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## FACTOR UNDERUTILIZATION AND THE THEORY OF INTERNATIONAL TRADE\*

Hamid BELADI and Sugata MARJIT

*Abstract:* In this paper we formulated a two-sector, general equilibrium model in the presence of Underutilization of Capital and integrate it with the main corpus of Trade Theory. In general, our model shows that protection granted to the agricultural sector may be inferior to protecting the other industry and the essence of our policy implication is that protecting agricultural sector from foreign competition is likely to increase Underutilization of Capital and idle capacity.

### INTRODUCTION

Trade problems in the presence of labor unemployment has been extensively analyzed by Trade Theorists (see, for instance, Batra and Seth [1977], Das [1981], Mendez [1983], Batra and Lahiri [1987], and Yu [1982] among others). By comparison, no attempt has been made to analyze trade problems in the presence of capital underutilization and idle capacity. This is a well-known phenomenon in many less developed economies. In such countries the lack of absorptive capacity is the major obstacle to the speed of growth and development. Capital stock cannot be fully utilized due to several reasons, for example, the presence of monopolistic markets, lack of aggregate demand, lack of technical and managerial techniques, insufficiency of manpower and skilled labor in different levels, or constraints in the supply of some essential inputs such as electric power in many less developed economies. Furthermore, in most of the LDC's, public sector has huge amount of excess capacity and the price of capital which is administered by the government is rigid since the revenue consideration plays an important role.

The purpose of this paper is to formulate a two-sector, three factor model slightly along the lines of the Steedman and Metcalfe [1977] in the presence of factor underutilization (capital unemployment) and integrate it with the main corpus of the theory of international trade.

The layout of the paper is as follows, after describing the model and its solution in Section II and III respectively, factor accumulation and outputs are examined in Section IV. In Section V, we analyze factor rewards and commodity prices whereas, Section VI deals with the industry supply curves for a capital-surplus economy. Finally in Section VII, we outline some concluding remarks.

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## II. ASSUMPTIONS AND THE MODEL

Consider an economy consisting of two sectors,  $X_a$  (agricultural sector) and  $X_m$  (manufacturing sector). The manufacturing good is produced with the help of capital ( $K$ ) and labor ( $L$ ) whereas the agricultural good is produced with the help of capital, labor and a specific factor land ( $V$ ). Production functions are linearly homogenous and quasi-concave, producers face perfect product and labor markets, factor supplies are inelastic, non-specific factors are fully mobile. However, part of the capital is in idle surplus in the sense that it would not be fully utilized due to an exogenously given rate of return on capital and hence causing unemployment in the capital market. The production side of the model is described by the following equations,

$$X^m = X^m(K_m, L_m) \quad (1)$$

$$X^a = X^a(K_a, L_a, V) \quad (2)$$

where  $K_i$  and  $L_i$  are respectively capital and labor used in the  $i$ th sector and  $V$  is land used in the agricultural sector. The standard marginal productivity conditions are given as,

$$PX_L^m(K_m, L_m) = X_L^a(K_a, L_a, V) \quad (3)$$

$$r = PX_K^m(K_m, L_m) \quad (4)$$

$$r = X_K^a(K_a, L_a, V) \quad (5)$$

$$\rho = X_V^a(K_a, L_a, V) \quad (6)$$

Where  $X_j^m$  and  $X_j^a$  are the marginal product of the  $j$ th factor in the two sectors,  $P$  is the relative price of  $X^m$ ,  $r$  is the real rental of capital expressed in terms of  $X^a$  and  $\rho$  is the real rental of land. We also assume that  $X^a$  is the numeraire, so that its price equals 1. In order to provide a convincing economic rationale for the existence of underutilized physical capital in the presence of a positive rate of return, consider the following scenario, where physical capital has already been produced and the owners of capital find that the demand is inefficient for a *minimum* income that they had expected to earn. Figure 1 describes the situation where  $O\bar{K}$  is the supply of capital and  $D_K$  denotes the demand for capital. It should be noted that there is no positive rate of return at which market clears. One possibility in this situation is that owners of capital decide on a collusive return, say  $\bar{r}$ , we shall assume that  $\bar{r}$  is exogenously given and does not respond to changes in the system. In most of the less developed economies public sector has huge amount of excess capacity and the price of capital which is administered by the government does not fall due to the fact that revenue consideration plays an important role.

