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## Tariff Policy, Equipment Production and Employment in Developing Countries

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CENTER DISCUSSION PAPER NO. 170

TARIFF POLICY, EQUIPMENT PRODUCTION, AND  
EMPLOYMENT IN DEVELOPING COUNTRIES

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## I. Introduction\*

Various analysts have commented on developing countries trade and exchange policies which permit importation of capital equipment at favorable exchange rates, e.g. Little, Scitovsky, and Scott [6]. It is argued that such policies artificially reduce the ratio of capital to labor costs and induce the adoption of capital intensive imported technology and/or the undertaking of capital intensive projects which appear profitable only because of the prevailing distortions in factor pricing. Thus, the underpricing of imported equipment would influence the type and sector-allocation of foreign technology, and tend to reduce the employment opportunities in the modernized industrial sector of developing countries and the rate of absorption of labor released from traditional sectors. In addition, there is the view that such a policy will be detrimental to employment to the extent that it inhibits either the growth or establishment of domestic equipment industries. Pack and Todaro [8] argue that these industries produce machinery which is more labor intensive and thus better adapted to the relative factor endowments of labor surplus economies. They also cite evidence which suggest that the domestic resource requirements of the equipment industries are not such as to counteract these benefits. This evidence supports the hypothesis that (a) the machinery industries themselves are not highly capital intensive and (b) the real resource cost of a dollar reduction in machinery imports is low relative to the cost of import substitution in other manufactured commodities.

The purpose of this paper is to develop a theoretical framework for

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\* We are grateful to Richard Brecher for helpful discussion. Errors, of course, are our own.

analyzing the employment effects of changes in the mix of imported and domestically-produced equipment when the two types of equipment may be viewed as different factors of production.<sup>1</sup> We confine ourselves to considering only the case where the changes in equipment composition are induced by policies affecting both the general and the equipment tariff rates.

In section II, the structure of a general equilibrium trade model involving labor and the two forms of equipment is analyzed. Open unemployment of labor arises in this system as a consequence of two factor prices, the real wage and the user cost of imported equipment, being exogenously specified. Section III consists of a detailed analysis of equipment and general tariff rate changes on the aggregate employment rate. In section IV, the effect on social welfare of a change in the equipment tariff rate is investigated along with the possibility of conflict between welfare improvement and increases in the employment rate. In section V, we empirically test some of the assumptions unique to our model: in particular, that industries which are heavy users of imported equipment are more capital intensive, i.e., employ more total capital per unit of output and labor, than industries with a low component of imported equipment. Turkey's 1964 Census of Manufacturing and Business Establishments (covering business activities in 1963) is one of the few industrial

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<sup>1</sup>Such an assumption is legitimate where the comparative cost of LDC's producing the simple machinery associated with labor intensive techniques is a great deal lower than that of more complex, heavier machinery. Also, because of established lending and trade arrangements, certain types of equipment suitable to the domestic factor endowment may not be imported even though they are produced abroad. See Ranis [9, p. 5].

censuses which presents a breakdown of equipment investment into domestically-produced and imported categories. We fit our hypothesized relationships between sectoral wage and equipment shares to data drawn from this census. The final section involves a summary of the empirical and theoretical findings and their policy implications.

## I. THE MODEL

A. Production. Let us consider an economy composed of two sectors, with production functions of the form

$$(1.1) \quad \hat{x}_i = A_i (k_{mi})^{a_i} (k_{di})^{b_i}$$

where  $i = 1, 2$ ,  $\hat{x}_i$  is the ratio of value added (at base-year world prices) to employment in the  $i$ th sector,

$k_{mi}$  is the ratio of imported equipment (valued at world prices) to employment in the  $i$ th sector

and  $k_{di}$  is the ratio of domestically produced equipment (valued at world prices) to employment in the  $i$ th sector.<sup>1</sup>

The sector one commodity is assumed to be the import competing good, and the sector two commodity, the exportable. We assume that domestically-produced equipment is assembled in the import-competing sector, but is not traded to a significant degree (even though it is possible to use or

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<sup>1</sup>We confine ourselves to the Cobb-Douglas formulation, because it is highly amenable to empirical testing.

produce the same type of equipment abroad). We have chosen the physical units of total service time in which the two forms of capital are measured so as to make both their world and internal prices equal. This formulation in the case where the tariff rate on competitive is higher than that on noncompetitive machinery imports (an assumption tested later) implies that domestically-produced equipment will not be traded. Plant investment is assumed to depend on the total level and not the composition of equipment investment, and the sector producing structures is treated as exogenous to the system. Let us suppose that the coefficients of the production functions in the two sectors are restricted in the following way:

$$(1.2) \quad a_1 + b_1 > a_2 + b_2$$

$$(1.3) \quad a_1/b_1 > a_2/b_2$$

The first assumption indicates that, in competitive equilibrium, the relative share of capital is higher in sector 1 than it is in sector 2. The second assumption implies that the ratio of imported to domestic equipment in sector 1 will exceed that in sector 2.

Two of the factor prices are exogenously fixed. The real wage rate (expressed in terms of commodity 2) is equal to an institutionally-determined minimum ( $\bar{w}_2$ ). The second exogenously-specified factor price is the user cost of imported capital, which is assumed to be a policy instrument. Assume that home country can influence the world price of its exports but not that of equipment imports or imports in general. Denote the fixed world price of imported equipment by  $q$ , the effective equipment tariff by  $t$ , and the interest rate on imported equipment by  $r_m$ . Then, neglecting corporate income taxes, the user cost of imported equipment is defined by the relationship

$$u_m = r_m (1 + t)q$$

Assuming  $r_m$ , as well as  $q$ , is exogenously determined, the user cost for imported equipment would then depend on the tariff policy of the developing country.

Given the restrictions on the production function parameters, the total capital-employment ratio ( $k_{m1} + k_{d1}$ ) will be higher in sector 1 than it is in sector 2, provided the user cost of imported ( $u_m$ ) is not greater than that of domestically produced equipment, ( $u_d$ ), i.e.,  $u_m \leq u_d$ . For proof of this proposition (designated as Lemma 1), see Appendix A.

With factor prices determined as noted above, the production side of the system is summarized by the equilibrium conditions:

$$(1.4) \quad \bar{w}_2 = A_2 (k_{m2})^{a_2} (k_{d2})^{b_2} (1 - a_2 - b_2)$$

$$(1.5) \quad \bar{u}_{m1} = a_1 A_1 (k_{m1})^{a_1 - 1} (k_{d1})^{b_1}$$

where  $\bar{w}_2$  denotes the institutionally determined wage rate expressed in terms of commodity 2 and  $\bar{u}_{m1}$ , the user cost of imported capital expressed in terms of commodity 1. In competitive equilibrium, relative factor prices will be equal in the two sectors.<sup>1</sup> From this relationship it is clear that  $k_{m2}$  and  $k_{d2}$  are functions of  $k_{m1}$  and  $k_{d1}$  respectively. By substituting these relationships into (1.4) and (1.5) we obtain:

$$(1.6) \quad \bar{w} = a_2 (\mu_1 k_{m1})^{a_2} (\mu_2 k_{d1})^{b_2} (1 - a_2 - b_2)$$

$$(1.7) \quad u_{m1} = a_1 A_1 (k_{m1})^{a_1 - 1} (k_{d1})^{b_1}$$

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<sup>1</sup>Equations (A.1), in Appendix A, represent the exact form of these conditions.

where:

$$\mu_1 = \frac{a_2}{(1 - a_2 - b_2)} \cdot \frac{(1 - a_1 - b_1)}{a_1}$$

and,

$$\mu_2 = \frac{b_2}{(1 - a_2 - b_2)} \cdot \frac{(1 - a_1 - b_1)}{b_1}$$

Once  $k_{m1}$  and  $k_{d1}$  have been determined by means of these expressions, the equilibrium conditions (relating factor proportions to relative factor prices) may be used again to determine the two wage rental ratios and the two capital-employment ratios in sector 2. Thus with two factor prices specified, factor proportions are determined in each sector.

The transformation surface corresponding to given values of  $\bar{w}_2$  and  $\bar{u}_{m1}$  can be derived in the following manner: the aggregate ratio of imported to domestically-produced equipment can range between 0 and 1. Since the individual equipment components are subject only to non-negativity constraints, the limit on factor use in each sector is the condition:

$$(1.8) \quad \bar{k} = e[(\lambda (k_{m1} + k_{d1}) + (1 - \lambda) (k_{m2} + k_{d2}))]$$

$$0 < \lambda < 1$$

where  $e$  is the aggregate employment rate,  $\bar{k}$  is the specified total capital-labor ratio, and  $\lambda$  is the proportion of the total employed labor force in sector 1. Then the production functions in the two sectors may be re-written as follows:

$$(1.9) \quad x_1 = e \lambda (k_{m1})^{a_1} (k_{d1})^{b_1}$$

$$(1.10) \quad x_2 = e \lambda (k_{m2})^{a_2} (k_{d2})^{b_2}$$



where  $x_i$  is the ratio of value added in sector  $i$  to total labor force (including both the employed and unemployed).

