Unilateral International Transfers and their Effects on the Welfare of the Recipient and ·Donor Countries

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This paper analyses impacts of unilateral income and capital transfers on welfare and terms of trade of the recipient and donor countries within a two-country framework. Introduction of the external economies of scale, helps in explicitly incorporating the differences in factor endowment between developed and developing economies in the analysis. The paper discusses the conditions under which unilateral capital transfer from a developed country may yield paradoxical result, i.e. immiserize the developing country, despite market stability. The analysis reinforces Brecher and Choudhri's analytical support to Singer-Prebisch thesis from a new angle.

I. INTRODUCTION

The impact of unilateral international transfers on the welfare levels and terms of trade of the countries concerned has been analysed extensively. In general, the interest had been in the conditions under which such transfers could harm a recipient country. In the context of developing economies, these findings have special relevance for countries like Pakistan, whose development process, to a large extent, depends on grants from developed economies. The results, in fact, cast serious doubts on the effectiveness of an aid-receiving policy. The transfer can be in the form of income (purchasing power) or capital (a productive resource). The focus, however, has been on the effect of income transfer. This paper highlights the difference in the impacts of these two type of transfers under different conditions.

According to the well-known Singer-Prebisch thesis (Singer, 1950, and Prebisch, 1959), less developed countries in the growing world economy suffer a welfare loss because of a secular decline in their international terms of trade for primary-product exports. This had been criticized on both theoretical and empirical

grounds.   Brecher and Choudhri (1982) supported the Singer-Prebisch thesis but cited the process of foreign investment as an additional factor responsible for the welfare loss of the less developed countries.   In this paper, we suggest yet another cause of welfare loss — external economies of scale in production within the context of a unilateral capital-transfer.

Earlier economists believed that the donor country suffered a net burden from unilateral income-transfer while the recipient country benefited from it, but were not agreed on the direction of the effect of terms of trade.   Leontief (1936) demonstrated that an international transfer of purchasing power can paradoxically immiserize the recipient country and enrich the donor country, through an improvement in the terms of trade (a secondary effect) for the donor.   Samuelson (1947, p. 29), however, showed that Leontief's paradoxes were related to the existence of multiple and unstable equilibria.[1]   Balasko (1978) has redefined Samuelson's argument within the framework of regular economies and draws a distinction between local and global versions of the paradox.   He has demonstrated that in a regular and smooth exchange economy with two agents and two commodities, it is necessary and sufficient (i) for the local transfer paradox to occur that the Walrasian equilibrium be locally unstable, and (ii) for the global transfer paradox to occur at a locally Walrasian stable equilibrium that there be multiple Walrasian equilibria.[2]

Brecher and Bhagwati (1982) have shown that market instability is not required for the immiserizing transfer from abroad when the transfer itself induces distortions.[3]   Johnson (1960) has shown that within a two-country framework, with one country disaggregated into groups, a transfer may yield paradoxical results. Komiya and Shizuki (1967) were the first to show that Johnson's result holds despite market stability.   Gale (1974), using a restrictive three-agent Walras-stable model with given endowments of goods and fixed coefficients in consumption, has shown that both donor and the recipient can benefit from the transfer, harming the third agent.[4]   Bhagwati, Brecher, and Hatta (1983a) have shown that the transfer paradoxes cannot arise even in the three-country framework if the recipient and

[1] See also Samuelson (1952, 1954), Johnson (1955, 1956, 1971, 1974), Mundell (1960, 1968 p. 17), Srinivasan and Bhagwati (1983), Jones (1970, 1975) and Kemp (1969). Postlewaite and Webb (1980) have shown that, if there is a transfer which simultaneously benefits the donor and harms the recipient, then there must be multiple equilibria after the transfer where the competitive equilibrium does not give the counterintuitive result.

[2] Polemarchakis (1983) has extended Balasko's analysis to a large number of goods and agents and show that the paradoxes are of interest only either in its local version or when Walrasian equilibrium is unique. Hatta (1984) has shown that in commodity framework conditions normality in consumption and stability are substitutes.

[3] Recently Kemp and Kojima (1985) has shown that the donor benefits and the recipient suffers despite market stability when the aid is tied.

[4] Yano (1983) has extended Gale's analysis into a fully general three country model allowing for substitutability in both production and consumption. Bhagwati, Brecher and Hatta (1983b, 1984), have also analysed the transfer problem in more than two country framework.

donor countries uniformly and jointly impose an optimal tariff policy against the third country, thus showing that the failure to eliminate a (foreign) distortion in the sense of Bhagwati (1971) is the source of Leontief transfer-paradoxes in the three-country case.

When capital (a productive resource) is involved in the transfer, the world supply as well as the demand curve may shift as observed by Caves and Jones (1977, p. 57). It is thus possible that both countries, together, may gain from the unilateral capital transfer. Lin (1983) has shown this to be a possibility when the countries involved in the transfer have different but linear homogeneous production functions, referred to as the Neo-Hecksher-Ohlin (N-H-O) framework. This, however, is not true in the context of Heckscher-Ohlin-Samuelson (H-O-S) framework where the countries are assumed to have identical and linear homogeneous production functions.

Using duality framework, first introduced into the welfare analysis of international trade theory by Hatta (1973, 1977), Takayama (1974), Chipman (1979), and most comprehensively by Dixit and Norman (1980) and Woodland (1982), this paper highlights the difference in the impacts of income and capital transfers under different conditions. This will be accomplished, first, by examining the effects of income transfer on terms of trade and welfare. The analysis shows that the qualitative impacts of an income transfer are independent of the underlying production structures in the countries. In the second stage, the effects of unilateral capital transfer will be analysed. It will be shown that, within the H-O-S framework, the qualitative impacts of unilateral income and capital transfers are identical.[5] Within the N-H-O framework, however, the impacts of the two types of transfers are different and a unilateral capital transfer will yield paradoxical result under certain conditions, i.e. it will immiserize the recipient country and enrich the donor country through changes in terms of trade.[6] Finally, extending the H-O-S framework, we will analyse the effects of a capital transfer from a developed country on the welfare of a developing country.

