

Technological Progress, Immiserizing Growth and Income Distribution

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It has been shown by Findlay and Grubert¹ that if the export sector is the capital intensive sector, a neutral technological progress or a labor-using technological progress in the export sector will cause an ultra protrade biased growth.² In the case where the export sector is the labor intensive sector, a neutral technological progress or a capital-using technological progress in the export sector would cause an ultra pro-trade biased growth. On the other hand, it has been shown by Bhagwati³ that the possibility of immiserizing growth arises when there is an ultra pro-trade biased growth.

The purpose of this paper is to show how the income distribution within the country will be affected when immiserizing growth occurs due to a technological progress in the export sector.⁴ The standard two input, two output trade model will be used in this study. The inputs are L(labor) and K(capital). The outputs are the labor intensive good X and the capital intensive good Y. All production functions are homogeneous of the first degree. We also assume that capitalists and laborers have identical homothetic tastes and perfect competition prevails in both output and input markets. This paper

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1. Findlay, Ronald and Grubert, Harry, "Factor Intensities, Technological Progress and the Terms of Trade," *Oxford Economic Papers*, February 1959, pp. 112-121.

2. Growth reduces the domestic production of the importable good and increases the domestic production of the exportable good at constant relative commodity prices.

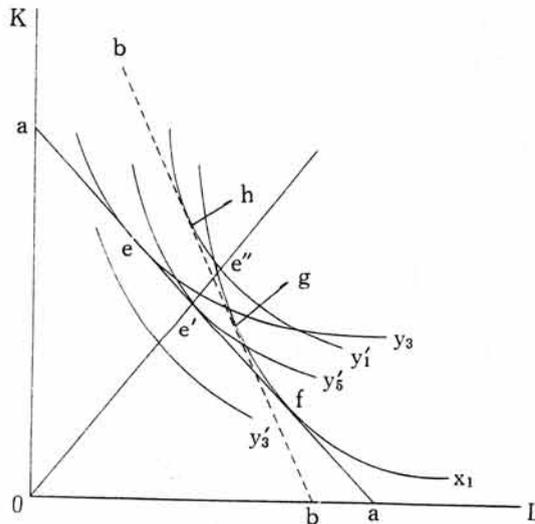
3. Bhagwati, Jagdish N., "Immiserizing Growth: A Geometrical Note," *Review of Economic Studies*, June 1958, pp. 210-215.

4. It is assumed that the country concerned is a "large country." The terms of trade would be affected when a technological progress takes place in the country. For a study on how a technological progress would affect the income distribution in a "small country", see Yeh, Yeong-Her, "A Note the Technological Progress and Income Distribution", *American Economist*, Spring 1980, pp. 67-70.

will study the case where the export sector is the capital intensive sector. However, the analysis can be applied to the case where the export sector is the labor intensive sector.

In Figure 1, isoquant x_1 represents one unit of the labor intensive good X , whereas isoquant y_3 represents three units of the capital intensive good Y . Assume that before a technological progress takes place, the output price ratio in the domestic and international markets is $1X=3Y$. Since the cost of producing one unit of X is equal to that of producing three units of Y , isoquants x_1 and y_3 should be tangent to the same isocost line. Therefore, the input price ratio is measured by slope of line aa .

(Figure 1)

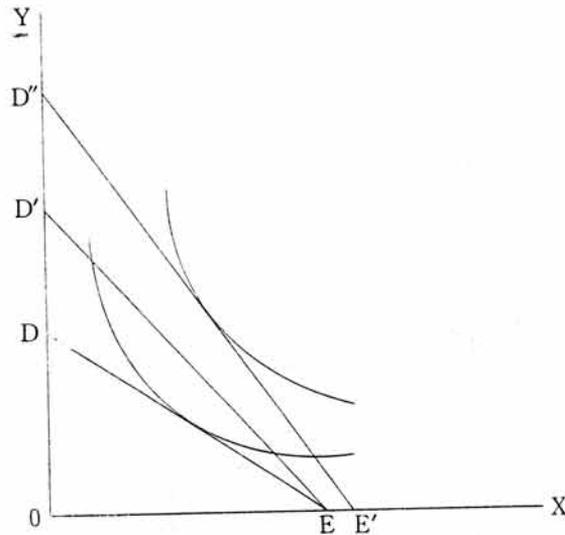


In Figure 2, OD measures the total income of the labor class in terms of output Y before a technological progress takes place. It is the product of the marginal physical product of labor in sector $Y(MPP^Y_L)$ at e (in Figure 1) and the total amount of labor. On the other hand, OE measures the total income of the labor class in terms of output X before a technological progress takes place. It is the product of the marginal physical product of labor in sector $X(MPP^X_L)$ at f (in Figure 1) and the total amount of labor.⁵