Macroeconomic justification of rigid return to capital in the presence of excess capacity can be found in Taylor [1983]. However, our paper is a little different

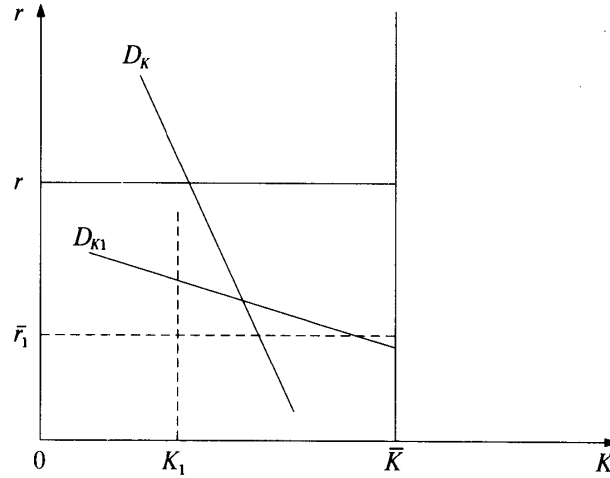


Figure 1

since it does not address the effective demand problem as in Taylor [1983], instead what we are focusing here is a situation in which the prices fail to adjust frequently. A very elastic demand for capital such as  $D_{K1}$  may give an equilibrium at  $r_1$ , but  $r_1 \bar{K} < \bar{r} K$  and assuming that capitalists can collude, this does not seem to be an unnatural outcome.

On the other hand, labor is fully employed because its return is perfectly flexible in both direction. Hence we have,

$$L_a + L_m = \bar{L} \quad (7)$$

$$V = \bar{V} \quad (8)$$

Where  $\bar{L}$  and  $\bar{V}$  are the inelastic supply of labor and land. With this last equation the description of the model is complete.

### III. THE SOLUTION OF THE MODEL

This model has eight equations in eight variables,  $X^a$ ,  $X^m$ ,  $K_a$ ,  $K_m$ ,  $L_a$ ,  $L_m$ ,  $V$ , and  $\rho$ , and four parameters,  $\bar{L}$ ,  $\bar{V}$ ,  $r$  and  $P$ . With linearly homogenous production functions, marginal products are homogenous if degree is zero, hence equations (3), (4) and (5) can be written as

$$PX_L^m(l_m) = X_L^a(l_a, v) \quad (9)$$

$$r = PX_K^m(l_m) \quad (10)$$

$$r = X_K^a(l_a, v) \quad (11)$$

Where  $l_i = (L_i/K_i)$  is the labor-capital ratio in the  $i$ th sector and  $v = (V/K_a)$  is the land/capital ratio in agricultural sector. ( $v$  represents the significance of land in agricultural sector expressed in terms of capital employed in this sector). Equations

(9)–(11) have three variables  $l_m$ ,  $l_a$  and  $v$  and two parameters,  $P$  and  $r$ . The factor proportion in this model, as in the standard Heckscher-Ohlin model of a fully employed economy, are also independent of factor endowments which implies that factor prices are also independent of factor supplies and they depend only on  $r$  and  $P$ . From (7) and (8) we have,

$$l_m K_m = l_a K_a = \bar{L} \quad (12)$$

$$v K_a = \bar{V} \quad (13)$$

It is fairly clear that  $l_m$ ,  $l_a$  and  $v$  can be solved from (9), (10) and (11) so that  $K_a$  and  $K_m$  can be obtained from (12) and (13) and these can be plugged into the production function obtain  $X^m$  and  $X^a$ .

Finally we assume that the country under study is a small open economy so that  $P$ , the terms of trade is given exogenously.

