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 pro-trade 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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⁴ Growth reduces the domestic production of the importable good and increases the domestic production of the exportable good at constant relative commodity prices.
⁶ 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 $Y(MPP_{PL})$ 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 $X(MPP_{PL})$ at $f$ (in Figure 1) and the total amount of labor.$^5$

$^5$ Total labor income = $(P_X \cdot MPP_{PL}^X) \cdot L_X + (P_Y \cdot MPP_{PL}^Y) \cdot L_Y$ (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 for $X$ = $(P_X) \cdot MPP_{PL}^X \cdot L_X + MPP_{PL}^X \cdot L_Y = MPP_{PL}^X \cdot L_X + MPP_{PL}^Y \cdot L_Y = MPP_{PL}^X (L_X + L_Y)$.

Similarly, it can be shown that total labor income for $Y$ = $MPP_{PL}^Y (L_X + L_Y)$. 
The slope of income line $DE$ (measuring $MPP_x \cdot MPP^*_x$) is equal to the output price ratio $P_x/P_Y(1X=3Y)$. This is so because $MPP_x \cdot P_Y = MPP^*_x \cdot P_X$ 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 $Y(MPP^*_x)$ 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 $X(MPP^*_x)$ at $f$ (in Figure 1) and the total amount of capital. $^{6}$ The slope of income line $FG$ (measuring $MPP^*_x / MPP^*_X$) also is equal to the output price ratio $P_X/P_Y(1X=3Y)$. This is so because $MPP^*_x \cdot P_Y = MPP^*_X \cdot P_X$ under the assumption of perfect competition.

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

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

Similarly, it can be shown that total capital income $= P_X(K_X + MPP^*_x)$. 

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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 progress 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, $x_i$ 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 $MPP_L^*$ (at $f$ in figure 1) is not changed. Then draw a line from $E$ parallel to the new

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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 $D'E'$. 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 $\text{MPP}_K^X$ (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 the 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 $y_1$, (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 $\text{MPP}_L^X$ at $g$ is greater than $\text{MPP}_L^X$ at $f$ (in Figure 1). 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 $\text{MPP}_K^X$ at $g$ is less than $\text{MPP}_K^X$ at $f$ (in Figure 1). Then draw a line from $G'$ parallel to the output price line (measuring $1X = 7Y$) to get the

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9. This implies that $\text{MPP}_L^X$ at $e'$ (in Figure 1) is greater than $\text{MPP}_L^X$ 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 $F''G$. 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 burn 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.

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