The paper establishes the conditions under which a capital transfer from a developed country may immiserize a developing country. The analysis explicitly takes account of the difference in factor endowment between countries, something that had not been done in any previous studies. The adoption of the dual approach helps in dealing with the issue in a general-equilibrium framework and enables us to analyse the effects of transfers on terms of trade and welfare levels simultaneously, thus permitting a unified and clear exposition of the theory.

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[5] For quantitative impacts to be identical, the amount of capital transfer must be such that it earns rental equal to the income transfer.

[6] Brecher and Choudhri (1982) first showed this. See also Lin (1983).

The paper is organized as follows. In Section II, we outline a model of the world economy without specifying the underlying production structures of the countries. In Section III, we discuss the stability of the model. Section IV contains an analysis of unilateral income-transfer. In Section V, the effects of unilateral capital-transfer are analysed. In Section VI, we extend the analysis of Section V to study the effects of capital transfer from a developed country on the welfare and terms of trade of a less developed recipient country. Section VII summarizes the results.

II. THE MODEL

The world is assumed to consist of two countries, country α and country β. Each produces and consumes two goods, which are produced with the help of capital and labour.

The following notations will be used in our model.

q	=	the relative price of good 1 (non-numeraire good);
u^i	=	the welfare level of country i $(i = \alpha, \beta)$;
T	=	the value of income transfer in terms of good 1 (the non-numeraire good);
k^i	=	the amount of capital stock in country i $(i = \alpha, \beta)$;
k^{0i}	=	the initial amount of capital stock in country i $(i = \alpha, \beta)$;
I	=	the amount of capital transfer;
$e^i(q, u^i)$	=	the expenditure function of country i $(i = \alpha, \beta)$;
$g^i(q, k^i)$	=	the GNP function of country i $(i = \alpha, \beta)$;
$z^i(q, u^i, k^i) =$		the compensated import demand function for good 1 (the non-numeraire good) for country i $(i = \alpha, \beta)$. It is positive (negative) as country i imports (exports) goods 1;
$x^i(q, u^i)$	=	the compensated demand function for good 1 (the non-numeraire good) for country i $(i = \alpha, \beta)$;
$y^i(q, k^i)$	=	the output supply function for good 1 (the non-numeraire good) for country i $(i = \alpha, \beta)$; and
$c^i(q, u^i, k^i) =$		$e^i(q, u^i) - g^i(q, k^i)$ the overspending function[7] for country i $(i = \alpha, \beta)$.

We adopt the notational convention that small letters with superscripts α and β denote variables of country α and country β, respectively. If country α gives part

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[7]This term is due to Bhagwati, Brecher and Hatta (1983).

of its income (T) and capital (k) to country β, then the international equilibrium under the two types of transfers is characterized by the following equations:

$$c^{\alpha}(q, u^{\alpha}, k^{\alpha}) + T = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (2.1)$$

$$c^{\beta}(q, u^{\beta}, k^{\beta}) - T = 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (2.2)$$

$$z^{\alpha}(q, u^{\alpha}, k^{\alpha}) + z(q, u^{\beta}, k^{\beta}) = 0 \qquad \ldots \qquad \ldots \qquad \ldots \quad (2.3)$$

$$k^{\alpha} = k^{0\,\alpha} - I \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (2.4)$$

$$k^{\beta} = k^{0\,\beta} + I \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (2.5)$$

Equations (2.1) and (2.2) are the budget constraints for country α and country β, respectively. Equation (2.3) is the market equilibrium condition for the non-numeraire good. In the absence of taxes, both countries face an identical relative commodity price, q, of the non-numeraire good. The capital stock in country α and β is determined by Equations (2.4) and (2.5), respectively. Equations (2.1) to (2.3), with $I = 0$, represent the model of the world economy with unilateral income-transfer. It will be referred to as the *Income-Transfer Model of the World Economy*. Similarly, the model described by Equations (2.1) to (2.5), with $T = 0$, represents the model of the world economy with a unilateral capital-transfer. It will be referred to as the *Capital Transfer Model of the World Economy*. The derivation of the model is based on the work of Dixit and Norman (1980, pp. 128–136) and Woodland (1982, pp. 296–298), and also of Lin (1983) who used an extended version of Dixit's Model.

Throughout the paper, subscripts refer to the derivative of the function with respect to the particular variable. The own-price derivative of the world's compensated excess import demand function will be defined as $z_q = z_q^{\alpha} + z_q^{\beta}$. It will be further assumed that (i) $e_u^{\alpha} = e_u^{\beta} = 1$, without loss of generality, (ii) the non-numeraire good is capital-intensive in both countries, and (iii) factor-intensity reversal does not occur.

III. THE STABILITY ANALYSIS

In this section, we discuss what Walrasian stability means in our model and prove that assumption of stability implies a negative Jacobian of Equations (2.1) – (2.5) with respect to the variables u^{α}, u^{β} and q.

In the model described by Equations (2.1) to (2.5), the world-market equilibrium condition, i.e. Equation (2.3), is expressed in terms of the compensated import-demand functions. The Walrasian stability conditions, however, is defined for the

ordinary (or uncompensated) demand functions. Therefore, we define $\bar{z}$, the uncompensated import-demand function, as

$$\bar{z}^i(q, k^i) = \bar{x}^i(q) - y^i(q, k^i) \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3.1)$$

where $\bar{x}^i(q)$ is the uncompensated demand function for the non-numeraire good and $i = \alpha, \beta$. If the indirect function is substituted for u^i in $z^i(\cdot)$, it can be readily seen that $\bar{z}^i(\cdot)$ and $z^i(\cdot)$ are equivalent.

In the world market, commodity prices adjust in response to the excess demand until an equilibrium is reached. Let $\dot{q}$ denote the derivative of q with respect to time, and let

$$\bar{z}(q) \equiv \bar{z}^\alpha(q) + \bar{z}^\beta(q) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3.2)$$

be the world's uncompensated excess import demand function for the non-numeraire good. In the Equation (3.2), k^α and k^β are suppressed because they are kept constant in this section. The adjustment process for the non-numeraire good can then formally be written as

$$\dot{q} = f(z) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3.3)$$

where $z = \bar{z}(q)$ and f is a differentiable sign-preserving function of z satisfying $f(0) = 0$. Under this adjustment process, whenever there is excess import demand for the non-numeraire good its relative price, q, increases. Thus Equations (2.1), (2.2), (2.4), (2.5), and (3.3) represent the model of the world economy when it is out of equilibrium. The equilibrium of this economy has to be the equilibrium of Equation (3.3) since $z = 0$ follows from Equation (2.3). For given I and T the adjustment process, Equation (3.3), gives rise to the following differential equation.

$$\dot{q} = h(q) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3.4)$$

Definition: An equilibrium of the world economy is Walras-stable if it is a locally stable equilibrium of Equation (3.4) and if the first-order derivative of $h(q)$ does not vanish.