Given a value for  $x_1$ , the valued added- total labor ratio for sector 1,  $e$  and  $\lambda$  may be determined by solving (1.8) and (1.9) simultaneously; the specified factor prices determine the capital-employment ratios in each sector. From (1.10), in turn the ratio of value added in sector 2 to the total labor force is obtained. The relationship between  $x_2$  and  $x_1$ , derived from (1.8), (1.9), and (1.10), may be written simply as:

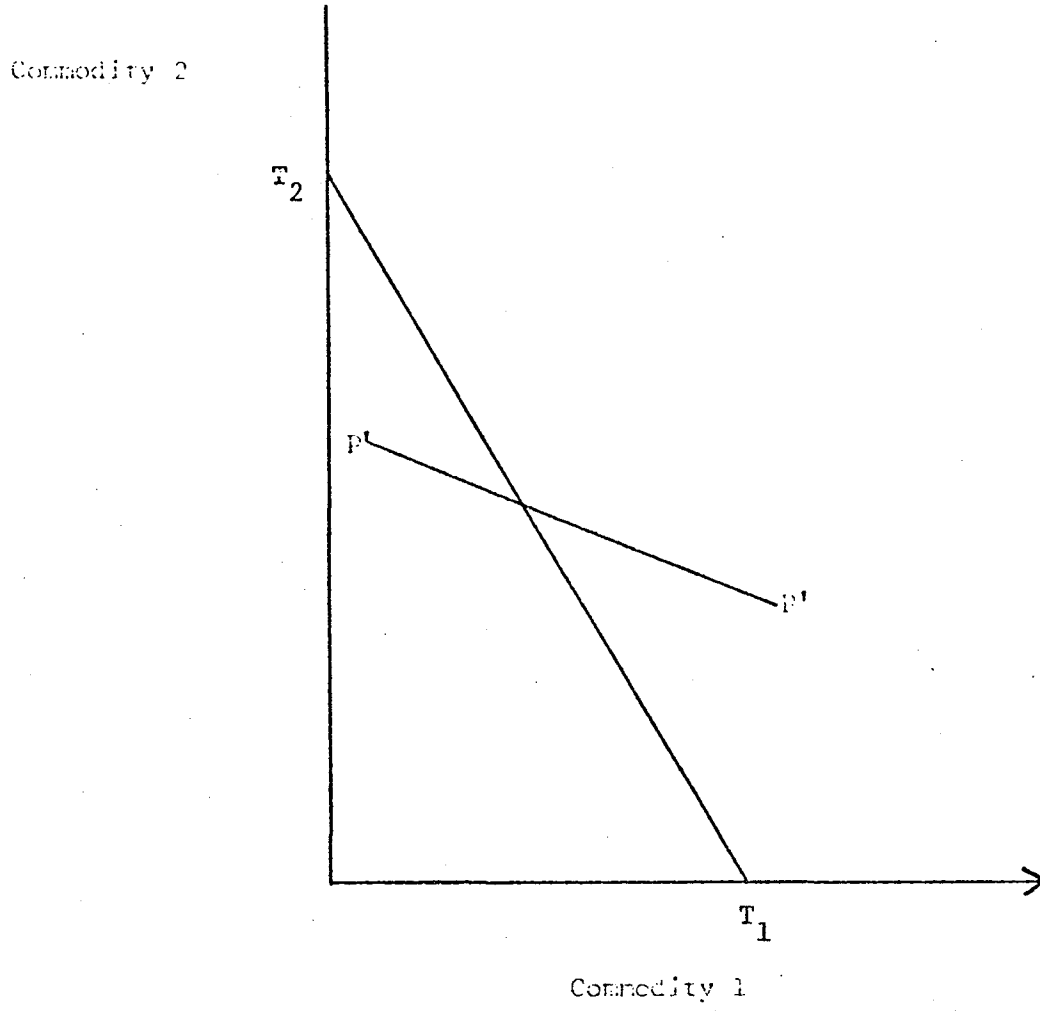
$$(1.11) \quad x_2 = \frac{1}{\tilde{k}_2} (\bar{k} - \tilde{k}_1 x_1) = \frac{\bar{k}}{\tilde{k}_2} - \pi x_1$$

where  $\pi$  is the ratio of the capital-output ratio in sector 1 ( $\tilde{k}_1$ ), to the capital-output ratio in sector 2 ( $\tilde{k}_2$ ).

In Figure 1,  $T_1 T_2$  is the transformation surface in the region of incomplete specialization. Since  $\pi$  is constant, the surface is linear. It is clear that a movement along this surface from  $T_1$  to  $T_2$ , implying greater production of commodity 2, is associated with an increase in the employment rate. In order to keep the aggregate capital-labor ratio constant, the employment rate must increase since a larger proportion of total capital would have to be allocated to the sector with the relatively low capital-employment rate.

The commodity price line in Figure 1, is represented by  $p'p'$ . If we denote the ratio of the internal price of commodity 2 to the internal price of commodity 1 by  $P$  then the slope of this is equal to  $-1/p$ . To demonstrate that total output per laborer (measured in domestic prices)

Figure 1



increases as the output share of commodity 2 rises, it is necessary to show that the absolute value of the slope of  $T_2T_1$ ,  $\pi$ , is steeper than that of the commodity price line,  $p'p'$ .

In Appendix A we prove the proposition (Lemma 2) that  $\pi > 1/p$  only if the total capital-output ratio is higher in sector 1 than it is in sector 2, i.e.  $\pi$  is greater than unity.

B. Demand

The demand side of the system is based on standard trade theory.

From the equilibrium condition

$$(1.12) \quad p\bar{w}_2 = w_1$$

which implies that

$$p = \frac{w_1}{\bar{w}_2},$$

where  $w_1$  is real wage expressed in terms of commodity 1, it is clear that the commodity price ratio,  $p$ , is uniquely determined by the specified set of factor prices ( $\bar{w}_2$  and  $\bar{u}_{m1}$ ) in the region of incomplete specialization. The wage rate expressed in terms of commodity 1,  $w_1$ , depends only on the two capital-employment ratios in sector 1, given by (1.6) and (1.7). Define total capital income per laborer (total payments to capital divided by the labor force) by the identity

$$(1.13) \quad y = u_{m1} (\bar{k} - kd) + kd (u_{d1}) \\ = u_{m1} \bar{k} + (u_{d1} - u_{m1}) kd$$

where  $k_d$  is the aggregate ratio of domestically produced equipment to labor. Total wage income per laborer,  $w$  (expressed in terms of good 1) is defined by the identity

$$(1.14) \quad w = \bar{w}_1 e = p \bar{w}_2 e$$

Demand in the two sectors may be broken down into two components: investment and consumer-good demand. Suppose that the rate of depreciation on the two kinds of equipment is equal to the same magnitude and the system is in steady state equilibrium.<sup>1</sup> Then total gross investment per laborer expressed in terms of good 1 ( $i$ ) is given by the expression

$$(1.15) \quad i = (n + \delta) \bar{k}$$

We assume that consumer demand for commodity  $i$  is determined by the functions of the form

$$(1.16) \quad c_i = c^i (w - \theta i, y - (1 - \theta)i, P)$$

Where  $\theta$  is the proportion of gross investment financed by wage income.

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<sup>1</sup>Government savings and taxes are adjusted to offset changes in private savings associated with changes in the level and functional distribution of income.

By substituting (1.13), (1.14), and (1.15) into the consumer demand function, we obtain

