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A NOTE ON UNDERUTILIZATION OF CAPITAL AND UNEMPLOYMENT IN A HARRIS-TODARO FRAMEWORK

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I. INTRODUCTION

IN a recent paper the problem of capital underutilization in less developed countries has been analyzed [4]. A deficiency of this analysis is the assumption that labor is fully employed.[1] It is well known that both capital and labor are unemployed in most economies and particularly in Third World countries. The object of this note is to extend the model of capital underutilization to incorporate unemployment of labor.

Labor unemployment in the context of the idle capacity model is generated by using the well-known Harris-Todaro framework which is integrated into the Hazari-Bakalis model of capital underutilization. The issues we analyze on the basis of the above merger are (i) the formal demonstration of the existence of both types of unemployment; capital and labor and (ii) the impact of changes in the degree of underutilization of capital on both labor unemployment and welfare.

It is established that the relation between changes in the degree of underutilization, unemployment of labor, and welfare are all ambiguous. Hence, there exist possibilities of trade-off between the level of welfare attained and the level of unemployment of labor. It is shown that a decrease in the degree of capital utilization may raise employment. This result runs counter to the commonly held belief that more capital generally creates greater employment. Moreover, it is also shown that more idle capacity may raise welfare. These results show that reduction in unemployment is not *necessarily* associated with an increase in welfare and idle-capacity utilization. Hence, from a policy point of view there may exist a conflict between utilizing more capital stock and reducing unemployment. This poses a dilemma for the policymaker, because the model does not provide a clear-cut answer to these important issues. A possible method of resolving this problem is to simulate the Harris-Todaro model with a capital constraint. The methodology of conducting such simulations is available in a paper by Srinivasan and Bhagwati [5]. This framework with suitable modifications for the capital constraint can be utilized for the trade-offs between employ-

Comments received from an anonymous referee are gratefully acknowledged.

[1] See Hazari and Bakalis [4] and Winston [6].

ment and welfare. A policy prescription may then be devised by examining the actual numbers and selecting a course of action based on the government's objective functions.

II. A MODEL OF UNDERUTILIZATION OF CAPITAL WITH A HARRIS-TODARO MINIMUM WAGE

In this section we verbally set up a model consisting of two final goods and one pure intermediate good which is required to generate the flow of capital services to the two sectors that produce the final goods. It is not necessary to state the model in mathematical terms as all the results will be presented geometrically.[2]

We shall assume that there exists a strictly concave aggregate utility function. The arguments of this function are the consumption of the two commodities, C_A consumption of agricultural goods and C_M the consumption of manufactured goods. This utility function will be assumed to possess both behavioral and normative significance. Given utility maximization it follows that at the point of interior equilibrium the marginal rate of substitution in consumption equals the ratio of prices.

It is assumed that part of the agricultural good is exported and part of the manufactured good is imported so that the domestic consumption, C_A, of the agricultural good equals domestic production, X_A, minus exports, E_A; and the domestic consumption of the manufactured good, C_M, equals domestic production, X_M, plus the imports of the manufactured goods, M_M.

The balance-of-payments equilibrium requires that the value of exports in equilibrium must equal the value of imports.

The production functions of the two sectors depend on the allocation of labor L_A, L_M and of sector specific capital services KS_A and KS_M to each sector. The physical stock of capital is denoted by $\overline{K}_A$ and $\overline{K}_M$. The physical capital stock is assumed to be intersectorally immobile and exogenously given. It is assumed that there is a linear relation between the physical stock of capital and the flow of capital services. The maximum flow is reached when $\overline{KS}_A$ and $\overline{KS}_M$ of the flow is utilized. The relation between the physical capital stock and flow of capital services is illustrated in Figure 1. In Figure 1-a the exogenously given capital stock is denoted by $\overline{K}_M$. The relation between the physical capital stock and flow of capital services is shown by line $O_M F_M$. The maximum flow is shown by $\overline{KS}_M$ where the given capital stock is fully utilized. A similar interpretation can be given to Figure 1-b.