#### IV. CAPITAL UNDERUTILIZATION, FACTOR ACCUMULATION AND OUTPUTS

The model described above can be utilized to examine the effect of an increase in  $\bar{L}$  or  $\bar{V}$  on sectoral output and utilization of capital. At this time we should point out that with a constant  $P$ ,  $l_i$  and  $v$  are also constant. The production functions in (1) and (2) can be written as,

$$X^m = K_m f_m(l_m) \quad (14)$$

$$X^a = K_a f_a(l_a, v) \quad (15)$$

Where  $f_m \equiv X^m(l_m, 1)$  and  $f_a \equiv X^a(l_a, v, 1)$ . Differentiating (12) and (13) totally we obtain,

$$dK_m = (vd\bar{L} - l_a d\bar{V})/vl_m \quad (16)$$

$$dK_a = (d\bar{V}/v) \quad (17)$$

Differentiating (14) and (15) totally and using (14) and (15) we obtain

$$dX^m = f_m [vd\bar{L} - l_a d\bar{V}] vl_m \quad (18)$$

and

$$dX^a = f_a [d\bar{V}/v] \quad (19)$$

From (18) and (19), it is fairly clear that  $(dX^m/d\bar{L}) > 0$ ;  $(dX^a/d\bar{L}) = 0$ ;  $(dX^m/d\bar{V}) < 0$  and  $(dX^a/d\bar{V}) > 0$ . The following propositions are now immediate.

**PROPOSITION I.** *In the presence of capital underutilization, a rise in the supply of labor, at constant product price ratio, raises the output of the manufacturing sector but has no effect on the output of the agricultural sector.*

PROPOSITION II. *With underutilized capital, a rise in the supply of land raises the output of the agricultural sector at the expense of the output of the manufacturing sector.*

The intuitive explanation of these results is simple. A rise in the supply of any fully utilized factor causes the reallocation of other factors from one sector to the other because at a give product-price ratio factor-proportions remain constant, hence as  $\bar{L}$  rises, more capital is needed in the manufacturing sector to absorb the additional labor and this increases the utilization of capital in the manufacturing sector. (It is evident from (16) that  $(dK_m/d\bar{L}) > 0$ ). However, the output of the agricultural sector does not change because land cannot be released or absorbed from the manufacturing sector, so that  $(dK_a/d\bar{L}) = 0$ , but total utilization of capital rises.

On the other hand, as  $\bar{V}$  rises, the agricultural sector expands, and it absorbs labor from the manufacturing sector, causing a fall in  $K_m$  as well as  $X^m$ , but  $K_a$  rises. By adding (16) and (17) we obtain

$$dK_m + dK_a = [vd\bar{L} + d\bar{V}(l_m - l_a)]/vl_m \quad (20)$$

From (19), it is clear that the effect of a rise in  $\bar{V}$  on total utilization of capital depends on the labor intensities in the two sectors of  $l_m > l_a$  then underutilization of capital declines. We now have the following proposition.

PROPOSITION III. *A rise in the supply of labor unambiguously reduces capital underutilization, whereas a rise in the supply of land reduces or raises capital underutilization depending on the labor intensities in the two sectors.*

We now proceed to derive results relating to the impact of factor accumulation on the real income in the absence of full capital utilization. Let  $I$  be the real income, then we have,

$$I = W\bar{L} + r(K_a + K_m) + \rho\bar{V} \quad (21)$$

By differentiating (20) with respect to  $\bar{L}$  and  $\bar{V}$  and using (16), (17), and (19) we obtain,

$$(dI/d\bar{L}) = W + (r/l_m) \quad (22)$$

and

$$(dI/d\bar{V}) = \rho + r(l_m - l_a)/vl_m \quad (23)$$

It is obvious from (21) and (22) that  $(dI/d\bar{L})$  is unambiguously positive whereas  $(dI/d\bar{V}) > 0$  if  $l_m > l_a$ . We now have the following proposition.

PROPOSITION IV. *In a capital-surplus economy, factor accumulation may not result in immiserizing growth.*

## IV. FACTOR-REWARDS AND COMMODITY PRICES

In this section we extend our analysis regarding the effect of an exogenous change in product price ratio on the rental of land and real wages. Differentiating (9)–(11) totally and assuming for simplicity that  $P=1$  initially we obtain the following matrix system,

$$\begin{bmatrix} -X_{Li}^m & X_{Li}^a & X_{Lv}^a \\ X_{Ki}^m & 0 & 0 \\ 0 & X_{Ki}^a & X_{Kv}^a \end{bmatrix} \begin{bmatrix} dl_m \\ dl_a \\ dv \end{bmatrix} = \begin{bmatrix} wdP \\ -rdP \\ 0 \end{bmatrix} \quad (24)$$

