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OIL PRICES, WELFARE AND THE TRADE BALANCE: AN INTERTEMPORAL APPROACH

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ABSTRACT

The paper examines welfare effects and the trade balance response to changes in the world oil prices and interest rates for a small oil-importing economy. The trade balance is mainly seen as the difference between saving and investment, and these are derived from intertemporal optimization. It is shown that the welfare effects consist of static terms of trade effects, intertemporal terms of trade effects, and employment effects. The trade balance deteriorates for temporary oil price increases, whereas its response is ambiguous for permanent oil price increases. For a fall in the world interest rate, the trade balance deteriorates, if the economy is a net borrower.

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OIL PRICES, WELFARE AND THE TRADE BALANCE: AN INTERTEMPORAL APPROACH*

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I. Introduction and summary of results

This paper examines the trade-balance response to changes in world oil prices and interest rates for a small oil-importing open economy. The theoretical interest in this problem is, of course, derived from the oil price increases in 1973-4 and 1979-80 and the resulting huge surpluses in OPEC current accounts and trade balances, and corresponding overall deficits vis-à-vis OPEC in the rest of the world. World markets have since then been flooded by OPEC's supply of credit, and there is evidence that world real interest rates fell during the 1970s.[1]

By now, starting with the works by, among others, Schmid [1976], Findlay and Rodrigues [1977], Buiter [1978], and Bruno and Sachs [1979], there exists a large literature on many theoretical macroeconomic aspects of these events. To the extent that this literature has dealt with determinants of the current account, it has, however, mostly used a rather static approach and even overlooked obvious and important intertemporal aspects. Whether the current account balance is described in terms of export minus import or equivalently as income minus absorption, it has rarely been seen as the outcome of intertemporal decisions on saving and investment. As argued by Sachs [1981, p.212]: "A one-period theory of the current account that describes a static balance of imports and exports makes as much sense as a one-period theory of savings or investment. Because current account imbalances reflect intertemporal choices, expectations of future events can be a decisive factor in determining the size of deficits and surpluses ..."[2]

Svensson and Razin [1982] have developed a two-period many-goods model of a small open economy, for the purpose of examining the classic Harberger-Laursen-Metzler terms of trade effect on aggregate spending and saving. They can resolve previous controversies on the determinants of the effect, precisely because they develop a model where expenditure and saving are the outcome of intertemporal optimization. Their model also gives rise to a theory of the current account that explicitly takes the intertemporal aspects into account, and they derive the effects on on the current account of temporary, permanent, and expected future changes in world prices, assuming perfect international capital mobility and a given world rate of interest. The discussion is, however, limited to the case with fixed (full employment) output vectors and no investment, except for a brief discussion of consequences of static and intertemporal substitution in production.

In this paper, the analysis of Svensson and Razin [1982] is specialized to deal with two traded goods, namely a domestically produced final good and an imported raw material, called oil, which is used as an input in production. The analysis is furthermore extended to include investment, rigid wages, and changes in employment. The effects on welfare and on the trade balance[3] in terms of final goods of exogenous increases in oil prices (relative to final goods) and a decrease in the world (real final-goods) interest rate are examined,[4] taking into account endogenous changes in saving, investment and employment. As in Svensson and Razin [1982], the model uses an explicitly microeconomic framework, and abstracts completely from monetary aspects. There is no government and the effects of different policies are not considered. Throughout the analysis it is assumed that capital and labor, capital and oil, and oil and labor, are all 'cooperative' (in the sense that the corresponding cross partials of the production function are all positive),[5] that oil is used only as an intermediate input and not consumed directly, that oil cannot be stored, and that there is no home production of oil. Then the following results are derived:

With flexible wages and full employment, the effect on welfare of changes in oil prices and the interest rate is independent of the possibilities to substitute oil for capital or labor in production. The welfare effects can be simply expressed as a sum of static oil terms of trade effects and an intertemporal interest rate terms of trade effect. With rigid wages and less than full employment, welfare is in addition affected by employment changes, which do depend on the degree of substitutability of oil in production.