By applying electric power to the physical stock, the flow of capital services is generated. For analytical convenience we shall assume that there is a proportional relation between the utilization of capital stock and the use of electric power. This relation is shown in Figure 2 for the manufacturing sector.

In Figure 2 the axis $O_M E_M$ represents the supply of electricity to the manufacturing sector. The full utilization of the capital stock requires $O_M \overline{E}_M$ of

[2] The algebraic setup may be obtained from the authors.

Fig. 1.

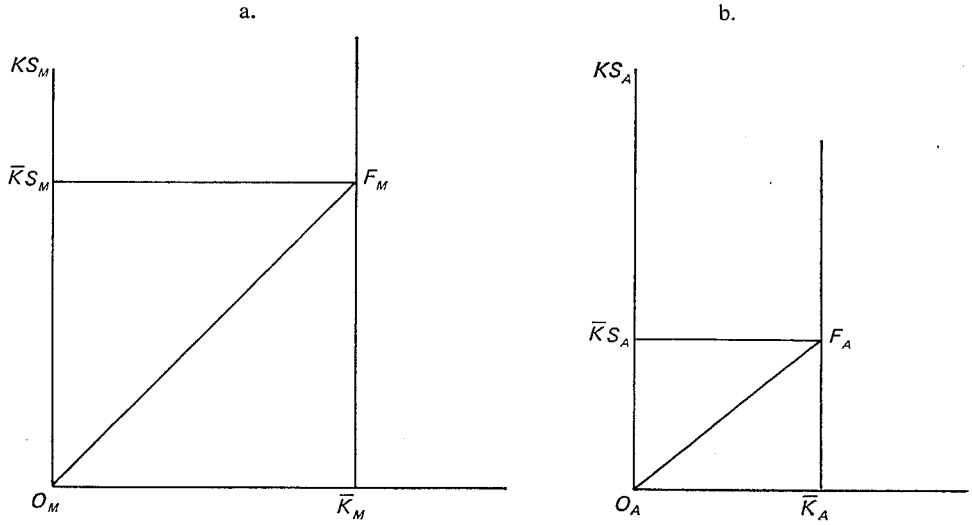
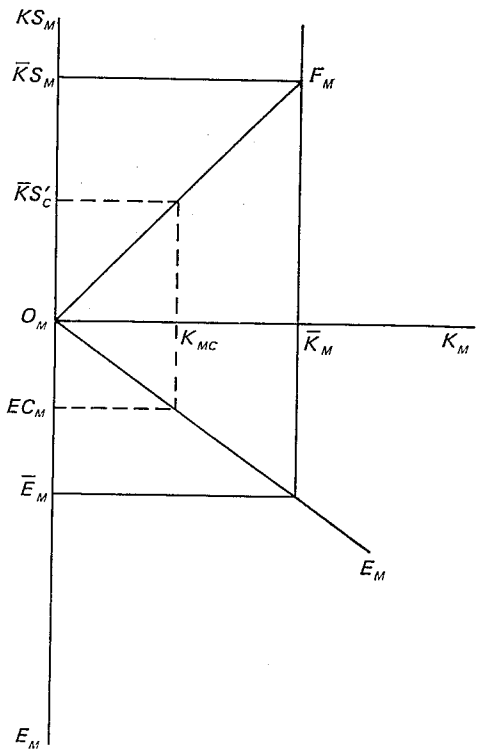

a.
b.
KS_M
$\bar{K}S_M$
F_M
O_M
$\bar{K}_M$
KS_A
$\bar{K}S_A$
F_A
O_A
$\bar{K}_A$

Fig. 2.