Where the determinant of the system is given by  $D = -X_{Ki}^m[X_{Li}^a X_{Kv}^a - X_{Lv}^a X_{Ki}^a]$ . Assuming that an increase in the use of any factor reduces its own marginal product but raises the marginal product of the other factors, then the own partial derivatives are negative, but the cross partials are positive, hence  $D > 0$ . Solution of the matrix yields,

$$dl_m = -(r/X_{Ki}^m)dP \quad (25)$$

$$dl_a = (1/D)X_{Kv}^a[rX_{Li}^m - WX_{Ki}^m]dP \quad (26)$$

$$dv = (1/D)X_{Ki}^a[WX_{Ki}^m - rX_{Li}^m]dP \quad (27)$$

From (24)–(26) it is clear that  $(dl_m/dP)$  and  $(dl_a/dP)$  are negative whereas  $(dv/dP)$  is positive. Since  $W = X_{Li}^a(l_a, v)$  and  $\rho = X_{Lv}^a(l_a, v)$ , we have,

$$dW = (1/X_{Ki}^m)[WX_{Ki}^m - rX_{Li}^m]dP \quad (28)$$

$$d\rho = X_{Lv}^a dl_a + X_{Kv}^a dv \quad (29)$$

It is obvious from these equations that  $(dW/dP) > 0$  whereas  $(d\rho/dP) < 0$ . The following proposition is now in order.

**PROPOSITION V.** *In a capital-surplus economy, a rise in the relative price of agricultural commodity causes the land rental to rise and real wage to fall and conversely.*

The intuitive explanation of the above result is this. Since capital and labor are the only factors of production used in the manufacturing sector, a rise in the relative price of  $X^m$ ,  $P$ , must raise  $W$ , assuming that  $r$  is given. This implies that in the agricultural sector whose relative price has fallen, the rental of land must fall, because the real wage is the same in the two sectors. Hence, the model shows a conflict of interest between capitalists and laborers.

On the other hand, an exogenous change in the rental of capital must lower real wage in the manufacturing sector and then in the agricultural sector, given that  $P$  is constant. However, rental of land,  $\rho$ , will rise if agricultural sector is

labor-intensive relative to the manufacturing sector, so that a rise in  $r$  hurts manufacturing sector more than agricultural sector. We now deduce the following proposition.

**PROPOSITION VI.** *In a capital-surplus economy, an exogenous rise in the rental of capital, at a constant product price ratio, causes a fall in the real wage but the effect on the rental of land depends labor-intensities in the two sectors.*

#### V. THE INDUSTRY SUPPLY CURVES IN A CAPITAL-SURPLUS ECONOMY

In this section we take a digression to establish the concept of the transformation curve for a capital surplus economy. In order to see how any changes in relative prices affect the output of manufacturing and agricultural sector, we differentiate (1), (2), (7) and (8) with respect to  $P$  and obtain,

$$\begin{aligned} (dX^m/dP) &= (f_m l_a / v)(K_a / l_m)(dv/dP) \\ &\quad - (f_m K_a / l_m)(dl_a/dP) \\ &\quad - [K_m(f_m - l_m f'_m) / l_m](dl_m/dP) \end{aligned} \quad (30)$$

and

$$\begin{aligned} (dX^a/dP) &= K_a f_{al}(dl_a/dP) \\ &\quad - (K_a/v)[f_a - v f'_a](dv/dP) \end{aligned} \quad (31)$$

Where  $(f_m - l_m f'_m) > 0$  and  $f_a > v f'_a$ . Since  $(dl_i/dP) < 0$  and  $(dv/dP) > 0$ , hence  $(dX^a/dP) > 0$  and  $(dX^m/dP) < 0$ , so that  $(dX^a/dX^m) < 0$ . We now have the following proposition.

**PROPOSITION VII.** *In the presence of idle capital surplus, the industry supply curves are upward sloping, so that a rise in a sectors's output cannot occur without a corresponding rise in its relative price.*

The intuitive explanation of this result is that as, for example, the manufacturing sector expands, since labor is fully employed, it must move from agricultural sector to manufacturing sector, causing a fall in the production of  $X^a$ , this causes an excess supply of land, leading to a fall in  $\rho$  (rental of land). Assuming that  $r$  is given, this means that the real wage will increase, forcing a rise in the average cost and price of  $X^m$  relative to  $X^a$ . Hence  $(dX^m/dP) > 0$  and  $(dX^a/dP) < 0$ .

