 1\right)\right)\cdot\left(\frac{A_M\cdot L_M}{L^{*}_{F}}\cdot\left(\frac{\sigma-1}{\sigma}\right)^{2}\cdot\frac{1}{c^{2}_{M,MOD}\left(\downarrow\right)}\cdot\frac{1}{T_M}\right)^{\mu}\right) \tag{28}$$

4. Conclusion

The effects of rising economies of scale are reflected in falling marginal costs and fixed costs. It became apparent that relative income inequality is decreasing. The price of industrial goods continues to fall. The agricultural product price and quantity remain unchanged. The volumes of industrial goods produced per company and in the region as a whole are increasing. The number of companies continues to increase. These results increase the prices of agricultural products. The incomes of the advanced West are increasingly weaker. In the

East, less income is transferred from the West to the East, but industrial goods prices are also falling. As this has only a "minor" impact on consumption and income, the East's total income remains stronger. Utility increases for both regions; however, the underdeveloped East is catching up faster with the West due to the latter's increasing economies of scale. The utility differences decrease.

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