KS_M
$\bar{K}S_M$
F_M
$\bar{K}S'_C$
O_M
K_{MC}
$\bar{K}_M$
K_M
EC_M
$\bar{E}_M$
E_M
E_M

electricity. Suppose that there is a shortage of electric power and only O_MEC_M of electric power is supplied where C stands for a constrained situation. This implies that only O_MK_{MO} of the physical capital is used resulting in a flow of capital services of $O_M\bar{K}S'_C$. An example might help. Suppose $O\bar{K}_M$ represents installation of four lathes. Using all the four lathes requires $O\bar{E}_M$ of electric power be supplied to the manufacturing sector. However, only O_MEC_M of electric power is supplied resulting in only the use of three lathes instead of four. Thus $K_{MO}\bar{K}_M$ becomes the idle capacity of the manufacturing sector.

We shall assume that the electric power is generated via a Leontief fixed coefficient production function and is produced with the help of labor and a specific factor S_E. The assumption of zero elasticity between labor and the specific factor S_E highlights the importance of having a tight resource constraint in electricity production. It is easy to demonstrate that if the specific factor S_E is in adequate supply the entire system ends up at a point of full employment equilibrium. However, an inadequate supply of S_E will result in underutilization of capital as demonstrated fully in Hazari-Bakalis [4].

We now proceed to introduce the Harris-Todaro mechanism. Assuming profit maximization the real wage rate in agriculture equals the value of its marginal product:

$$W_A = pf'_A. \tag{1}$$

The real wage in the manufacturing sector also equals the value of labor's marginal product in this sector, but is constrained by the sticky wage requirement:

$$W_M = f'_M \geq \bar{W}_M. \tag{2}$$

This minimum wage is defined in terms of the manufactured good.

It is now appropriate to define the urban expected wage:

$$W^e{}_U = \frac{\bar{W}_M L_M}{L_U}, \qquad \frac{L_M}{L_U} \leqq 1. \tag{3}$$

The expected real wage in the urban sector, $W^e{}_U$ is equal to the real minimum wage $\bar{W}_M$ weighted by the total urban labor force actually employed, L_M/L_U (where L_U denotes the total urban labor force, that is, employed and unemployed labor). In other words, the expected wage is assumed to be equal to the average urban wage whenever $W_M = f'_M$. In the case of full employment in the manufacturing sector ($L_M = L_U$) the expected wage equals the minimum wage.

Equilibrium condition requires that the real wage rate in the agricultural sector equals the expected wage rate:

$$W_A = W^e{}_U = \frac{\bar{W}_M L_M}{L_U}. \tag{4}$$

This equilibrium condition is a by-product of the hypothesis that rural-urban

migration is a positive function of the urban-rural expected wage differential. Implicit in this migration function is the assumption that the migrant from the rural to the urban area gives up only his marginal product.[3]

III. A GEOMETRIC EXPOSITION OF THE EXISTENCE OF URBAN UNEMPLOYMENT AND CAPITAL UNDERUTILIZATION

In the previous section a model of a small open economy that can handle unemployment of both capital and labor has been presented. We demonstrate the existence of both urban unemployment and underutilization of capital. This is accomplished via the use of the box diagram, the total product curve for labor in the electricity sector and the value of the marginal product curves in both sectors. From the above information the production possibility curve is drawn. This allows us to obtain and compare various positions of welfare.