$$(1.17) \quad c_i = c_i'(\bar{w}_2, p, e, \bar{k}, kd)$$

In Appendix B is shown that  $kd$  is determined by a function of the form

$$(1.18) \quad kd = \Psi(e, \bar{w}_2, p)$$

where  $\Psi_e > 0$

Therefore substituting (1.18) into (1.17) yields

$$(1.19) \quad c_i = c_i''(\bar{w}_2, p, e, \bar{k})$$

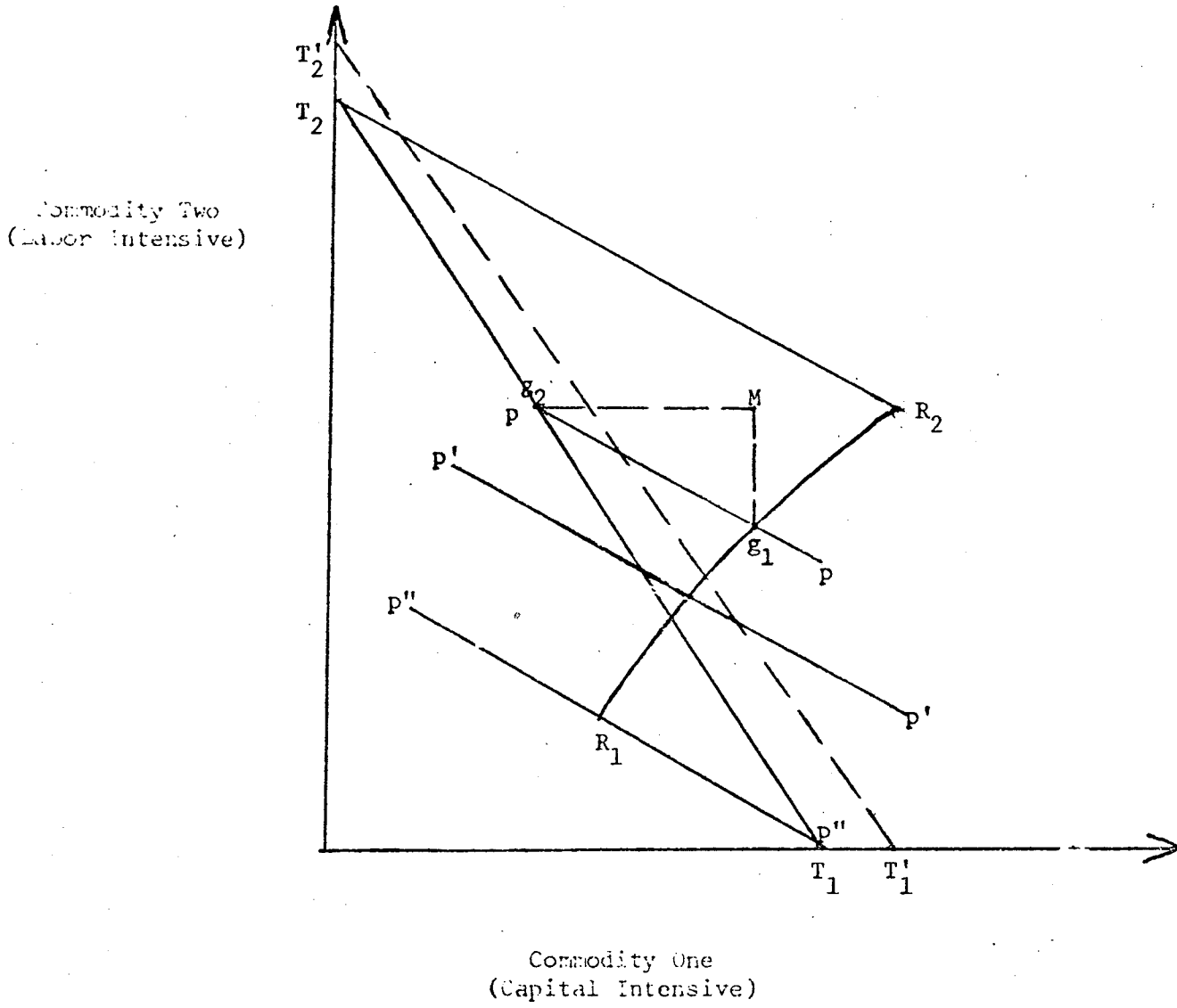
Final demand for sector 1 commodity per laborer ( $d_1$ ) and final demand for the sector 2 good per laborer ( $d_2$ ) are given by the relations

$$(1.20) \quad d_1 = c_1''(\bar{w}_2, p, e, \bar{k}) + (n + \delta) \bar{k}$$

$$d_2 = c_2''(\bar{w}_2, p, e, \bar{k})$$

Recall (a) that each combination of  $x_1$  and  $x_2$  represents a unique value of  $e$  and (b) that  $p$  is given by the specified factor prices ( $\bar{w}_2$  and  $\bar{u}_{m1}$ ). Then by starting at  $T_1$  and moving up the transformation surface in Figure 2, we may determine the final demands for each commodity from (1.20). If the user cost of domestically-produced equipment ( $ud$ ) is great than that of imported capital (an assumption we shall make throughout this paper), then, from (1.13) and (1.18), an increase in the output

Figure 2



share of commodity 2, and thus  $e$ , will increase both wage and capital income. Under these conditions the curve  $R_1R_2$ , giving the final demand combinations corresponding to each point on the transformation surface, will be positively sloped assuming that neither commodity is inferior (i.e., the partial derivatives of the consumer demand function with respect to  $w$  and  $y$  are both positive).

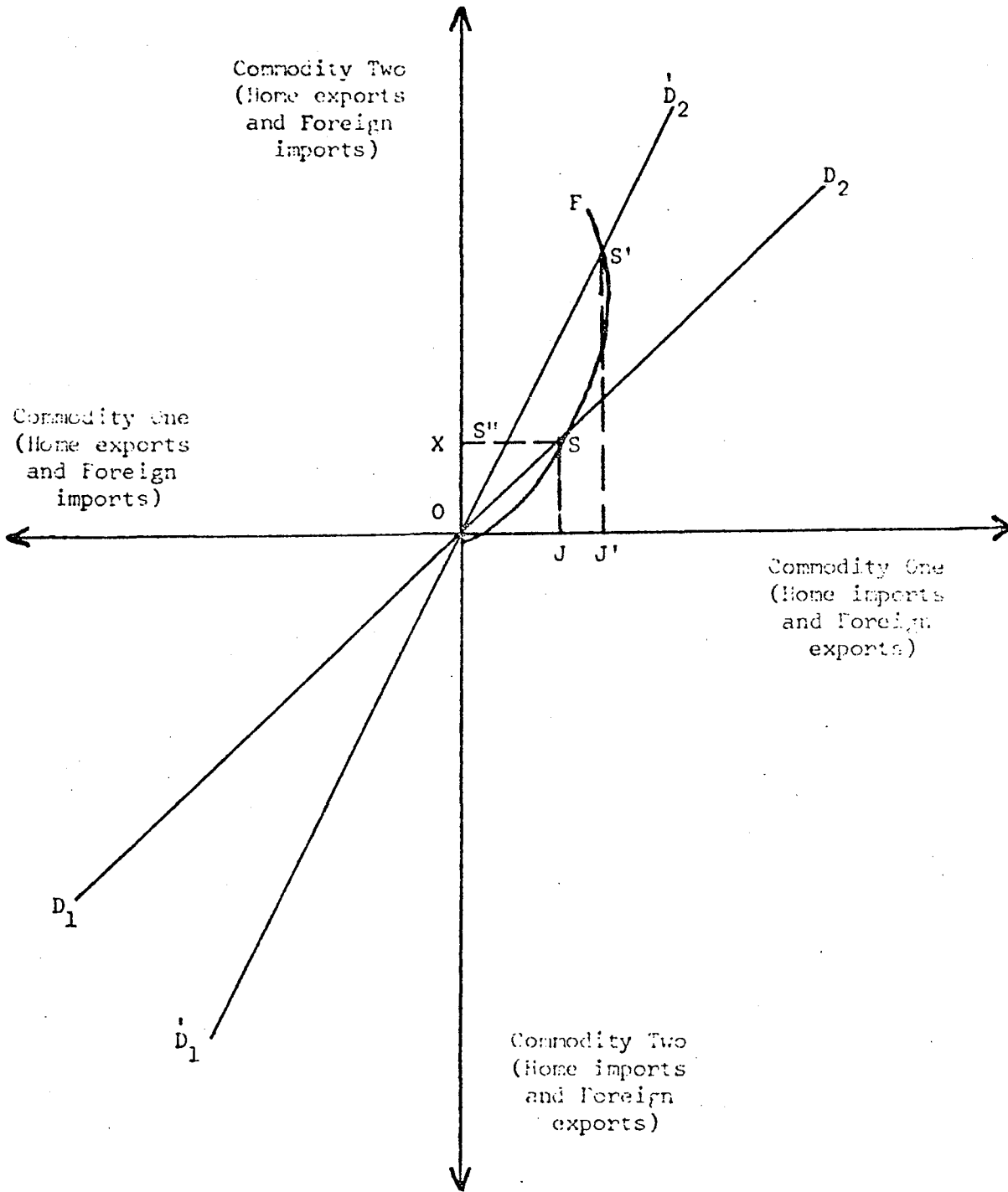
We also assume imports per laborer of good 1,  $m_1$ , and exports per laborer of good 2,  $e_2$ , are determined residually, i.e.,

$$(1.21) \quad \begin{aligned} m_1 &= d_1 - x_1 \\ e_2 &= x_2 - d_2 \end{aligned}$$

From the demand curve  $R_1R_2$  and the transformation surface  $T_1T_2$  we can then derive the home country's offer curve from the two commodities. From the production-cum-demand combinations associated with given points on  $T_1T_2$  (e.g.,  $g_1$ -cum- $g_2$ ) in Figure 2, offer triangles may be formed. In the case of the triangle  $g_1Mg_2$ ,  $Mg_2$  represents the exports which are offered for an equal value of imports. The autarchy point is determined by the intersection of the demand curve with the transformation surface.

Placing all such triangles into Figure 3 produces the offer curve  $D_2D_1$ . This offer curve is of the straight line Ricardian variety in the region of incomplete specialization. By contrast, the foreign offer OSF curve has the conventional shape associated with an import price elasticity

Figure 3





less than infinite. In Figure 3, the offer triangle corresponding to the intersection of the home and foreign offer curves OSJ is shown. This has the same dimensions as the offer triangle  $g_1Mg_2$  at the equilibrium production point.