With flexible wages and full employment we can show that:

(1) A (present) temporary oil price increase (at a constant rate of interest) unambiguously deteriorates[6] the (present) trade balance through a decrease in saving, whereas investment is unaffected.

(2) An (expected) future oil price increase unambiguously improves the (present) trade balance through an incrase in saving and a decrease in investment.

(3) A permanent oil price increase has, in general, an ambiguous effect on the trade balance. To get more specific results we need further restrictions, for instance that oil imports and oil price increases are the same in both periods, and that the marginal propensity to consume is the same in the present and in the future (alternatively, that the rate of time preference is independent of the welfare level). Then the (present) trade balance unambiguously improves, because saving is unaffected but investment decreases.[7]

(4) If the country has a (present) deficit in the trade balance, a decrease in the world rate of interest unambiguously deteriorates the (present) trade balance by a decrease in saving and an increase in investment. Otherwise, the effect on the trade balance is ambiguous.

With rigid wages both in the present and the future, oil price increases decrease employment, which increases the magnitude of the effects on the trade balance under (1) and (3) above. If there are rigid wages only in the present but flexible wages and full employment in the future, there is an increased tendency towards deterioration of the (present) trade balance for present oil price increases.

These results show the differences in the response of saving, investment and the trade balance to temporary and permanent oil price increase. The results also show that for a permanent oil price increase, the trade balance may - somewhat paradoxically - actually improve, unless the rate of interest falls. It follows that in order to create a deficit in the trade balance vis-à-vis OPEC for the non-OPEC world, it may be necessary for the world rate of interest to fall.[8] Thus we get a possible theoretical explanation of the alleged fall in world rates of interest during the 1970s after the 1973-4 oil price rise.

We also show that there is a complete analogy between the effects on welfare and the trade balance of (i) exogenous oil price increases at full employment, (ii) exogenous decreases in employment at constant oil prices, and (iii) exogenous decreases in productivity at constant oil prices and full employment.[9]

The paper is organized as follows: Section II specifies the equilibrium of the small country and defines the trade balance. In Section III the effects on welfare and the trade balance of changes in oil prices and the interest rate are derived under the assumption that there is full employment. A graphical illustration of these effects is provided in Section IV. Rigid wages and changes in employment are discussed in Section V. Section VI mentions some extensions, draws some general conclusions, discusses some limitations of the analysis, and suggests some areas for future research.

II. Equilibrium under full employment

We consider a small country in an intertemporal framework. There are two periods, indexed $t = 1$ and 2, and called the 'present' and the 'future', respectively. In each period there are two goods, namely a final good and oil. They are both traded on the world market at given relative spot prices at each date. The country has access to a world credit market with a given final-goods real rate of interest. We let q^1 and q^2 denote the relative spot prices of oil in periods 1 and 2 in terms of final goods. The (final-goods) discount factor (equal to one over one plus the real rate of interest) is denoted by δ.

The country produces final goods, using oil as an imported intermediate input together with domestic capital and labor. There is no domestic production of oil, and oil cannot be stored. Production possibilities are given by well-behaved concave production functions $x^t = f^t(k^t, \ell^t, z^t)$ relating output x^t of final goods to capital stock k^1, labor input ℓ^t and oil input z^t, all in period t. The present capital stock, k^t, is predetermined, whereas the future capital stock, k^2, can be augmented by investment of final goods in the present period. There is no investment in the future.

With regard to welfare and demand, we assume that the country can be adequately represented by a well-behaved utility function $U(c^1, c^2)$, where c^1 and c^2 denote present and future consumption of final goods. Oil is not consumed.