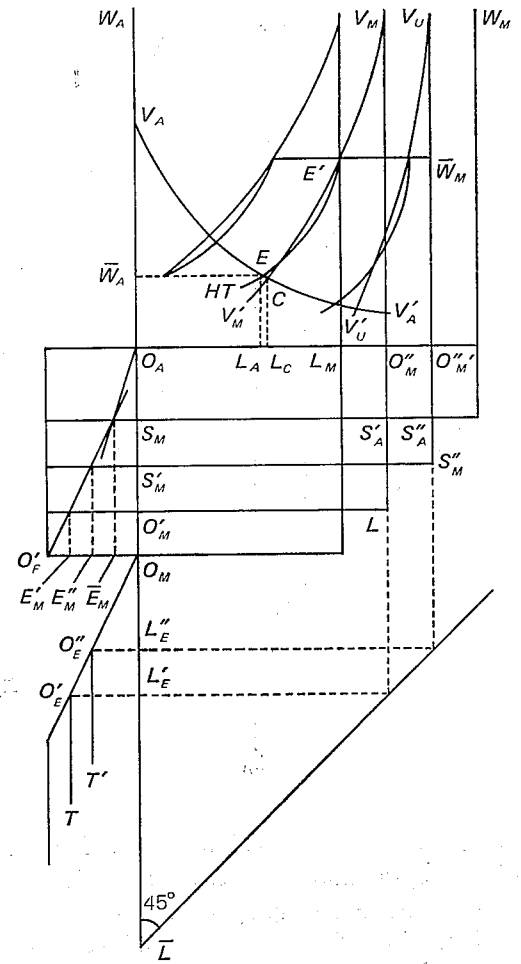
The box diagram is constructed in the same manner as in Hazari-Bakalis [4]. However, two additional diagrams are added to the box—one above and one below. The diagram above represents the value of the marginal product curves in both sectors and the Harris-Todaro curve. The diagram below the box represents the total product curve of labor in the electricity sector along with the residual labor force.

In Figure 3, $O_MO'_ET$ shows the total product curve of labor in the electricity sector. The output of electricity is shown by the distance $O_ME'_M$ which is not enough to generate the amount of electricity required for full utilization of capital stock. The amount of electricity required for full utilization is shown by $O_MO'_F$. The kink in the total product curve reflects the assumption of fixed coefficients in the electricity sector. The amount of labor employed in the electricity sector is shown by $O_ML'_E$. The remaining labor force $L'_E\bar{L}$ is transferred to the box and is shown by the distance O'_ML. With an inadequate supply of electricity full utilization of capital is no longer possible. We assume that the government rations electricity to the sectors involved and gives priority to the agricultural sector.

The government allocation of electric power to the agricultural sector results in full capacity utilization in that sector. But the manufacturing sector is allocated a reduced amount of electricity. The manufacturing sector utilizes only O'_MS_M of its specific factor leaving $O_MO'_M$ as idle capacity. From Figure 2 it is clear that only O_MK_{MC} of the physical capital stock can now be utilized. The Edgeworth-Bowley box for the manufacturing and agricultural sector is $O'_MO_AO''_ML$. The set of feasible factor allocations is given by the horizontal line $S_MS'_A$ where O_A represents the origin for labor employed in the agricultural sector and O''_M for labor employed in the manufacturing sector. From exogenously given set of international prices and feasible factor allocations we draw in the top part, the two value of the marginal product curves $V_AV'_A$ for the agricultural sector and $V_MV'_M$ for the manufacturing sector.

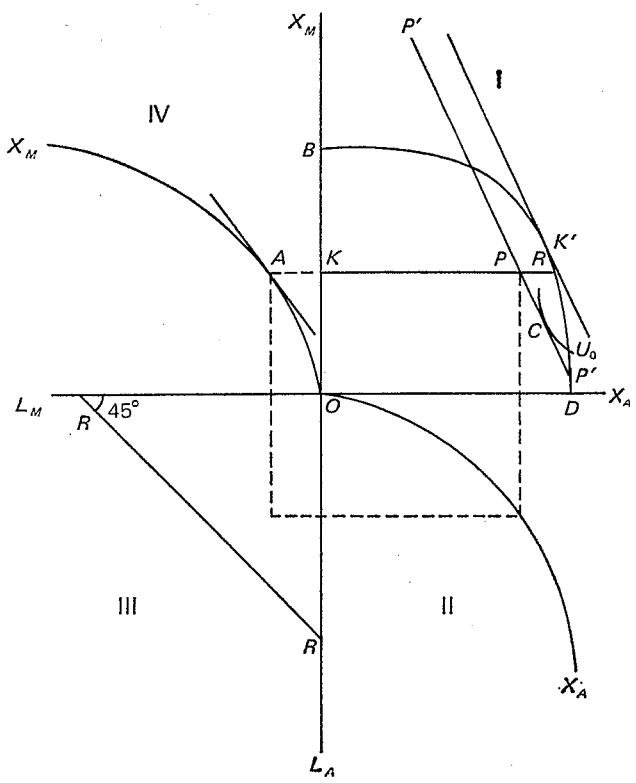
[3] The model is fully spelled out in Harris and Todaro [2]. Simple versions of this model are available in Bhagwati and Srinivasan [1] and Hazari [3].