## II. Employment Effects of Equipment and Overall Tariff Changes

### A. Changes in the User Cost of Imported Equipment

The model presented in the first section enables us to analyze the effects of a change in the relative cost of imported equipment on employment. To do so, let us assume first an increase in the user cost of imported equipment through, for example, an equipment tariff increase, with the overall tariff rate remaining constant. Such a policy change will have two broad effects on employment: first there is the direct substitution of labor for capital arising from the factor price change; second indirect substitution would occur as a result of a change in the commodity price ratio and the bill of goods demanded, with an associated change in the output share of the labor-intensive good.

To determine the effect of an increase in the user cost of imported equipment (expressed in terms of good 1),  $\bar{u}_{m1}$  on the capital labor ratios in the two sectors, let us differentiate (1.6) and (1.7) totally to obtain the effect of  $\bar{u}_{m1}$  on  $k_{d1}$  and  $k_{m1}$  with  $\bar{w}_2$  held constant. Denote the Jacobian matrix for equations (1.6) and (1.7) by  $J$  and the value of its determinant by  $|J|$ . Then the expressions for the total changes in  $dk_{d1}$  and  $dk_{m1}$ , with  $\bar{w}_2$  constant may be written as:

$$(2.1) \quad dk_{m1} = -H_1 \bar{d}u_{m1}$$

$$(2.2) \quad dk_{d1} = H_2 \bar{d}u_{m1}$$

where

$$H_1 = \frac{(1 - a_2 - b_2)}{|J|} \mu_2 u_{d2}$$

$$H_2 = \frac{(1 - a_2 - b_2)}{|J|} \mu_1 u_{m2}$$

The sign conditions

$$(2.3) \quad \frac{dk_{m1}}{d\bar{u}_{m1}} = -H_1 < 0$$

$$(2.4) \quad \frac{dk_{d1}}{d\bar{u}_{m1}} = H_2 > 0$$

are unambiguous, since the determinant of the Jacobian,  $/J/$ , can be shown to be always positive. The equilibrium conditions equating relative factor prices in the two sectors imply that  $k_{m2}$  must move in the same direction as  $k_{m1}$  and  $k_{d2}$  must move in the same direction as  $k_{d1}$ .

What, then, is the impact of an increase in  $\overline{u_m}_1$  on the total capital employment ratio ( $k_{mi} + k_{di}$ ) in each sector? To show that the total capital-employment ratio in sector 2 declines, we must show that the absolute value of the decline in  $k_{m2}$  exceeds the increase in  $k_{d2}$ . By differentiating condition (1.4) totally it can show that

$$dk_{d2} < - dk_{m2} \text{ as}$$

$$u_m < u_d$$

A similar condition may be derived for sector 1, from (2.1) and (2.2).

The conclusion from this analysis is that the effect of a change in tariff on import equipment on the total capital employment rate in each sector is ambiguous. Provided, however, that the user cost of domestic exceeds that on imported equipment, an increase in tariff, in fact, decrease total capital employment ratios in both sectors.<sup>1</sup>

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<sup>1</sup>This rather tedious and roundabout analysis is necessary because our assumptions about factor intensity in each sector pertains to factor shares rather than the capital/labor ratio. In turn these assumptions have been chosen because they are easier to test empirically in the context of developing countries.

In the same connection, it is important to stress that in both sectors a decline of the total capital/employment ratio is associated with a decline of the capital output ratio. In the case of sector 2 this is obvious if the total capital/employment ratio falls, the capital output ratio must decline, since the employment/output ratio determined by  $\bar{w}_2$  remains constant.

Differentiating the expression for the capital output in sector 1 totally yields

$$(2.6) \quad d \left( \frac{k_{m1} + k_{d1}}{\hat{x}_1} \right) = G \cdot (1 - a_1 - a_1^{k_{d1}/k_{m1}}) dk_{m1} + G \cdot (1 - b_1 - b_1^{k_{m1}/k_{d1}}) dk_{d1}$$

where  $G = 1/B_1 (k_{m1})^{-a_1} (k_{d1})^{-B_1}$ ,

Therefore, since

$$-dk_{m1} > dk_{d1}$$

it follows that the capital-output ratio will decline in sector 1 if

$$(2.7) \quad (1 - B_1 - B_1^{k_{m1}/k_{d1}}) < (1 - a_1 - a_1^{k_{d1}/k_{m1}})$$

In competitive equilibrium this sufficient condition reduces to

$$(2.8) \quad u_d > u_m$$

Thus if the rental rate on domestically-produced exceeds that on imported equipment the capital-output ratios will decline in both sectors. The implication of this decline is that an increase in  $u_m$  results in an outward movement in transformation surface which is illustrated by the shift from  $T_1 T_2$  to  $T_1' T_2'$  in Figure 2.

It is clear from (1.12) that the commodity price ratio  $p$  is an increasing function of the real wage (expressed in terms of good 1). Thus, in competitive equilibrium, we have

$$(2.9) \quad p = \frac{w_1}{w_2} = \frac{(1 - a_1 - b_1) A_1 (km_1)^{a_1} (kd_1)^{b_1}}{w_2}$$

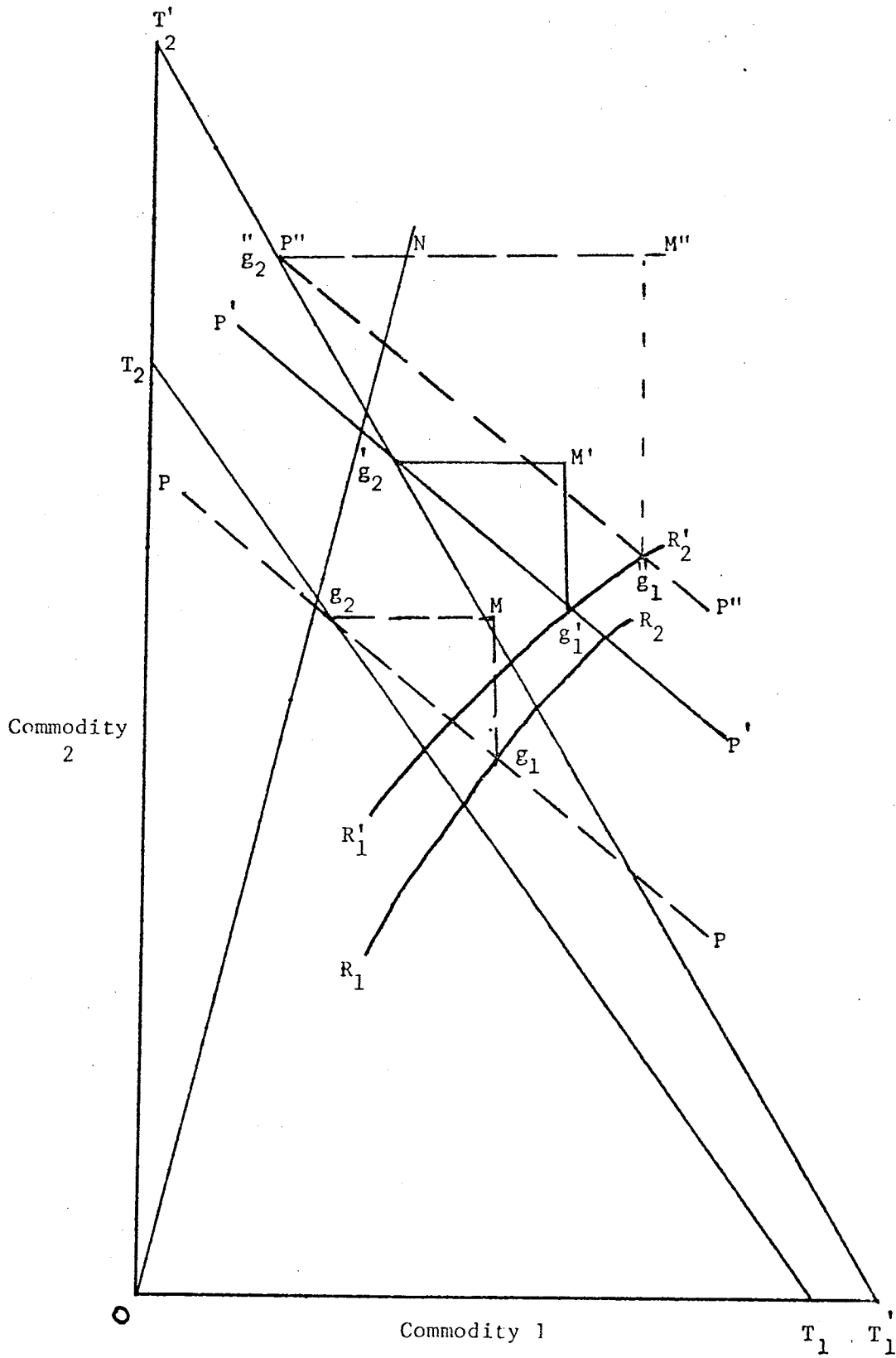
By differentiating this relationship totally and using (2.1) and (2.2) to substitute for  $d km_1$  and  $d kd_1$ , we obtain the condition

$$(2.10) \quad dp \begin{matrix} > \\ < \end{matrix} 0 \text{ as } \frac{a_2}{b_2} \begin{matrix} > \\ < \end{matrix} \frac{a_1}{b_1}$$

Thus, given the restriction (1.3) on the production function parameters, the ratio of the price of commodity 2 to the price of commodity 1 must decline if  $\bar{u}_{m1}$  increases due to an increase in the equipment tariff rate.