Local stability of Equation (3.4), together with the condition that the first-order derivative of $h(q)$ does not vanish, implies that $dh(q)/dq$ is negative. Thus stability condition for the world economy is written as

$$d\bar{z}/dq < 0 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3.5)$$

Theorem 1: If an equilibrium of the world economy is Walras-stable, then

$$
\Delta \equiv
\begin{vmatrix}
1 & 0 & z^\alpha \\
0 & 1 & z^\beta \\
x_m^\alpha & x_m^\beta & z_q
\end{vmatrix}
< 0
$$

Proof: See Appendix I

Note that the Jacobian Δ is the determinant of the system of Equations (2.1) – (2.5) with respect to the variables u^α, u^β and q. Determining that at a stable equilibrium of the world economy Δ is negative is nothing but the Marshall-Lerner condition.

IV. THE EFFECTS OF A UNILATERAL INCOME-TRANSFER

We now examine the impact of an exogenous increase in T upon the variables u^α, u^β and q. To facilitate exposition, the total effect of an exogenous increase in T on the welfare levels of the countries will be decomposed into two components, namely the primary effect and the terms-of-trade effect. The presence of the terms-of-trade effect either reinforces or weakens the primary effect of a change in T at a Walrasian-stable equilibrium of the world economy.

Consider the income-transfer model of the world economy described by Equations (2.1) – (2.3) with $I = 0$. It has three equations to determine three variables, u^α, u^β and q, and one parameter, T. We write the solution function as

$$
u^i = \upsilon^i(T) \qquad i = \alpha, \beta \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.1)
$$

$$
q = q^*(T) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.2)
$$

where k^α and k^β are suppressed because they remain constant throughout this section.

Lemma 1: The following relations hold in the income-transfer model of the world economy.

$$
\Delta \cdot \frac{du^\alpha}{dT} = -z_q \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.3)
$$

$$
\Delta \cdot \frac{du^\beta}{dT} = z_q \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.4)
$$

$$\Delta \cdot \frac{dq}{dT} = x_m^\alpha - x_m^\beta \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.5)$$

Proof: Taking the total differential of Equations (2.1) to (2.3), from which Equations (4.1) and (4.2) are derived, and using the properties of the expenditure and the GNP functions, we get the following matrix form:

$$\begin{bmatrix} 1 & 0 & z^\alpha \\ 0 & 1 & z^\beta \\ x_m^\alpha & x_m^\beta & z_q \end{bmatrix} \begin{bmatrix} du^\alpha \\ du^\beta \\ dq \end{bmatrix} = \begin{bmatrix} -1 \\ 1 \\ 0 \end{bmatrix} dT$$

Applying Cramer's rule and using the fact that $z^\beta = -z^\alpha$, we get relations (4.3) to (4.5).   *Q.E.D.*

The term $x_m^\alpha - x_m^\beta$ represents the gap in marginal propensity to spend on the non-numeraire good between country α and country β. This is also referred to as the "consumption effect" of income transfer on international terms of trade. Similarly, as z_q is the own-price derivative of the world's compensated imported-demand function, it is termed the "consumption effect" of income transfer on welfare levels. If country β imports the non-numeraire good, i.e. $z^\beta > 0$, an income transfer will improve its terms of trade if its initial imports are cheaper at the new prices, i.e. $z^\beta, dq/dT < 0$.

Theorem 2 (Samuelson-Mundell): At a Walras-stable equilibrium of the world economy, an exogenous increase in unilateral income-transfer (i) improves (deteriorates) the terms of trade for the recipient country if that country imports the non-numeraire good and, compared with the donor country, has smaller (higher) marginal propensity to spend on the non-numeraire good, and (ii) immiserizes the donor country and enriches the recipient country.

Proof: We know that z_q, the own-price derivative of the world's compensated import-demand function for the non-numeraire good, is always negative. Also, $\Delta < 0$ at a Walrasian-stable equilibrium of the world economy. Therefore, from Lemma 1 we have

(i) $\dfrac{dq}{dT} \underset{>}{\overset{\leq}{}} 0$ according as $x_m^\alpha \underset{<}{\overset{\geq}{}} x_m^\beta$

(ii) $\dfrac{du^{\alpha}}{dT} < 0$

(iii) $\dfrac{du^{\beta}}{dT} > 0$ $\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ *Q.E.D.*

As the impacts of an income transfer on terms of trade and welfare do not involve changes in the world supply of the non-numeraire good, it suggests that the qualitative impacts of an income transfer are independent of the underlying production structure in the two countries.

If the change in world's potential welfare[8] is defined as $e_u^{\alpha} du^{\alpha} + e_u^{\beta} du^{\beta}$, then by adding Equations (4.3) and (4.4) it can be easily demonstrated that a unilateral income-transfer leaves the world's welfare, i.e. the aggregate Gross National Product (GNP) measured in initial prices, unaltered.

A change in the unilateral income-transfer affects the welfare levels of country α and country β both directly through T, referred to as the Primary (Pr) effect, and indirectly through q, referred to as the Terms of Trade (TOT) effect, the secondary effect. For an economic interpretation of Equations (4.3) and (4.4) in terms of the Pr effect and the TOT effect, we divide the income-transfer model of the world economy into two sub-models. From Equations (2.1) and (2.2), which describe our first sub-model, the solution for u^{α} and u^{β} can be expressed as functions of (T, q). In particular, we write the solution function as

$$u^i = v^i(T, q) \qquad i = \alpha, \beta \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.6)$$

where k^{α} and k^{β} are suppressed as they are kept constant in this section. If we substitute the value of q from Equation (4.2) in Equation (4.6), the $v^i(\cdot)$ obtained must be identical to $v^i(\cdot)$ in Equation (4.1), i.e.

$$v^i = v^i(T, q^*(T)) \qquad i = \alpha, \beta \qquad \ldots \qquad \ldots \qquad \ldots \quad (4.7)$$