Fig. 3.



It is appropriate now to show how urban unemployment arises in this model. In the non-distortionary framework it is known that at the point of interior equilibrium the value of the marginal product in one sector equals the value of the marginal product in the other sector. In terms of Figure 3 the two values are equal at point C where $O''_M L_C$ of the labor force is employed in manufacturing and $O_A L_C$ in agriculture. In a competitive framework with flexible factor prices labor is fully employed at the wage rate CL_C. The institutionally determined minimum wage in the manufacturing sector is given by $\overline{W}_M$ which is greater than the competitive wage. This wage is shown by $\overline{W}_M$ in the diagram. This results in employment in the manufacturing sector $O''_M L_M$. The remaining labor force is now allocated by the Harris-Todaro mechanism. The Harris-Todaro curve is drawn from point E' and is shown as $E'HT$. This curve $E'HT$ is a rectangular

Fig. 4.



hyperbola and is a representation of equation (3). It intersects $V_AV'_A$ at E and gives a labor allocation to agriculture of O_AL_A. The agriculture wage is shown by $\overline{W}_A$ and L_AL_M represents urban unemployment. The total urban labor force is shown by O''_ML_A and consists of both urban employed and unemployed. Like other versions of the Harris-Todaro model it is assumed that there is some institutional arrangement to provide subsistence income to those unemployed. Thus, we have demonstrated the existence of both underutilization of capital and unemployment of labor.

Before proceeding to study the interrelationship between underutilization and unemployment we present the above information in terms of the production possibility curve. This is accomplished by using a four quadrant diagram. In Figure 4, the total product curve for labor in agriculture and manufacturing are shown in quadrant II and IV respectively, OX_A and OX_M. These correspond to the case of underutilized capital as shown in the box diagram. The 45° line RR in quadrant III shows the amount of residual labor available to the two sectors (i.e., labor available after meeting the needs of the electricity sector). From this information the production possibility curve $BK'D$ is obtained and is shown in

quadrant I. The imposition of a minimum wage $\overline{W}_M$ implies that only one point on the curve OX_M remains feasible under the small country assumption with given terms of trade. Let us suppose that this point is A. It then follows that the production possibility curve of the Harris-Todaro economy now becomes the line segment KR where the extreme point R is excluded.[4] Let us suppose that the production and consumption solution are given by points P and C on the international price line $P'P'$ which provides a complete representation of our system in the commodity space.