The nature of the demand change brought on by an increase in  $u_{m1}$  now can be analyzed geometrically. The fall in the ratio of the price of commodity 2 to price of commodity 1, together with the outward movement of the transformation surface, is associated with a shift in the home offer curve, from  $D_1 D_2$  to  $D_1' D_2'$  (in Figure 2). The changes in the factor prices  $\bar{u}_{m1}$  and  $u_{d1}$  will change the functional distribution of income associated with a given  $x_1$  and  $x_2$  combination. If the relative commodity price effects dominate the factor share effects of a change in  $\bar{u}_{m1}$  the demand curve will shift to the left from  $R_1 R_2$  to  $R_1' R_2'$  (see Figure 4). Suppose that production is now at point  $g_2'$  on the transformation surface  $R_1' R_2'$ . The segment  $g_1' m'$  of the offer triangle  $g_1' m' g_2'$  represents the amount exported when production is at this point. Exports at the new point of production are the same as in the original position. However, the associated shift in the home offer curve depicted in Figure 3 indicates that if exports

Figure 4



are held constant at their initial level, there will be an excess demand for the home country's exportable in world markets. To eliminate this excess demand, exports must increase to point S. This implies a shift in production of the exportable commodity from  $g_2'$  to  $g_2''$  in Figure 4. Since this point is associated with greater specialization in commodity 2 than point  $g_2'$ , it represents a higher level of employment and output measured at constant domestic prices. However, the relationship of the output share at point  $g_2''$  to that at initial point  $g_2$  remains uncertain. Since the position of the production point  $g_2''$  relative to the constant output share line ON is ambiguous,<sup>1</sup> the output share of the labor-intensive commodity may increase or decrease depending on such factors as the shift and curvature of the demand curve and the shift in the transformation surface. For example, if the demand curve is concave to the origin, and there are large outward movements in the transformation surface at the same time as the price elasticity of demand is low, the output share of the capital intensive sector may well increase. For this reason, the effect on employment of an increase in  $\bar{u}_{m1}$  cannot be established without further assumptions about the nature of demand shifts.

Is it likely that the output share of the labor-intensive sector would decline sufficiently to counteract the decline in sectoral capital intensity if commodity 2 is not inferior? By examining the magnitudes of the home and foreign import price elasticities, we may be able to determine the conditions for a total increase in the employment rate, and their likelihood to prevail.

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<sup>1</sup>The position of  $g_2''$  to the left of ON in Figure 4 is purely illustrative.

Define:

$$(2.12) \quad \frac{-1/P}{M_1} \cdot \frac{dZ_1}{d(1/p)} = \eta_1$$
$$\frac{-P}{M_2} \cdot \frac{dZ_2^*}{dP} = \eta_2^*$$

where  $Z_1$  is the net imports of the first commodity by the home country and  $Z_2^*$  is the net imports of good 2 by the rest of the world. The elasticity  $\eta_1$  must be interpreted as a partial elasticity since it represents response to price with the employment rate and  $\bar{w}_2$  held constant; the total import elasticity in this case is infinite. The elasticity  $\eta_2^*$  is the conventional total price elasticity for the rest of the world. It is shown in Appendix B that, given non-inferiority and  $u_d$  greater than  $u_m$ , the employment rate will increase if the familiar Marshall-Lerner condition

$$(2.13) \quad \eta_1 + \eta_2^* > 1$$

is met.

The restriction that  $u_d$  exceed  $u_m$  is a sufficient but not a necessary condition for an increase in aggregate employment rate when the Marshall-Lerner condition is met. If the total capital employment ratio is higher in sector 1 than it is in sector 2, then the aggregate employment rate will increase even though the total capital employment ratios in the two sectors may rise. In this instance, the indirect substitution resulting from increase in the output share of the labor intensive sector outweighs the depressing effect of the direct substitution of capital for labor on employment in both sectors.



B. Changes in overall tariffs

Aggregate income and employment may be increased by an overall reduction in trade barriers, e.g. through lowering of overall tariff rates or the provision of export subsidies, but keeping the tariffs on equipment constant. Such policies may be designed to increase the output share of the labor intensive sector. In the context of our model, this would be accomplished by changing the slope of the linear segment of the home offer curve without affecting either the demand curve or the transformation surface. Since relative factor prices would remain fixed, the increase in employment would result purely from indirect substitution. The conditions under which a given policy will have the desired effect are presented in the standard trade literature. The case being considered is the one in which the relatively labor intensive commodity is being exported. In this case, it is well known that, provided the Metzler paradox does not hold, an export subsidy or tariff decrease will cause the real wage to rise. In contrast to the standard trade model in our model, unemployment causes the real wage to remain at a specified minimum. However, with downward wage rigidity and unemployment, the standard conditions ensuring an increase in the real wage in our system imply an increase in employment.<sup>1</sup>

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<sup>1</sup>In this case, our model is perfectly analogous to the two-factor model presented by Brecher. His results and accompanying proofs apply here. See [1, pp. 123-131] and [2].

### III. Welfare Implications

We confine ourselves to the welfare effects of changes in the tariff on equipment, since the overall tariff results, in our model, are identical to Brecher's [1]. Welfare analysis is considerably complicated by the redistribution of income among laborers and owners of imported and domestically-produced equipment due to a change in  $um_1$ . For the sake of simplicity, let us assume that the utility functions of all individuals in the economy are the same (implying equal marginal propensities to consume out of wage and capital income). Let us further assume that lump-sum transfers are used to distribute the welfare effects of a particular policy measure equally among the different classes of income earners. Under these assumptions, the welfare function takes the form

$$(3.1) \quad \tilde{w} = \sigma \bar{N} \tilde{U}(c_1, c_2)$$

where  $\sigma$  is the constant labor-force participation rate,  $\bar{N}$  is the specified population level, and  $\tilde{w}$  is aggregate welfare.

Taking  $C_i$  ( $i = 1, 2$ ) from equation (1.16) and totally differentiating  $\tilde{U}(c_1, c_2)$  with respect to  $um_1$ , we obtain

$$(3.2) \quad \frac{d\tilde{u}}{du_{m1}} = u_1 \frac{dc_1}{du_{m1}} + u_2 \frac{dc_2}{du_{m1}} = u_1 \left[ \frac{dc_1}{du_{m1}} + \frac{u_2}{u_1} \frac{dc_2}{du_{m1}} \right]$$

This reduces to

$$\frac{d\tilde{u}}{du_{m1}} = u_1 \left[ \frac{dc_1}{du_{m1}} + P \frac{dc_2}{du_{m1}} \right]$$

if  $P = u_2/u_1$ , i.e., the marginal condition for utility maximization is met.

With balanced trade,

$$(3.3) \quad (n + \delta) \bar{k} + c_1 + p^* c_2 = x_1 + p^* x_2$$

where  $p^*$  is the world price ratio of good 2 to good 1. With all tariff rates zero initially,

$$(3.4) \quad p^* = p$$

Assume that this condition is met and note that

$$x_i = x_i(e, p; \bar{k}, \bar{w}_2)$$

Define GDP per laborer (expressed in terms of good 1),  $q_1$ , by the relationship

$$(3.5) \quad q_1 = x_1 + px_2 = w_1 e + (ud_1 - \bar{u}m_1) kd + \bar{u}m_1 \bar{k}$$

Then by differentiating (3.3) totally and substituting into (3.2), we obtain

$$(3.6) \quad \frac{\tilde{d}u}{d\bar{u}m_1} = \tilde{u}_1 \left\{ \frac{\partial q_1}{\partial e} \frac{de}{d\bar{u}m_1} + \left[ \frac{\partial x_1}{\partial p} + p \frac{\partial x_2}{\partial p} + (x_2 - c_2) \right] \frac{dp}{d\bar{u}m_1} \right\}$$

From (3.5), it can be shown that

$$(3.7) \quad \frac{\partial q_1}{\partial e} = w_1 + (ud_1 - \bar{u}m_1) \Psi_e$$

where  $\Psi_e$  is the partial derivative of (1.18), the function determining  $kd$ , with respect to  $e$ . Thus, if

$$ud_1 > um_1,$$

$$(3.8) \quad \partial q_1 / \partial e > w_1 > 0$$

Moreover, from the condition equating the marginal product in both sectors to the real wage and the relationship

$$(3.9) \quad p \cdot \bar{w}_2 = w_1,$$

we obtain

$$(3.10) \quad \frac{\partial x_1}{\partial p} + p \frac{\partial x_2}{\partial p} = v_1 + v_2$$

$$\text{where } v_1 = \frac{\bar{w}_2 e \lambda}{(1-a_1-b_1)} \text{ and } v_2 = \left[ 1 - \frac{(1-a_2-b_2)}{(1-a_1-b_1)} \right] p \frac{\partial x_2}{\partial p}$$