Differentiating Equation (4.7) with respect to T, we get the following decomposition.

$$\underbrace{\frac{dv^i}{dT}}_{\text{Total effect}} = \underbrace{\frac{\partial v^i}{\partial T}}_{\text{Pr effect}} + \underbrace{\frac{\partial v^i}{\partial q}\frac{dq}{dT}}_{\text{TOT effect}} \quad \ldots \quad (4.8)$$

The first term on the right-hand side of Equation (4.8), i.e. $\partial v^i / \partial T$, the Pr effect, represents the change in the level of welfare due to a change in the income

[8] Dixit and Norman (1980) refer to this as simply a change in welfare.

transfer, at constant terms of trade. Its sign can be determined by differentiating Equations (2.1) and (2.2) with respect to T while holding $dq = 0$. As the Pr effect involves nothing but the transfer of income from one country to another, it is always positive (negative) for the recipient (donor) country, i.e.

$$\frac{\partial v^\alpha}{\partial T} < 0 \text{ and } \frac{\partial v^\beta}{\partial T} > 0 \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (4.9)$$

The Pr effect is nothing but an outward (inward) shift of the budget constraint in the recipient (donor) country. Since the market-clearing equation has not been taken into account, the Pr effect does not depend on whether the market for the non-numeraire good is in or out of the equilibrium.

The second term on the right-hand side of the decomposition, i.e. the TOT effect, contains $\partial v^i / \partial q$. This corresponds to a change in the welfare induced by an exogenous change in the price of the non-numeraire good. Its sign can be determined by differentiating Equations (2.1) and (2.2) with respect to q while keeping $dT = 0$. If country β imports the non-numeraire good, i.e. $z^\beta > 0$, then the following is true:

$$\frac{\partial v^\alpha}{\partial q} > 0 \text{ and } \frac{\partial v^\beta}{\partial q} < 0 \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (4.10)$$

i.e. an exogenous increase in the price of the non-numeraire good increases (decreases) the welfare of the country exporting (importing) the non-numeraire good.

We know from Theorem 2 that the impact of a change in T on the welfare of country β (country α) is always positive (negative). This indicates that, at a stable equilibrium of the world economy, the Pr effect of an income transfer always dominates the TOT effect. We know further that at a stable equilibrium of the world economy dq^*/dT is negative (positive) as $x_m^\alpha > x_m^\beta$ ($x_m^\alpha < x_m^\beta$). Note that $x_m^\alpha < x_m^\beta$ implies $dq^*/dT > 0$, i.e. the non-numeraire good becomes dearer. Thus when country β imports the non-numeraire good, i.e. $z^\beta, > 0$, the TOT effect works against it by decreasing the benefits from the transfer, and in favour of country α by decreasing the burden of an income transfer. In other words, the TOT effect weakens the Pr effect. In case $x_m^\alpha > x_m^\beta$, the Pr effect is reinforced by the TOT effect. In the special case when $x_m^\alpha = x_m^\beta$ or when the recipient country is small and it cannot influence the international commodity prices, the TOT effect does not matter, i.e. $dq/dT = 0$.

V. THE EFFECTS OF A UNILATERAL CAPITAL-TRANSFER

This section examines the effects of a change in I on the variables u^α, u^β and q. Throughout the section, all the results will be stated under the assumption that the

recipient country imports the non-numeraire capital-intensive good. Consider the capital-transfer model of the world economy described by Equations (2.1) to (2.5) with $T = 0$. It determines three variables u^α, u^β and q. Each variable can be solved in terms of the parameter I. In particular, we write the solution functions as

$$u^i = v^i(I) \qquad i = \alpha, \beta \qquad \dots \qquad \dots \qquad \dots \qquad \dots \quad (5.1)$$

$$q = q^*(I) \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \quad (5.2)$$

Lemma 2: The following relations hold in the capital-transfer model of the world economy:

$$\Delta . \frac{dq}{dI} = (x_m^\alpha . r^\alpha - x_m^\beta . r^\beta) + (y_k^\beta - y_k^\alpha) \qquad \dots \qquad \dots \quad (5.3)$$

$$\Delta . \frac{du^\alpha}{dI} = -r^\alpha . z_q + z^\beta \left[x_m^\beta . (r^\alpha - r^\beta) + (y_k^\beta - y_k^\alpha) \right] \qquad \dots \quad (5.4)$$

$$\Delta . \frac{du^\beta}{dI} = -\left[-r^\beta . z_q + z^\beta \left[x_m^\alpha . (r^\alpha - r^\beta) + (y_k^\beta - y_k^\alpha) \right] \right] \quad \dots \quad (5.5)$$

Proof: Taking the total differential of Equations (2.1) to (2.5) from which equations (5.1) and (5.2) are derived and using properties of the expenditure and the GNP functions, we get the following matrix form

$$\begin{bmatrix} 1 & 0 & z^\alpha \\ 0 & 1 & z^\beta \\ x_m^\alpha & x_m^\beta & z_q \end{bmatrix} \begin{bmatrix} du^\alpha \\ du^\beta \\ dq \end{bmatrix} = \begin{bmatrix} -r^\alpha \\ r^\beta \\ y_k^\beta - y_k^\alpha \end{bmatrix} dI$$

Applying Cramer's rule and using the fact that $z^\beta \equiv -z^\alpha$, we get relations (5.3) to (5.5). *Q.E.D.*

We already know that (i) Δ, the Jacobian of Equations (2.1) to (2.5) with respect to the variables u^α, u^β and q, is negative at a Walras-stable equilibrium of the world economy, (ii) z_q, the own-price derivative of the world's compensated import-demand function, is always negative, (iii) z^β is positive (negative) as a country β imports (exports) the non-numeraire good, and (iv) x_m^i ($i = \alpha, \beta$), the marginal propensity to spend on the non-numeraire good, is always positive in both countries as long as it is normal. Thus the impact of a unilateral capital-transfer on the terms of

trade and welfare levels of the countries involved in the transfer depends on the signs of $r^\alpha - r^\beta$ and $y_k^\beta - y_k^\alpha$.