IV. UNDERUTILIZATION OF CAPITAL, UNEMPLOYMENT OF LABOR, AND WELFARE

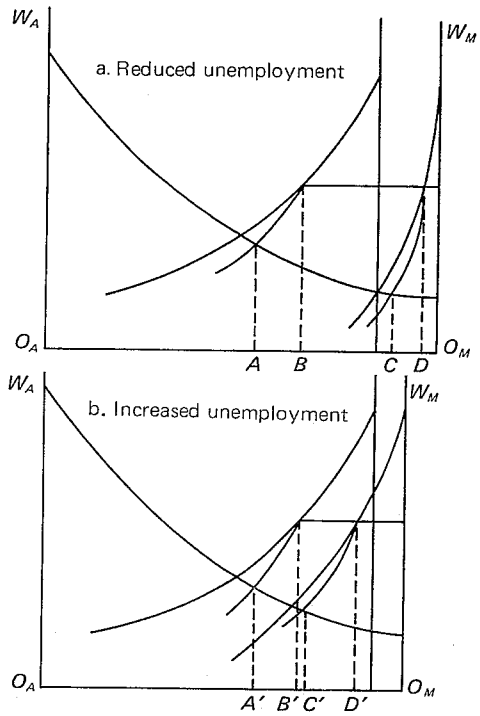
In this section we examine the effect of a further decline in the supply of electric power on unemployment of labor and welfare. This has interesting and important implications for the solution to the general equilibrium model. Suppose that the supply of specific factor S_E is reduced. Such a reduction is not unreasonable if we think of the specific factor S_E as being a hydroelectric power station whose productivity depends on water supply. In this case it could be argued that there is a further shortage of S_E due to inadequate rainfall. Let us suppose that S_E decreases from the point of equilibrium already obtained. This results in a shift of the total product curve from $O_MO'_ET$ to $O_MO''_ET'$ as shown in Figure 3. It shows that $O_ML''_E$ units of labor are combined with the lower quantity of S_E, hence a decline in the supply of electric power. Point O''_E corresponds to a lower isoquant for the electricity sector. With this decline in output of electricity $L''_EL'_E$ units of labor become redundant and seek employment in the other sectors of the economy. Due to zero elasticity of substitution between the specific factor S_E and labor in the electricity sector the amount of labor released will be proportional to the decline in the output of the electricity sector. We use Figures 3 and 6 to examine the consequences of a decline in electric power to general equilibrium problems. We assume as before that government rations electricity to the sectors and allows for full capacity utilization in the agricultural sector.

Given the above assumption the value of the marginal product curve $V_AV'_A$ in Figure 3 and the total product curve OX_A in Figure 4 remain unaltered. But, the manufacturing sector is allocated a reduced amount of electricity (which equals the rest of the available electricity) $\bar{E}_ME''_M$. The manufacturing sector can now utilize only $S_MS'_M$ of its specific factor leaving $O_MS'_M$ as idle capacity.

Figure 3 is adjusted to accommodate the above change and shows a higher degree of idle capacity. The Edgeworth-Bowley box now becomes $O_AS'_MS''_MO''_M'$. The revised set of feasible factor allocations is given by the horizontal line $S_MS''_A$. Point O_A represents the origin for labor employed in the agricultural sector and O''_M' the origin for labor employed in the manufacturing sector. The value of the marginal product curve $V_AV'_A$ for the agricultural sector remains unchanged. The curve $V_UV'_U$, the value of the marginal product curve in the manufacturing sector corresponds to the reduced supply of capital services. The wage in the

[4] See Bhagwati and Srinivasan [1] for the formal demonstration of this point.

Fig. 5.