Substituting (3.10) into (3.6) yields

$$\frac{d\tilde{u}}{d\bar{u}m_1} = \tilde{u}_1 \left\{ \partial q_1 / \partial e \frac{de}{d\bar{u}m_1} + [v_1 + v_2 + (x_2 - c_2)] \frac{dp}{d\bar{u}m_1} \right\}$$

The terms of this expression represent a de-composition of the effects of a change in  $\bar{u}m_1$  on welfare. First there is the effect of a change in  $\bar{u}m_1$  on the employment rate and the associated change in wage and capital income with factor and commodity prices held fixed. Under the usual assumption that

$$ud_1 > um_1,$$

this component of the effect of a decrease in  $\bar{u}m_1$  on welfare will be positive; since, from (3.8),  $\partial q_1 / \partial e$  will be unequivocally positive. Then there is the impact of change in output per employed laborer in

sector 1 brought on by a change in  $\bar{u}_1$  and an associated change in the commodity price ratio. This impact with output shares constant is reflected in  $v_1$ , which is positive. The effect of varying the output share of sector 2 with labor productivity and the employment rate constant is represented by  $v_2$ , which is negative when  $u_d$  exceed  $u_m$ . All these changes are evaluated at the initial commodity price ratio. Finally, the term  $(x_2 - c_2)$  brings out the effect of a shift in the terms of trade. If the home country exports commodity 2, there  $(x_2 - c_2)$  will be positive. It is impossible to determine, in general, whether or not the absolute value of  $v_2$  exceeds that in  $v_1$ . Therefore, since  $\frac{dp}{d\bar{u}_1}$  is negative, the impact of a change in  $\bar{u}_1$  on welfare is ambiguous.

Nonetheless, if, as is often argued, the foreign import price elasticity is close to infinite, the absolute value of the term

$$\partial q / \partial e \frac{de}{d\bar{u}_1}$$

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<sup>1</sup>We have proven earlier that when the employment rate is allowed to vary the decrease in  $p$  associated with an increase in  $\bar{u}_1$  will cause the transformation surface to shift completely outward. However, when the employment rate is fixed, there is an inward shift everywhere except at the point of complete specialization in commodity 2.

will be very large. See Appendix B. Consequently, in cases where the foreign offer curve is highly elastic it is quite clear that increases in  $\bar{u}_1$  will lead to increase in both welfare and the employment rate.

#### IV. Empirical Tests

In part III, we derived conditions under which an increase in tariff rate on imported equipment and a reduction in the overall tariff rate will lead to a rise in the aggregate employment rate. The remainder of this paper is devoted to an analysis of whether or not these conditions prevailed in one developing country examined, Turkey. This analysis was based first on the assumption implied by conditions (1.2) and (1.3) that the wage share is higher in the sector with the lower ratio of imported to domestically-produced equipment, i.e., when a cross-sectional comparison is made, the wage share is negatively associated with the ratio of imported to total equipment in each sector.<sup>1</sup> Second, it was shown that, under reasonably realistic assumptions about demand elasticities in foreign trade, an increase in equipment tariffs would unambiguously increase both welfare employment if two additional conditions were met:

- (a) the user cost of domestic exceeded that of imported equipment; and
- (b) the sector with the higher total capital employment ratio required more capital per unit of output than the sector with the lower capital-employment ratio.

We shall now test the validity of these assumptions in the case of one developing country, Turkey.

A. Equipment composition and wage shares.

The hypothesis involving factor shares may be tested in several ways. One approach is to use a linear approximation of the relationship between the wage share and the intensity of imported equipment. Let us substitute the ratio of imported to total gross equipment investment,  $I_m/I$ , for the ratio of imported to total equipment stock ( $K_m/K$ ). Now suppose that we estimate the relationship

$$(4.1) \quad w/v = A_0 + A_1 (I_m/I) + \hat{e}$$

where  $w/v$  is the wage share,  $A_0$  and  $A_1$  are coefficients, and  $\hat{e}$  is an error term. Our null hypothesis in this case is that

$$A_1 < 0$$

Fitting the equation (4.1) to a cross section of sectors presents a number of problems. First,  $I_m/I$  may not be a good proxy for  $K_m/k$ .<sup>1</sup> Second, to the extent that the relationship is non-linear,  $A_1$  will be an inconsistent estimate of the partial derivative of the dependent with respect to the independent variable evaluated at the mean value of  $I_m/I$ . The last and perhaps the most serious difficulty is that the error term  $\hat{e}$  is not normally distributed since the dependent variable is constrained to lie between 0 and 1.

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<sup>1</sup>For the implications of using flow rather than stock estimates are explored in [ 7 ].

To overcome the limited dependent variable problem, we assume that the relationship between  $w/v$  and  $Im/I$  takes the form of a logistics curve.

$$(3.2) \quad w^* = \frac{1}{1 + e^{A_1 + A_2 k^* + E}}$$

where  $w^* = w/v$ ,  $k^* = Km/K$ , and  $E$  is a normally distributed error term with a mean of zero. Our null hypothesis is that  $A_1$  is positive, implying that the wage share is a decreasing function of  $k^*$ . By taking logs and rearranging terms, we obtain

$$(3.3) \quad \log (1/w^* - 1) = A_1 + A_2 k^* + E$$

Note that the dependent variable in this equation has the limits

$$\lim_{w^* \rightarrow 1} \log (1/w^* - 1) = -\infty$$

$$\lim_{w \rightarrow 0} \log (1/w^* - 1) = +\infty$$

$$w \rightarrow 0$$

which are consistent with the normally-distributed error term.

We fitted (4.3), with  $Im/I$  substituted for  $k^*$ , to data taken from the 1963 Turkish manufacturing census [11]. The regression equation, estimated from a sample of 104 manufacturing sectors (at the three and four digit level) took the form:

$$(4.4) \quad \log (1/w^* - 1) = .451 + .007 Im/I$$

(4.7) (3.1)

$$R^2 = .08 \quad F = 9.31$$

The coefficient for  $Im/I$  has the hypothesized positive sign and is significantly non-zero at the one percent level.<sup>1</sup> The magnitude of the  $F$  statistic indicates that, although the value of the  $R^2$  coefficient is low, it is significantly greater than zero at the one percent level.

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<sup>1</sup>In each regression, the numbers in parentheses represent the ratio of the parameter estimate to its standard error.



It is possible that  $Im/I$  is positively correlated with the scale of production in each sector. Since relative capital intensity may be an increasing function of scale, the negative association between  $Im/I$  and the wage share implied by (4.4) may be the result of omitting a scale variable from the regression equation. Suppose that we represent the average scale of production by means of the ratio  $X/n$  where  $X$  is total value added and  $n$  is the number of firms in each sector. Including this variable in the regression equation yields:

$$(4.5) \quad \log (1/w^* - 1) = .442 + .006 \text{ Im/I} + .00001 \frac{X}{n}$$

$$(4.6) \quad (2.7) \quad (1.5)$$

$$R^2 = .10 \quad F = 5.91$$

The  $Im/I$  ratio still has a positive sign and is significantly non-zero at the five percent level. While the coefficient for  $X/n$  has the hypothesized sign, it is not significantly greater than zero at the five percent level. Further, by means of an F ratio test it can be shown that the explanatory power of (4.5) is not significantly greater than that of (4.4) at the five percent level. These results indicate the robustness of the hypothesized relationship between  $w^*$  and  $Im/I$ .

#### B. Implications for the capital-output ratio.

Note that, while there is a significant association between the wage share and  $Im/I$ , the simple correlation coefficient between the money wage rate and  $Im/I$  was not significantly different from zero at the 5 percent level. This is important, since if money wage/capital rental ratio is the same for industries having both high and low imported-equipment intensities and total output equals total factor payments, the capital/labor ratio will be inversely related to the wage share. This negative

relationship holds a fortiori when, as the assumption

$$u_d > u_m$$

implies the average money rental rate on capital is a decreasing function of  $Im/I$  and thus an increasing function of the wage share. Further, it is clear that if under these circumstances the money wage rates are the same in all sectors, the capital-output ratio will be an increasing function of the wage share and  $Im/I$ . Given an inverse relationship between the total capital employment ratio and the wage share, this implies that there will be no conflict between increases in output measured at domestic prices and employment when the output and capital share of the labor intensive sector rises with factor prices constant. This empirical evidence indicating a positive association between capital output and capital-employment ratios is the basis of the assumption, made in section II, that the absolute slope of the commodity price line is less than that of the transformation surface. (See Appendix A, lemma 2).

C. Relative user costs.

There are considerable problems in testing empirically the conditions in our model pertaining to the relative user costs on the two types of equipment.