The term $r^\alpha - r^\beta$ is the gap in the return on capital between country α and country β. The term $y_k^\beta - y_k^\alpha$, on the other hand, corresponds to a change in the world supply of the non-numeraire good induced by a unilateral capital-transfer, at hypothetically constant terms of trade. This is the "production effect" of capital transfer. Taken individually, y_k^α and y_k^β are the Rybczynski effects in country α and country β respectively. As $y_k^i \equiv g_{kq}^i \equiv \partial r^i / \partial q$, y_k^i also represents the Stopler-Samuelson effect on the price of capital of a change in the price of the non-numeraire good in country i. Consequently, $y_k^\beta - y_k^\alpha = \partial(r^\beta - r^\alpha)/\partial q$ is also the change in the gap between the prices of capital in country α and country β induced by a change in the price of the non-numeraire good.

A. The Effect of Capital Transfer on Terms of Trade

A unilateral transfer of capital from country α to country β improves the latter country's terms of trade if its initial imports are cheaper at the new price, i.e. $z^\beta \, dq/dI < 0$. If country β imports the non-numeraire good, i.e. $z^\beta > 0$, the necessary and sufficient condition for a capital transfer to improve its terms of trade is

$$(x_m^\alpha \, r^\alpha - x_m^\beta \, r^\beta) + (y_k^\beta - y_k^\alpha) > 0$$

The term $x_m^\alpha \, r^\alpha$ is the unit change in demand in country α induced by the capital transfer. Similarly, $x_m^\beta \, r^\beta$ is the unit change in demand in country β. Thus $x_m^\alpha \, r^\alpha - x_m^\beta \, r^\beta$ is the net change in aggregate demand induced by one dollar's worth of capital transferred from country α to country β. We will refer to this as the consumption (or demand) effect on the terms of trade. When production functions are linear homogeneous and identical between countries, as in the standard H-O-S framework, and factor prices are equalized, Equation (5.3) reduces to

$$\Delta \cdot \frac{dq}{dI} = r^\alpha \cdot (x_m^\alpha - x_m^\beta) \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (5.6)$$

since $y_k^\alpha = y_k^\beta$ and $r^\alpha = r^\beta$. Comparing Equation (4.3) with Equation (5.6), it is obvious that the qualitative impact of income and capital transfers on the terms of trade are identical in the standard H-O-S framework.

In general, the signs of $y_k^\beta - y_k^\alpha$ and $x_m^\alpha \, r^\alpha - x_m^\beta \, r^\beta$ can not be determined without the knowledge of the underlying production structures in the two countries. Thus we have the following theorem.

Theorem 3: At the Walras-stable equilibrium of the world economy, a set of sufficient conditions for a capital transfer to improve the terms of trade of country β is

(i) $z^\beta > 0$, i.e. country β imports the non-numeraire good; (ii) $y_k^\beta - y_k^\alpha \geqslant 0$, i.e. the capital transfer increases the world supply of the non-numeraire good; (iii) $x_m^i \geqslant 0$ ($i = \alpha, \beta$), i.e. the non-numeraire good is normal in both countries; (iv) $x_m^\alpha \geqslant x_m^\beta$, i.e. country β has a lower marginal propensity to spend on the non-numeraire good than country α; and (v) $r^\alpha \geqslant r^\beta$, i.e. country α has a higher return on capital than country β.

Proof: The proof follows from Equation (5.3).

If any of the inequalities in conditions (i) through (v) of Theorem 3 is reversed, then it is possible that the unilateral capital-transfer may improve the terms of trade of country α (the donor country). This has been shown by Brecher and Choudhri (1982) and Lin (1983) within the N-H-O framework. Throughout it is implicitly assumed that both countries have identical factor intensities, i.e. the non-numeraire good is capital- or labour-intensive in both countries. In the event of a factor-intensity reversal, if $y_k^\alpha < 0$ and $y_k^\beta > 0$, condition (ii) is always satisfied.

B. The Effect of Capital Transfers on Welfare

1. The Case of Reinforcing Terms of Trade Effect

A change in the unilateral capital-transfer affects the welfare levels of country α and country β both directly through I, referred to as the Pr effect, and indirectly through q, referred to as the TOT effect. For an economic interpretation of Equations (5.4) and (5.5) in terms of the Pr effect and the TOT effect, we divide the capital-transfer model of the world economy into two sub-models exactly as was done for income transfer. From Equations (2.1) and (2.2) with $T = 0$, which describe our first sub-model, the solution for u^α and u^β can be expressed as a function of (I, q). In particular, we write the solution functions as

$$u^i = v^i(I, q) \quad i = \alpha, \beta \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5.7)$$

If we substitute the value of q from Equation (5.2) in Equation (5.7), the $v^i(\cdot)$ obtained must be identical to $\dot{v}^i(\cdot)$ in Equation (5.1), i.e.

$$\dot{v}^i(I) = v^i(I, q^*(I)) \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5.8)$$

Differentiating Equation (5.8) with respect to I, we get the following decomposition.

$$\underbrace{\frac{dv^i}{dI}}_{\text{Total effect}} = \underbrace{\frac{\partial v^i}{\partial I}}_{\text{Pr effect}} + \underbrace{\frac{\partial v^i}{\partial q}\frac{dq}{dI}}_{\text{TOT effect}} \quad \ldots \quad (5.9)$$

The first term on the right-hand side, i.e. $\partial v^i / \partial I$ the Pr effect, represents the change in the level of welfare strictly due to a unilateral capital-transfer at constant terms of trade. Its sign can be determined by differentiating Equations (2.1) and (2.2) with respect to I. As the Pr effect involves nothing but the transfer of capital from one country to another, it is always negative (positive) for country α (country β), i.e.

$$\frac{\partial v^\alpha}{\partial I} < 0 \text{ and } \frac{\partial v^\beta}{\partial I} > 0 \dots \qquad \dots \qquad \dots \qquad \dots \quad (5.10)$$

The Pr effect can also be regarded as the effect of growth in the ith country on its welfare when international prices do not change. In other words, it is the outward (inward) shift of the production-possibility frontier in country β (country α). Note that since Equation (2.3) has not been taken into account, the Pr effect does not depend on whether the market for the non-numeraire good is in or out of equilibrium.