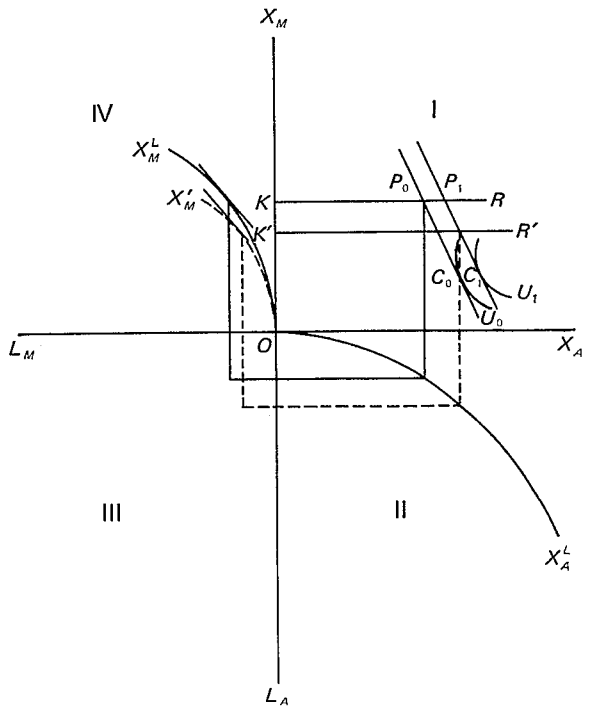


manufacturing sector remains at $\overline{W}_M$ as it is fixed institutionally. The effect on employment is ambiguous and depends on the relevant elasticities. Two cases are demonstrated in Figure 5. In Figure 5-a it is shown that a reduction in the flow of capital services reduces unemployment and in Figure 5-b the converse case is shown. Thus the effects of underutilization on employment are not monotonic. This raises the problem for the policymakers who mistakenly believe that increases (decreases) in underutilization lower (raise) employment.

In Figure 6 we examine the welfare consequences of the change in the degree of utilization of capital stock. We know that the mobile factor labor is being applied to a smaller flow of capital services, therefore in quadrant IV the total product curve OX'_M lies uniformly inside the total product curve with a higher degree of utilization. To avoid cluttering the production possibility curves associated with the above situations are not drawn. Only the feasible set of output allocations are drawn as shown by lines KR and $K'R'$. Production with the higher degree of utilization is shown by point P_0, consumption by C_0, and welfare by U_0. With the decrease in the degree of utilization at the exogenously given wage rate $\overline{W}_M$, the production point moves to P_1, consumption to C_1, and welfare to U_1. It follows that welfare increases as a consequence of a decrease in the degree of utilization.

A detailed explanation of the above result is given below. Given the utility function a change in welfare depends on the change in the consumption of the

Fig. 6.



two goods which in turn is a function of the change in the production of the two goods. A decrease in the supply of electricity lowers the amount of capital services available to the manufacturing sector. However, it also increases the amount of labor available for the production of the final goods. Note that the overall supply of labor is constant and the increased amount of labor available to the final goods sectors arises due to the reduced employment of labor in the electricity sector. This model assumes perfect mobility of labor between the electricity sector and the final goods sectors. The reduction in the amount of capital services available to the manufacturing sector reduces its output. However, the increased availability of labor results in an increase in the output of the agricultural sector. Thus, the output of the manufacturing sector decreases and the output of the agricultural sector increases. Since welfare depends on the sum of these movements in output, it follows that whenever the increase in agricultural output dominates the decrease in manufacturing output welfare increases. Welfare decreases when the decline in manufacturing output dominates the increase in agricultural output. The case of increased welfare is illustrated in Figure 6.

We have demonstrated all the ambiguities that arise in the relation between underutilization of capital, unemployment, and welfare.

REFERENCES

1. BHAGWATI, J. N., and SRINIVASAN, T. N. "On Reanalyzing the Harris-Todaro Model: Policy Rankings in the Case of Sector-Specific Sticky Wages," *American Economic Review*, Vol. 64, No. 2 (June 1974).
2. HARRIS, J. R., and TODARO, M. P. "Migration, Unemployment and Development: A Two Sector Analysis," *American Economic Review*, Vol. 60, No. 1 (March 1970).
3. HAZARI, B. R. *The Pure Theory of International Trade and Distortions* (London: Croom Helm, 1978).
4. HAZARI, B. R., and BAKALIS, S. "An Analysis of Capital Underutilization in Less Developed Countries—A Trade Theoretic Approach," *Developing Economies*, Vol. 23, No. 1 (March 1985).
5. SRINIVASAN, T. N., and BHAGWATI, J. "Alternative Policy Rankings in a Large, Open Economy with Sector-Specific Minimum Wages," *Journal of Economic Theory*, Vol. 11, No. 3 (December 1975).
6. WINSTON, G. C. "Capital Utilization and Optimal Shift Work," *Bangladesh Economic Review*, Vol. 2, No. 2 (April 1974).