5. Total labor income = $(P_X \cdot MPP^X_L) \cdot L_X + (P_Y \cdot MPP^Y_L) \cdot L_Y$ (where L_X and L_Y are the amount of labor used in sectors X and Y , respectively, and P_X and P_Y are the price of X and Y , respectively). Total labor income/ $P_Y = (P_X/P_Y) \cdot MPP^X_L \cdot L_X + MPP^Y_L \cdot L_Y = MPP^Y_L \cdot L_X + MPP^Y_L \cdot L_Y = MPP^Y_L (L_X + L_Y)$.

Similarly, it can be shown that total labor income/ $P_X = MPP^X_L \cdot (L_X + L_Y)$.

(Figure 2)



The slope of income line DE (measuring MPP_L^Y / MPP_L^X) is equal to the output price ratio P_X/P_Y ($1X=3Y$). This is so because $MPP_L^Y \cdot P_Y = MPP_L^X \cdot P_X$ under the assumption of perfect competition.

Since the slope of income line DE is equal to the output price ratio and consumers face the same output prices as producers, line DE also becomes the consumption possibility line facing the labor class as consumers. The welfare of the labor class is represented by the indifference curve tangent to line DE .

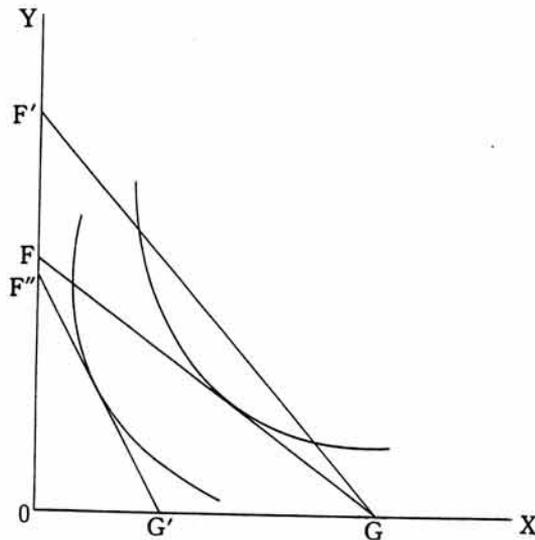
In Figure 3, OF measures the total income of the capitalist class in terms of output Y before a technological progress takes place. It is the product of the marginal physical product of capital in sector Y (MPP_K^Y) at e (in Figure 1) and the total amount of capital. On the other hand, OG measures the total income of the capitalist class in terms of output X before a technological progress takes place. It is the product of the marginal physical product of capital in sector X (MPP_K^X) at f (in Figure 1) and the total amount of capital.⁶ The slope of income line FG (measuring MPP_K^Y / MPP_K^X) also is equal to the output price ratio P_X^X/P_Y ($1X=3Y$). This is so because $MPP_K^Y \cdot P_Y = MPP_K^X \cdot P_X$ under the assumption of perfect competition.

Since the slope of income line FG is equal to the output price ratio and consumers

6. Total capital income = $(P_X \cdot MPP_K^X)K_X + (P_Y \cdot MPP_K^Y) \cdot K_Y$ (where K_X and K_Y are the amount of capital used in sectors X and Y , respectively). Total capital income/ $P_Y = (P_X/P_Y) \cdot MPP_K^X \cdot K_X + MPP_K^Y \cdot K_Y = MPP_K^X \cdot K_X + MPP_K^Y \cdot K_Y = MPP_K^X(K_X + K_Y)$.

Similarly, it can be shown that total capital income/ $P_X = MPP_K^X \cdot (K_X + K_Y)$.

(Figure 3)



face the same output prices as producers, line FG also becomes the consumption possibility line facing the capitalist class as consumers. The welfare of the capitalist class is represented by the indifference curve tangent to line FG .