The second term on the right-hand side of the decomposition, i.e. the TOT effect, contains $\partial v^i / \partial q$. This corresponds to the change in welfare induced by an exogenous change in the price of non-numeraire good. We know from Equation (4.10) that if country β imports the non-numeraire good,

$$\frac{\partial v^\alpha}{\partial q} > 0 \text{ and } \frac{\partial v^\beta}{\partial q} < 0$$

Thus from the decomposition (5.9) and Equations (4.10) and (5.10) it can be shown that the impact of a capital transfer on welfare levels depends on (i) the direction of the change in international terms of trade induced by capital transfer, and (ii) the relative magnitude of the Pr effect and the TOT effects. Note that when country β imports the non-numeraire good, an improvement in its terms of trade, i.e. $dq/dI < 0$, reinforces the positive (negative) impact of the Pr effect on the welfare level of country β (country α). In other words, an improvement induced by capital transfer in the terms of trade of country β (the recipient country) ensures that a capital transfer will always benefit the recipient country and harm the donor country.

2. The Case of Countervailing Terms-of-Trade Effect

In the event that country β experiences a deterioration in its terms of trade, i.e. $dq/dI > 0$, the transfer-induced gain and/or loss is/are not so straightforward. The following theorem shows, however, that the improvement in the welfare of country β can be consistent with its terms-of-trade deterioration.

Theorem 4: At the Walras-stable equilibrium of the world economy, a set of sufficient conditions for a capital transfer to enrich country β and immiserize country α is (i) $z^\beta > 0$, (ii) $y_k^\beta \geqslant y_k^\alpha$, (iii) $x_m^i \geqslant 0$, and (iv) $r^\alpha \geqslant r^\beta$.

Proof: The proof follows from Equations (5.4) and (5.5).

If any of the above conditions fails to hold, there is a possibility that a capital transfer may give paradoxical results, i.e. country α may get enriched and country β may become immiserized. Note that conditions (i) through (iv) of Theorem 4 are identical to conditions (i) through (iii) and (v) of Theorem 3. This shows that (a) an improvement in the terms of trade of country β always implies an improvement in its welfare and (b) an improvement in welfare is consistent with the terms-of-trade deterioration. This can alternatively be seen from the following equations obtained by substituting Equation (5.3) in Equations (5.4) and (5.5).

$$\frac{du^\alpha}{dI} = -r^\alpha - z^\alpha \cdot \frac{dq}{dI}$$

$$\frac{du^\beta}{dI} = r^\beta + z^\beta \cdot \frac{dq}{dI}$$

A transfer-induced improvement in the terms of trade of the recipient country, i.e. $z^\beta \cdot \frac{dq}{dI} < 0$ and $z^\alpha \cdot \frac{dq}{dI} > 0$, implies unambiguous increase (decrease) in the welfare of the recipient (donor) country. In case the transfer deteriorates the terms of trade of the recipient country, i.e. $z^\beta \cdot \frac{dq}{dI} > 0$ and $z^\alpha \cdot \frac{dq}{dI} < 0$, the welfare of the recipient (donor) country may still increase (decrease) as long as the rental earned (forgone) on the transferred capital is enough to compensate for the loss (gain) due to the terms of trade.

When factor prices are equalized in the standard H-O-S framework, Equations (5.4) and (5.5) reduce to

$$\Delta \cdot \frac{du^\alpha}{dI} = r^\alpha \cdot z_q \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots \quad (5.11)$$

$$\Delta \cdot \frac{du^\beta}{dI} = -r^\alpha \cdot q_q \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots \quad (5.12)$$

Since $y_k^\alpha = y_k^\beta$ and $r^\alpha = r^\beta$, comparing Equations (5.11) and (5.12) with Equations (4.3) and (4.4) respectively, we find that the qualitative impacts of a unilateral income and capital transfer on the welfare levels of each country are identical in the standard H-O-S framework.

So far it has been assumed that the non-numeraire good is capital-intensive in both countries. When factor intensities are different, condition (ii) may not hold. If, however, the non-numeraire good is labour-intensive in country α, i.e. $y_k^\alpha \leqslant 0$, and capital-intensive in country β, i.e. $y_k^\beta > 0$, condition (ii) always holds. Theorem 4 is essentially an extension of Lin's analysis to the case in which production functions are not necessarily linear homogeneous or identical.

As mentioned earlier, a capital transfer can change the world's aggregate GNP measured in the initial prices. This can be determined by adding Equations (5.4) and (5.5).

$$(du^\alpha + du^\beta) = -(r^\alpha - r^\beta) dI \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (5.13)$$

The term within the parentheses on the left-hand side is the change in the world's potential welfare, as already defined. A capital transfer from country α to country β will increase, leave unchanged, or decrease the world's potential welfare according as the rental rate in country β is greater than, equal to, or less than that in country α.

VI. CAPITAL TRANSFER AND IMMISERIZATION OF A DEVELOPING COUNTRY

The analysis presented in the preceding section is based on a rather general framework. The relevance of the results to specific situations is thus not clear. For example, the debate over the impact of capital transfer is more relevant and interesting in the context of a developed country transferring part of its capital to a developing country. There is nothing in the framework that clearly distinguishes a developed country from a developing country. The majority of the developing countries can be characterized as exporting mostly primary products and having smaller capital-labour ratio than those obtaining in developed countries.

Within the N-H-O framework, Brecher and Choudhri (1982) have analysed the impact of foreign investment, which includes a unilateral capital-transfer, on the welfare of a developing country.[9] They have demonstrated that if the primary-product exports of the developing countries are capital-intensive, then the process of foreign investment can immiserize the developing country through a deterioration of their terms of trade.[10] While their analysis does take into account some features of the developing countries' structure by considering nature of their exports, the results depend critically on the factor intensity of the developing countries' exports, which

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[9] Lin (1983) has extended Brecher and Choudhri's analysis by also examining the impact of the foreign investment on the welfare of the investing (donor) country.

[10] As noted by Brecher and Choudhri, their analysis is an alternative interpretation to the Singer-Prebisch thesis.

is unobservable. Also, the evidence suggesting that the primary-product exports of the developing countries are capital-intensive is not very convincing. In this section, by extending the familiar H-O-S framework, an attempt is made to incorporate explicitly the differences in factor endowment, an observable phenomenon, between the two countries. This makes the framework more realistic, especially in the context of developing versus developed countries. Later we will analyse the effects of capital transfer from a developed country on the welfare of a developing recipient country.