In Turkey external credit is generally used to finance imported equipment while internal credit can be used to finance both kinds. External credit is granted on more concenssionary terms than domestic

credit. However, it would be inappropriate to conclude on this basis alone that  $r_d > r_m$ . The relative terms alone are not themselves conclusive evidence about the equilibrium user cost of capital because during the period examined, the borrowing rate deviated from the physical return on capital. Domestic credit was rationed and relative credit availability was more important than terms [7]. But domestic interest rate pegging combined with a lack of excess bank reserves and stringent credit controls indicates that the official interest rate on domestic credit understated its true scarcity value.<sup>1</sup>

Neglecting corporate taxes, the user cost of capital is the product of the internal price of the capital good and the relevant interest rate. Kruegar presents evidence that effective exchange rate on non-competitive is substantially lower than that on competitive equipment imports in Turkey during the 1960's [5]. If, as in our model, units are chosen so as to equate the world prices of the two forms of equipment, this evidence supports the hypothesis that the internal price of imported equipment does not exceed that of domestically-produced equipment. In the Turkish case, there is no indication that corporate taxes and depreciation allowances depend on the origin of the equipment being utilized. Thus internal price differential supported by the effective exchange rate evidence, along with the observed differences in interest rates, does provide a prima facie case for  $r_d$  exceeding  $r_m$ .

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<sup>1</sup>See [ 5] and [10].

D. Exchange Liberalization and the Composition of Equipment Investment

While no reliable time series exists on aggregate employment in Turkey, there is evidence that the composition of equipment investment responded to equivalent tariff rate changes in a way which is consistent with our results. It may be argued that the ratio of the black market to the official exchange rate is a proxy for the degree of exchange control. Since there is evidence that import quota system in Turkey discriminates in favor of equipment imports, the more stringent the degree of quantitative control, the more we would expect the equivalent tariff on equipment to decline relative to that on other commodities [5]. Consequently, an increase in the degree of quantitative control would, according to the results of our model, decrease the employment rate in two ways: (a) by increasing the overall equivalent tariff rate and (b) by decreasing the rental rate on imported equipment deflated by the general import price index ( $um_1$ ). For the most part we would expect such a change to decrease the desired level of domestically produced equipment. It is interesting to note that, in line with this hypothesis, there is a significant negative association (at five per level using a one-tailed test) between the ratio of the black market to official exchange rate and to the level of gross domestic-equipment investment during the 1950-65 period.<sup>1</sup> The association of this variable

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<sup>1</sup>The regression equation took the form

$$Id = -.430 + .018 GNP - .022 (BM/D)$$

(15.85)                      (-1.83)

$$R^2 = .96, D.W. = 1.72, F = 145.85,$$

where Id is real gross investment in domestically produced equipment, GNP is real gross national product and BM/D is the ratio of the black market to the official exchange rate. The sources for the investment and GNP data is Korum [ 4] and for the exchange rate data Pick's currency yearbook and the IMF International Financial Statistics [12].

with gross investment in imported equipment when net foreign inflow was included in the same regression was negative and insignificant. The expected positive impact of lower real rental rate on investment in imported equipment may well have been counteracted by reduced capacity utilization during periods of stringent quantitative restriction not allowed for in our model. Also, this rental rate when expressed in terms of non-traded rather than import-competing may well have risen due to some increase in capital-good equivalent tariff.

#### V. Conclusions

In this paper, we have developed a two-commodity general equilibrium model involving three factors of production. Because two factor prices are exogenously fixed, this model has a solution which implies open unemployment of labor. It is assumed that the home country exports the relatively labor-intensive commodity, that the relative share of labor is higher in the sector with the lower ratio of domestic to imported equipment, and that the subsidization of imported equipment is carried to the point where its user cost lies below that of domestically-produced equipment. (These conditions are not necessary for some of our results to hold.) Neither commodity is inferior and there is incomplete specialization. In this model the aggregate ratio of imported to domestically-produced equipment is allowed to vary while the ratio of total equipment to labor is held fixed. These assumptions are sufficient but not necessary for the total capital employment to be higher in the sector which is intense in the use of imported equipment. (Given the wage share condition, a positive association may exist between total capital intensity and the share of equipment imported when the money rental on imported exceeds that on domestically-produced equipment.) Finally, the

sector with the higher capital employment ratio is also assumed to be the sector with the higher capital-output ratio.

This assumption, and the assumption about the relationship between equipment and wage shares are supported by data drawn from the Turkish manufacturing census. Similarly there is good reason to believe that imported equipment was subsidized heavily in Turkey during the 1960's. Investment in domestically produced equipment seemed to respond to changes in the degree of quantitative restriction in the direction implied by our model.

In this context, we have analyzed the impact of equipment and overall tariff rate changes on aggregate employment and welfare. The policy implications of our investigation may be summarized as follows:

1. Given the assumption of the model, an increase (decrease) in the tariff rate on imported equipment (with the overall tariff rate constant) will increase (decrease) the aggregate employment rate if only the Marshall-Lerner condition is met.

2. This result still holds even if the user cost on imported is greater than that on domestically-produced equipment as long as the total capital-employment ratio is higher in the sector which is relatively intense in imported equipment.

3. An increase (decrease) in the equipment tariff rate will cause the total capital-employment ratios in each sector to fall (rise) only if the user cost on imported is less than that on domestically-produced equipment.

4. If the home country exports the capital-intensive rather than the labor-intensive commodity, an equipment tariff increase will still cause the employment rate to increase provided the Marshall-Lerner condition is met. (See Appendix B.) The employment impact of an overall tariff change under these conditions is reversed.

5. If the Metzler paradox conditions do not hold, an overall tariff reduction (increase) will cause both the employment rate and the aggregate ratio of domestically-produced to imported equipment to increase (decrease).

6. Generally speaking, the impact of an equipment tariff increase and an overall tariff reduction on social welfare is ambiguous. (The latter is a function commodity consumption levels.) But if, as is frequently the case, world demand for the export commodity is highly elastic, the two variables will change in the same direction.

7. Devaluation cum liberalization measures which (a) reduce the overall rate of effective protection and/or (b) increase the rate of protection on capital goods relative to other goods are likely to be beneficial to employment as a result of changes in output composition and factor policies, apart from effects on overall business activity.

Appendix A

Lemma 1: The total capital employment ratio is higher in sector 1 than it is in sector 2 if the user cost imported equipment ( $u_m$ ) is lower than that for domestically-produced equipment ( $u_d$ ).

Proof: In competitive equilibrium, we have

$$(A.1) \quad \begin{aligned} km_1 &= \frac{a_1}{(1 - a_1 - b_1)} \frac{w}{u_m} & km_2 &= \frac{a_2}{(1 - a_2 - b_2)} \frac{w}{u_m} \\ kd_1 &= \frac{b_1}{(1 - a_1 - b_1)} \frac{w}{u_d} & kd_2 &= \frac{b_2}{(1 - a_2 - b_2)} \frac{w}{u_d} \end{aligned}$$

where  $w$  is the money wage rate,  $u_m$  is the money rental rate on imported equipment, and  $u_d$  is the money rental rate on domestically-produced equipment. The restrictions<sup>1</sup> on the production function parameters, (1.2) and (1.3), imply that

$$(A.2) \quad a_1 > a_2$$

It follows from this result and conditions (1.4) that

$$(A.3) \quad km_1 > km_2$$

As long as  $kd_2$  does not exceed  $kd_1$  by an amount which is greater than the difference between  $km_1$  and  $km_2$ , the total capital employment ratio will be higher in sector 1 than it is in sector 2. This will be true as long as

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<sup>1</sup>From (1.3), we obtain  $a_1 > a_2 (b_1/b_2)$ . Thus the inequality  $a_1 > a_2$  will hold as long as  $b_1/b_2 \geq 1$ . But if  $b_1/b_2 \leq 1$  and  $a_1 < a_2$ , then  $b_1 + a_1 < b_2 + a_2$  which contradicts condition (1.2).



$$(A.4) \quad A w/u_m > B w/u_d$$

where

$$A = \frac{a_1}{(1 - a_1 - b_1)} - \frac{a_2}{(1 - a_2 - b_2)}$$

and

$$B = \frac{b_2}{(1 - a_2 - b_2)} - \frac{b_2}{(1 - a_1 - b_1)}$$

Define

$$(A.5) \quad \gamma = u_m/u_d$$

Then the total capital employment ratio in sector 1 will be greater than that in sector 2 if and only if

$$(A.6) \quad A > \gamma B$$

Since condition (1.2) implies that A exceeds B, a sufficient condition for this inequality to hold is that

$$(A.7) \quad \gamma \leq 1$$

Lemma 2: The absolute value of the slope of the transformation surface is greater than that of the commodity price line if and only if the total capital output ratio is higher in sector 1 than it is in sector 2.