Now assume that a labor-using technological progress⁷ takes place in the capital intensive sector (also the export sector). Three units of output Y is now represented by a new isoquant, Y'_3 , in Figure 1. As mentioned above, this technological progress would cause an ultra pro-trade biased growth. Thus, the terms of trade would move against the home country.⁸

Suppose that the international market condition is such that the output price ratio becomes $1X=5Y$ when the technological progress takes place. In Figure 1, x_1 and y' (a new isoquant, representing five units of Y) are assumed to be tangent to the input price line aa . At this output price ratio ($1X=5Y$), both income classes will be better off. This can be explained as follows.

In Figure 2, $D'E$ is the new income line of the labor class. The total income of the labor class in terms of output X after growth is still equal to OE because $MPPY_L$ (at f in figure 1) is not changed. Then draw a line from E parallel to the new

7. We will get the same conclusion if a neutral technological progress takes place instead.

8. Under the assumption that there are no inferior goods, the home country would like to export more and import more after growth at constant relative commodity prices.

output price line (measuring $1X=5Y$) to get the new income line $D'E$.⁹ The welfare of the labor class is increased.

In Figure 3, $F'G$ is the new income line of the capitalist class. The total income of the capitalist class in terms of output of X after growth is still equal to OG because MPP^X_K (at f in Figure 1) is not changed. Then draw a line from G parallel to the new output price line (measuring $1X=5Y$) to get the new income line $F'C$. It is clear that the welfare of the capitalist class is also increased.

There will be no immiserizing growth at this output price ratio ($1X=5Y$) because both income classes are better off than they were before growth. Thus, for immiserizing growth to occur, the terms of trade have to deteriorate more. Let us assume that that international market condition is such that the terms of trade deteriorate to $1X=7Y$ when the technological progress takes place, and that immiserizing growth occurs at this output price ratio. It can be shown below that the burden of immiserizing growth would fall only on the capitalist class.

In Figure 1, isoquants x_1 and y'_7 (a new isoquant, representing seven units of Y) are tangent to the input price line bb , which is steeper than line aa . Isoquant x_1 is tangent to line bb at g , which would lie above f on isoquant x_1 . In Figure 2, $D''E'$ is the income line of the labor class when the output price ratio is changed to $1X=7Y$, and immiserizing growth occurs at this output price ratio. OE' measures the total income of the labor class in terms of output X . E' would lie to the right of E because MPP^X_L at g is greater than MPP^X_L at f (in Figure 1).¹⁰ Then draw a line from E' parallel to the output price line (measuring $1X=7Y$) to get the income line $D''E'$. The welfare of the labor class (represented by the indifference curve tangent to $D''E'$) is clearly higher than that before growth takes place. This implies that the burden of immiserizing growth has to fall on the capitalist class.

In Figure 3, $F''G'$ is the income line of the capitalist class when the output price ratio is changed to $1X=7Y$, and immiserizing growth occurs at this output price ratio. OG' measures the total income of the capitalist class in terms of output X . G' would lie to the left of G because MPP^X_K at g is less than MPP^X_K at f (in Figure 1). Then draw a line from G' parallel to the output price line (measuring $1X=7Y$) to get the

9. This implies that MPP^Y_L at e' (in Figure 1) is greater than MPP^Y_L at e . However, this cannot be figured out directly by comparing the capital-labor ratio used in producing output Y at e to that at e' because the production function of Y has changed.

10. The capital-labor ratio used in producing X at g is greater than that at f .

income line $F''G$.¹¹ The welfare of the capitalist class after growth (represented by the indifference curve tangent to $F''G$) is lower than that before growth takes place.

The above analysis can be applied to the case where the export sector is the labor intensive sector. In this case, the burden of the welfare loss would fall on the labor class when immiserizing growth occurs due to a technological progress in the export sector.

In conclusion, we have shown in this paper that if immiserizing growth occurs due to a technological progress in the export sector, the burden of the welfare loss falls on the factor used intensively in the export sector. If the export sector is the capital intensive sector, the burden would fall on the capitalist class. On the other hand, if the export sector is the labor intensive sector, the burden would fall on the labor class.

11. F'' would lie below F' because MPP_K^X at e' is equal to MPP_K^X at e'' , which in turn is greater than MPP_K^X at h .