In the subsequent discussion we assume the following:

(i) The production of the first commodity in both countries generates external economies of scale, and the industrial production function is homothetic; and

(ii) The second commodity is produced by linear homogeneous production function.

These assumptions directly affect the terms $r^\alpha - r^\beta$, i.e. the gap in the return on capital between country α and country β, and $y_k^\beta - y_k^\alpha$, i.e. change in the world supply induced by the capital transfer, in Equations (5.3) through (5.5). Taken individually, y_k^α and y_k^β represent the change in the output of y, the non-numeraire good, in country α and country β, respectively, at hypothetically constant terms of trade induced by a change in capital stock. When industrial production functions are linear homogeneous, the sign of y_k^i ($i = \alpha, \beta$) follows directly from the Rybczynski theorem, i.e. y_k^i ($i = \alpha, \beta$) is positive (negative) as y, the non-numeraire good, is capital (labour)-intensive relative to the other good.

In the standard H-O-S trade theory, which assumes a constant-return-to-scale (CRS) technology, factor prices depend only on commodity prices which are determined in the international market. In other words, there exists a one-to-one relationship between factor and commodity prices. Thus, when free commodity-trade equalizes factor prices, i.e. $r^\alpha - r^\beta = 0$, capital transfer does not alter the world supply. This, however, is not true under non-CRS technology. The presence of external economies of scale, which imply industrial production functions exhibiting increasing returns to scale (IRS), complicates the analysis, firstly because the relationship between factor and commodity prices is no longer one-to-one and secondly because the output-factor endowment relationship, i.e. the Rybczynski theorem, is not so straightforward.

In the presence of production externalities, the production structure of a closed economy producing two goods, using two factors of productions, has been analysed by Jones (1968), Kemp (1969), Panagariya (1980), and Burney (1985), assuming perfect competition and full employment. The analyses show that, in the presence of production externalities, factor prices also depend on factor endowments

and degrees of production externalities in addition to the commodity prices. For a closed economy producing two goods, when the production of the first commodity generates external economies of scale and the second is produced by CRS production function, Burney (1985) has examined the relationship between factor prices and factor endowments.[11]   It has been shown that at a Marshall-stable equilibrium of such an economy,[12]

$$D. \frac{dr}{dk} = -(\ell^2)^2 \, c_y^1 > 0 \quad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (6.5)$$

where D is the Jacobian of Equations (1) through (4) given in the Appendix, with respect to the variables Y^1, Y^2, w and r. It is positive at a Marshall-stable equilibrium of the economy.   For proof, the readers are referred to Burney (1985).   The term c_y^1 represents change in the unit cost of producing first commodity induced by a change in the industrial output. It is negative when production of Y^1 generates external economies of scale.

As already indicated, in the presence of production externalities, the Rybczynski theorem is not so straightforward.   Thus it is not clear whether y_k^i ($i = \alpha, \beta$) is positive or negative even when factor intensity is known. Hence, it is difficult to give any sign to the term $y_k^\beta - y_k^\alpha$. Burney (1985), however, has shown that if the equilibrium of the closed economy is Marshall-stable, the Rybczynski theorem continues to hold even in the presence of production externalities, i.e. in an economy producing goods-generating production externalities, y_k is positive (negative) as good y is capital (labour)-intensive relative to the other good, provided the equilibrium of such an economy is Marshall-stable.

Following the H-O-S framework, we assume that for each industry the production function is identical between country α and country β. Thus both countries have identical and homothetic production functions which are not necessarily linear homogeneous.   This assumption will be referred to as the *Similarity Condition* or Condition *S.*   Since production functions are assumed to be homothetic instead of being linear homogeneous, as in the H-O-S framework, the model of the world economy satisfying condition *S* is an extension of the H-O-S framework.

Let $\kappa = k/L$ be the capital-labour ratio, then $\frac{dr}{dk} > 0$ implies that $\frac{dr}{d\kappa} > 0$, i.e. there exists a positive relationship between return on capital and capital-labour ratio in an economy where the production of one commodity generates external economies of scale and the other exhibits CRS technology.[13]   This suggests that under a free commodity-trade, a country with higher capital-labour ratio will have

[11] For a brief description of the model see Appendix-II.
[12] In the standard H-O-S or N-H-O framework dr/dK = 0.
[13] See also Laing (1961) and Panagariya (1983).

higher return on capital. In the subsequent discussion we assume that, in the model of the world economy satisfying condition S, country α is capital-abundant compared with country β which is labour-abundant. This assumption may be expressed by $\kappa^\alpha > \kappa^\beta$. We will further assume that each country exports the commodity which uses its abundant factor more intensively and imports the commodity which uses its scarce factor more intensively, i.e. country α imports labour-intensive good and country β imports capital-intensive good. We label country α, which is capital-abundant and exports capital-intensive goods, a developed country and country β, which is labour-abundant and imports capital-intensive goods a developing country. It follows that in the model of the world economy satisfying condition S, the developed country will have a higher return on capital than the developing country under free trade, i.e.

$$r^\alpha - r^\beta > 0,$$

provided equilibria of the developed and the developing countries are Marshall-stable.

We now analyse the impact of a unilateral capital-transfer from a developed country on the welfare of a developing country. Unless otherwise stated, it will be assumed throughout that the non-numeraire good y is capital-intensive. It has been shown in the previous section that a unilateral transfer can immiserize the recipient country only through a deterioration of her terms of trade. From Theorem 3 we know that at a Walras-stable equilibrium of the world economy a set of sufficient conditions for capital transfer to improve the terms of trade of the recipient country is (i) $z^\beta > 0$, (ii) $y_k^\beta - y_k^\alpha \geqslant 0$ (iii) $x_m^i \geqslant 0$ $(i = \alpha, \beta)$, (iv) $x_m^\alpha \geqslant x_m^\beta$, and (v) $r^\alpha \geqslant r^\beta$ As each term has already been explained in the previous section, the explanation is not being repeated.