We are now in a position to derive results regarding the effects of a change in a relative prices on capital utilization. Differentiating (12) and (13) with respect to  $P$ , keeping  $\bar{K}$  and  $\bar{V}$  constant, we obtain,

$$\begin{aligned} (dK_m/dP) &= -(1/l_m)[K_m(dl_m/dP) + K_a(dl_a/dP)] \\ &\quad + (l_a/v)(K_a/l_m)(dv/dP) \end{aligned} \quad (32)$$



and

$$(dK_a/dP) = -(K_a/v)(dv/dP) \quad (33)$$

Hence,

$$\begin{aligned} (dK/dP) &= (dK_m + dK_a)/dP \\ &= (K_a/v)(1/l_m)(l_a - l_m)(dv/dP) \\ &\quad - (1/l_m)[K_m(dl_m/dP) + K_a(dl_a/dP)] \end{aligned} \quad (34)$$

Given that  $P=1$  initially, let  $\eta_v = (dv/dP)/v$  be the positive elasticity of land/capital ratio in agricultural sector with respect to  $P$ , hence we have,

$$(dK/dP) = G + (K_a/l_m)(l_a - l_m)\eta_v \quad (35)$$

Where  $G = -[K_m(dl_m/dP) + K_a(dl_a/dP)](1/l_m)$ , which is unambiguously positive. Since capital supply is fixed,  $dK$  signifies a change in utilization of capital and it also indicates how capital underutilization is affected in the economy. The following proposition is now immediate.

**PROPOSITION VIII.** *In a capital surplus economy, a rise in the relative price of agricultural sector need not reduce underutilization of capital even if the agricultural sector is capital intensive relative to the other sector.*

It is obvious from (34) that  $(dK/dP) > 0$  if  $l_a \geq l_m$ . Hence, capital utilization unambiguously rises if manufacturing sector is capital-intensive relative to agricultural sector or at most has the same labor-intensity. This is an interesting result because we would expect that capital utilization will rise if and only if the expanding industry is capital-intensive relative to the contracting industry. However, the presence of land has complicated our simple model.

First, consider the case where  $P$  rises so that  $X^m$  expands and  $X^a$  contracts. Here,  $K_m$  and  $L_m$  rise whereas  $K_a$  and  $L_a$  fall, but the decline in  $K_a$  may be small since  $X^a$  benefits from the fall in the rental cost of land, hence the fall in  $K_a$  is less than the rise in  $K_m$ , so that capital utilization rises even when  $l_m = l_a$  and it will certainly rise if  $l_m < l_a$ . It should be noted here that capital utilization can rise even when  $l_m > l_a$ .

On the other hand, as relative price falls, manufacturing sector declines whereas agricultural sector expands. As a result,  $K_m$  and  $L_m$  fall, but  $K_a$  and  $L_a$  rise. Furthermore, the rise in  $K_a$  may be small since the rental cost of land also rises, so that  $K_m$  may fall more than the rise in  $K_a$  even if agricultural sector is capital-intensive relative to manufacturing. It should be noted that an expansion of the agricultural sector due to a fall in  $P$  unambiguously raises capital-underutilization if  $l_a = l_m$ , since the rental cost of the land also rises. We now deduce the following proposition.

PROPOSITION IX. *In the presence of idle capital surplus, a rise in the relative price of agricultural sector unambiguously increases underutilization of capital if the agricultural sector is not the capital-intensive sector. However, a fall in its relative price reduces underutilization of capital when  $l_a \geq l_m$ .*

## VII. CONCLUDING REMARKS

Using a specific-factor general equilibrium model of trade, we have analyzed some trade problems in the presence of idle capital surplus. Among other things, our model shows that protecting agricultural sector need not reduce underutilization of capital even if it is capital-intensive relative to the other sectors. However, protection granted to the manufacturing sector may not reduce idle capital surplus if it is highly labor-intensive relative to the agricultural sector.

In general, other things remaining the same, our model shows that protection granted to the agricultural sector is inferior to protecting the other industries and the essence of our policy implications is that protecting agricultural sector from foreign competition is likely to increase the underutilization of capital.

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