Proof: The slope of the transformation surface  $T_1 T_2$  is given by the expression

$$(A.8) \quad \pi = \frac{(k_{m1} + k_{d1})}{(k_{m2} + k_{d2})} \frac{\hat{X}_2}{\hat{X}_1}$$

Making use of the equilibrium condition

$$(A.9) \quad p \bar{w} = p \hat{X}_2 (1 - a_2 - b_2) = w_1 = \hat{X}_1 (1 - a_1 - b_1)$$

to substitute for  $X_2$  and  $X_1$  and yields

$$(A.10) \quad \pi = \frac{(k_{m1} + k_{d1})}{(k_{m2} + k_{d2})} \frac{(1 - a_1 - b_1)}{p (1 - a_2 - b_2)}$$

Substituting the conditions given in (A.1) into this expression yields:

$$(A.11) \quad \pi = \left[ \frac{(1/um)a_1 + (1/ud)b_1}{(1/um)a_2 + (1/ud_2)b_2} \right] (1/p)$$

The bracketted expression represents the ratio of the total capital output ratio in sector 1 to the total capital output ratio in sector 2.

The inequality

$$(A.12) \quad \pi > 1/p$$

insures that a movement from  $T_1$  to  $T_2$  in Figure 1 will be accompanied by an increase in GDP per labor (measured at constant domestic prices). It is clear that a necessary and sufficient condition for the inequality

$$\pi > 1/p$$

is that the bracketted term in (A.11) exceed unity.

Appendix B

An Algebraic Analysis of Employment Change

Recall that commodity 1 is assumed to be the import-competing good. The output of this commodity per laborer,  $x_1$ , depends on the aggregate capital-labor ratio, the employment rate, the commodity price ratio, and the real wage (expressed in terms of commodity 2). Net imports of commodity 1 per laborer,  $z_1$ , are given by the equation

$$(B.1) \quad z_1 = c_1(y, w, 1/p) + (n + \delta) \bar{k} - x_1(1/p, e; \bar{k}, \bar{w}_2)$$

where

$$y = \bar{u}m_1 k + (ud_1 - \bar{u}m_1) k_d$$

and

$$w = w_1 e = p \bar{w}_2 e.$$

When factor proportions are held fixed,  $kd$  is uniquely determined by  $e$ .

From (1.8) and the identity

$$(B.2) \quad kd = e[\lambda kd_1 + (1 - \lambda) kd_2]$$

(where  $\lambda$  is the proportion of employed labor allocated to sector 1) a relationship between  $kd$  and  $e$  may be derived. We differentiate (1.8) and (B.2) totally and then solve for  $\frac{dkd}{de}$  with factor proportions constant.

This procedure yields

$$(B.3) \quad \frac{dkd}{de} = kd_2 - \frac{(kd_1 - kd_2)}{\epsilon - 1}$$

$$\text{where } \epsilon = \frac{km_1 + km_2}{kd_1 + kd_2}$$

If  $\epsilon > 1$ , then it can be shown that  $\frac{dkd}{de} > 0$  if  $\frac{km_1}{kd_1} > \frac{km_2}{kd_2}$ .

since factor proportions are determined by  $\bar{w}_2$  and  $p$ , we may write

$$(B.4) \quad kd = \Psi(e, 1/p, \bar{w}_2)$$

$$\Psi_e > 0$$

substituting (B.4) into (B.1) and noting that all factor prices are determined by  $\bar{w}_2$  and  $p$ , we obtain the expression

$$(B.5) \quad z_1 = z_1(e, 1/p; \bar{w}_2, \bar{k})$$

Denote the rest of the world's labor force by  $L^*$  and the rest of the world's net imports of commodity 2 per laborer by  $z_2^*$ . Assume, as in the standard literature, that  $z_2$  depends only on relative commodity prices. Then the balance of payments condition may be written as

$$(B.6) \quad Lz_1 - L^* pz_2^*(p) = 0$$

Differentiating this expression totally yields

$$(B.7) \quad \frac{\partial(Lz_1 - L^* pz_2^*)}{\partial p} \frac{dp}{dum} + L \frac{\partial z_1}{\partial e} \frac{de}{dum} = 0$$

It can be shown that

$$(B.8) \quad \frac{\partial(Lz_1 - L^* pz_2^*)}{\partial p} = L^* z_{2^*} (\eta_{2^*} + \eta_1 - 1)$$

where  $\eta_{2^*}$  is the absolute value of rest of the world price elasticity of demand for imports and  $\eta_1$  is the absolute value of home country's price elasticity of demand for imports with the employment rate and  $\bar{w}_2$  held constant. By substituting (B.8) into (B.7) and rearranging, we obtain

$$(B.9) \quad \frac{de}{d\bar{u}_{m1}} = \frac{-L^*z_{2^*} \cdot (\eta_{2^*} + r_{11} - 1) dP/d\bar{u}_{m1}}{L \partial z_1 / \partial e}$$

Denote the marginal propensity to consume commodity 1 out of wage income by  $M_{1w}$  and the marginal propensity to consume commodity 1 out of non-wage income by  $M_{1y}$ . These are the partial derivatives of (1.16) with respect to  $w$  and  $y$ . Denote the increase in the sector 1 share of aggregate output due to a rise in the employment rate (with factor prices constant) by  $\beta_{1e}$ . Thus the partial derivative of net imports per laborer with respect to the employment rate may be written as

$$(B.10) \quad \partial z_1 / \partial e = w_1 [M_{1w} - \beta_{1e}] + M_{1y} (u_{d1} - \bar{u}_{m1}) \psi_e$$

Since the total capital employment ratio is assumed to be higher in sector 1 than it is in sector 2,  $\beta_{1e}$  must be negative.

Therefore, if

$$(B.11) \quad u_{d1} - \bar{u}_{m1} > 0$$

and commodity 1 is not inferior in the sense that neither  $M_{1w}$  nor  $M_{1y}$  is negative, then

$$(B.12) \quad \partial z_1 / \partial e > 0$$

Under these conditions, it is clear that

$$(B.13) \quad \frac{de/\bar{u}_m}{d\bar{u}_{m1}} > 0 \quad \text{as} \quad (\eta_{2^*} + r_{11} - 1) > 0$$

for  $\frac{dP}{d\bar{u}_{m1}}$  has been shown to be negative.

See condition (2.10).

The requirement that the user cost of domestically-produced not be less than that of imported equipment is a sufficient but not necessary condition for (B.13) to hold. As long as the total capital employment ratio is higher in sector 1 than it is in sector 2, and commodity one is not in inferior condition

$$(B.14) \quad w_1 [M_{1w} - B_{1e}] > 0$$

will hold. Since the sign of  $dP/d\bar{u}_m$  does not depend on condition (B.11),  $de/d\bar{u}_m$  will be positive if the Marshall-Lerner condition is met and  $u_d$  is less than  $u_m$  provided that

$$(B.15) \quad w_1 [M_{1w} - B_{1e}] > M_{1y} (u_d - \bar{u}_m).$$

The assumption that the relatively labor intensive good is exported is not crucial. Provided that the share of labor in sector 2 is less than twice that of the labor share in sector 1, the increase in the output share of sector 2 due to an increase in the employment rate ( $\beta_{2e}$ ) will be greater than unity. See Kemp [3]. If the condition  $\partial > 1 / \partial e = w_1 (M_{2w} - B_{2e}) + M_{2y} (u_d - \bar{u}_m) \Psi_e < 0$  is met then it can be shown that

$$\frac{de}{\bar{u}_m} > 0$$

when commodity 2, the labor intensive good, is imported.

## BIBLIOGRAPHY

- [1] R. Brecher, "Minimum Wage Rates and the Pure Theory of International Trade," unpublished Ph.D. dissertation, Harvard University, 1971.
- [2] R. Brecher, "Minimum Wage Rates and the Pure Theory of International Trade," Growth Center Discussion Paper No. 140, Yale University, 1972.
- [3] M. Kemp, The Pure Theory of International Trade and Investment, Englewood Cliffs, New Jersey, Prentice Hall, 1969.
- [4] U. Korum, Ekonomik Modeller ve Turk Ekonomisi i Icin Bir Deneme, S.B.F. Yayinlari, No. 268, Ankara, 1969.
- [5] A. Krueger, Exchange Control, Liberalization and Economic Development: Turkey, National Bureau of Economic Research (unpublished manuscript).
- [6] I. Little, T. Scitovsky, M. Scott, Industry and Trade in Some Developing Countries--A Comparative Study, Oxford University Press, 1970.
- [7] J. McCabe and C. Michalopoulos, Investment Composition and Employment in Turkey, Agency for International Development, Discussion Paper No. 22, October, 1971.
- [8] H. Pack and M. Todaro, "Technological Transfer, Labor Absorption, and Economic Development," Oxford Economic Papers, November, 1969.
- [9] G. Ranis, "Some Observations on the Economic Framework for Optimum LDC Utilization of Technology," Economic Growth Center Discussion Paper No. 152, August 1972.
- [10] B. Yaser, "An Analysis of the Financial System in Turkey: 1949-1963," unpublished Ph.D. dissertation, Vanderbilt University, Nashville, Tennessee, August 1967.
- [11] Republic of Turkey: Prime Ministry, State Institute of Statistics, 1964 Census of Manufacturing Industries and Business Establishments: Manufacturing, Ankara, 1968.
- [12] International Monetary Fund, International Financial Statistics.
- [13] Pick's Currency Yearbook, Pick Publishing Corporation, New York.