In the model of the world economy satisfying condition S, as the developing country imports capital-intensive goods and has a lower return on capital than is obtained by the developed country, conditions (i) and (v) of Theorem 3 are automatically satisfied. However, in order to establish a meaningful factor-reward-endowment relationship and to rule out perversity in output-factor-endowment relationship, in the presence of production externalities, Marshallian stability has to be introduced into the framework. Assuming (i) normality in consumption in both countries and (ii) a taste bias in the developed country in favour of capital-intensive good or $x_m^\alpha \geqslant x_m^\beta$, i.e. a higher marginal propensity to spend on the capital-intensive non-numeraire good in the developed country than in the developing country, we arrive at the following theorem.

Theorem 5: At the Walras-stable equilibrium of the world economy satisfying condition S, if the equilibrium of each country is Marshall-stable, then a capital transfer

from the developed country will improve the terms of trade of the developing country provided the transfer increases the world supply of the non-numeraire good, i.e. $y_k^\beta - y_k^\alpha \geqslant 0$.

Since in a two-country framework improvement in the terms of trade for one country implies a simultaneous deterioration in those of the other, if conditions in Theorem 5 are satisfied, the transfer will deteriorate the terms of trade of the developed country. In case the transfer decreases world supply, the sign of dq/dI in Equation (5.3) is ambiguous even if $x_m^\beta \geqslant x_m^\alpha$. This is because return on capital in the developed country, i.e. country α, is always higher than that in the developing country, i.e. country β. Thus if capital transfer decreases world supply, it is likely that the terms of trade of the developing country may deteriorate. In the standard H-O-S framework, this is not possible as long as $x_m^\alpha \geqslant x_m^\beta$. The transfer will definitely deteriorate the terms of trade of the developing country if the "production effect", i.e. $y_k^\beta - y_k^\alpha$, dominates the "consumption effect", i.e. $x_m^\alpha r^\alpha - x_m^\beta r^\beta$.

Within the N-H-O framework, Brecher and Choudhri (1982) have shown that direct foreign investment will deteriorate the terms of trade of the recipient country if (i) the recipient country exports capital-intensive good, (ii) foreign investment decreases world supply, and (iii) the recipient country has higher propensity to spend on the non-numeraire good than the investing (donor) country. Note that Brecher and Choudhri's condition (ii) is identical to our condition in Theorem 5.

We know from our discussion in the previous section that a change in the unilateral capital-transfer affects the welfare of the recipient as well as donor country both directly through change in the capital stock, the Pr effect, and indirectly through change in the terms of trade, the TOT effect. While the Pr effect is always positive, the TOT effect can take any sign. The immiserization of the recipient country always implies a deterioration of its terms of trade induced by the transfer. Also, the welfare improvement of the recipient country can be consistent with its terms-of-trade deterioration. This can only be true if the rental earned on the amount of transferred capital is enough to compensate for the loss due to the deterioration of the terms of trade. Similarly, the transfer-induced improvement in the terms of trade of the donor country will not improve its welfare if the foregone rental on the transferred capital outweighs the benefits from the terms-of-trade improvement.

In the model of the world economy satisfying condition *S*, if the return on capital is not high in the developing country, then it is quite likely that the capital transfer from the developed country will yield paradoxical result, i.e. the transfer may immiserize the developing recipient country through a deterioration of its terms of trade and enrich the developed donor country despite the world equilibrium as well as the equilibrium of each country being stable. In the standard H-O-S framework, this is not possible.

As in the model of the world economy satisfying condition S, the return on capital is not equal in the developing and the developed countries. Therefore, capital transfer from the latter to the former can simultaneously immiserize both the countries and, hence, the world as a whole.

VII. CONCLUSION

Within a 2x2x2 framework, this paper has examined the effects of unilateral income and capital transfers on the terms of trade and welfare levels of two countries. It has been shown that within the H-O-S framework, qualitative effects of income and capital transfers on the terms of trade and welfare are identical. If the world equilibrium is Walras-stable, both types of transfers lead to an unambiguous increase (decrease) in the welfare of the recipient (donor) country. Within the N-H-O framework, however, effects of income and capital transfers are different. Also, a unilateral capital-transfer can yield a paradoxical result under certain conditions despite market stability, i.e. capital transfer can immiserize the recipient country and enrich the donor country. Finally, we have shown that in the extended H-O-S framework, a unilateral capital-transfer from a developed country may immiserize a developing country through a deterioration in her terms of trade.

Appendix I

Proof of Theorem 1

Proof: When the world economy is out of equilibrium, Equation (2.3) does not hold. Replacing Equation (2.3) by (3.2), then differentiating the entire model with respect of $\tilde{z}$, using properties of the expenditure and the GNP functions and writing in a matrix form, we have

$$
\begin{bmatrix}
1 & 0 & z^\alpha \\
0 & 1 & z^\beta \\
x_m^\alpha & x_m^\beta & z_q
\end{bmatrix}
\begin{bmatrix}
du^\alpha \\
du^\beta \\
dq
\end{bmatrix}
=
\begin{bmatrix}
0 \\
0 \\
1
\end{bmatrix} d\tilde{z}
$$

Applying Cramer's rule we get

$$
\Delta \cdot \frac{dq}{d\tilde{z}} = 1
$$

Hence $\dfrac{dq}{d\tilde{z}} < 0$ iff $\Delta < 0$ \hfill *Q.E.D.*

Appendix II

Assuming perfect competition and full employment, the production structure of such an economy is described by the following four equations. For a detailed derivation of the model, interested readers are referred to Burney (1985).

$$
\ell^1(y^1, w, r)\, y^1 + \ell^2(w, r)\, y^2 = L \qquad 1'
$$

$$
\varsigma^1(y^1, w, r)\, y^1 + \varsigma^2(w, r)\, y^2 = k \qquad 2'
$$

$$
c^1(y^1, w, r) = q^1 \qquad 3'
$$

$$
c^2(w, r) = q^2 \qquad 4'
$$

where $\ell^i(\cdot)$ and $\varsigma^i(\cdot)$ are respectively input demand functions for labour and capital per unit of output, corresponding to the ith good ($i = 1,2$); y^i is the output of the ith industry, w and r are returns to labour and capital, respectively; k and L are

respectively total amounts of capital and labour available in the economy; c^i ($\cdot$) is unit cost function of a firm in the ith industry; and q^i is the price that each firm in the ith industry faces in the absence of market distortions. The model differs from the H-O-S models in that y^1 appears in ℓ^i ($\cdot$). ζ^i ($\cdot$) and c^1 ($\cdot$).

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