Consider now a competitive equilibrium for the country, where the present capital stock, k^1, and the present and future labor supply, ℓ^1 and ℓ^2, are given exogenously. The country faces given spot prices at each date and a given discount factor.[10] Wages adjust so as to assure full employment of labor. (In Section V we shall deal with rigid wages and variable employment.) Such an equilibrium can be represented by the equation

$$(1) \qquad E(1, \delta, u) + I^1(\delta, q^2, \ell^2) =$$

$$= Y^1(1, q^1, \ell^1) + \delta Y^2(1, q^2, I^1(\delta, q^2, \ell^2), \ell^2) ,$$

the intertemporal budget constraint. The equation states that the present value of expenditure on consumption and investment equals the present value of accumulated domestic product over the two periods.

Here, expenditure on consumption is given by a standard (present value) expenditure function,[11] $E(1, \delta, u)$, of the price of present final goods (which is set equal to unity),[12] the present value of future final goods, δ, and the welfare level, u. Domestic Product (DP) in period t is given by a standard DP function, $Y^t(1, q^t, k^t, \ell^t)$, of the price of final goods, the oil price, and inputs of capital and labor, all in period t.[13] The level of investment is determined by the condition that the present value of the future marginal product of capital is equal to unity, the price of present final goods. Hence, it is given by an investment function, $I^1(\delta, q^2, k^1, \ell^2)$, of present capital stock, the discount factor, the future oil price, and the future employment level.[14] The future capital stock is the sum of the investment and the predetermined present capital stock. The latter has been suppressed as an argument of the investment function and the DP functions in (1).

Alternatively, the budget constraint can be written as present value of expenditure on consumption equal to wealth, W, where wealth is defined as

$$(2) \qquad W = Y^1 - I^1 + \delta Y^2 ,$$

i.e. the present value of the sum of present domestic products, net of investment, and future domestic product.[15]

The budget constraint can be understood as expressing the welfare level u as an implicit function of the given world prices and discount factor, and the employment levels. By standard properties of the expenditure function, the equilibrium consumption levels are given by the corresponding price derivatives, $c^1 = E_1(1, \delta, u)$ and $c^2 = E_\delta(1, \delta, u)$.[16] Also, by standard properties of the DP function, equilibrium output of final goods and oil import are given by $x^t = Y^t{}_1(1, q^t, k^t, \ell^t)$ and $z^t = -Y^t{}_q(1, q^t, k^t, \ell^t)$. Thus, the equilibrium of the small open economy is fully specified.

Let us also define the (present) trade balance (surplus) measured in final goods, t^1. It equals the present current account surplus since there is no initial foreign debt. It is defined as

$$(3) \qquad t^1 = Y^1 - E_1 - I^1 ,$$

which in equilibrium simultaneously equals (i) the value of the present net export, i.e. $(x^1 - c^1 - i^1 - q^1z^1)$, (ii) the excess of present domestic product over spending on consumption and investment at date 1, i.e. the excess of domestic product over absorption, (iii) the difference between present saving $(Y^1 - E_1)$ and investment, and (iv) the net increase in foreign asset holdings, i.e. the capital account deficit.

Having defined an equilibrium and the trade balance, we shall go on to discuss changes in the trade balance. In interpreting the various effects on the trade balance, we will find it helpful to look at it mainly as the difference between saving and investment.

III. Increases in oil prices and the discount factor

In the introduction, we mentioned that there is empirical evidence of a fall in world rates of interest during the 1970s after the oil price increase in 1973-4. We shall now examine the effect on the trade balance of our small economy of a combination of oil price increases and a decrease in the rate of interest. As a first step we derive the effects of these changes on national welfare, assuming constant (full employment) labor input. Differentiating the budget constraint (1), using standard properties of the expenditure and DP functions, as well as the equilibrium condition for investment, we get

$$(4) \qquad E_u du = - z^1 dq^1 - \delta z^2 dq^2 + t^2 d\delta$$

where E_u denotes $\partial E/\partial u$, the inverse of the marginal utility of wealth, which is positive, and where t^2 denotes the (current value) future trade balance,

$$(5) \qquad t^2 = Y^2 - E_\delta = x^2 - c^2 - q^2 z^2 .$$

Hence the change in welfare is proportional to the sum of the oil-import weighted oil price changes and the trade balance weighted discount rate change. The effect on welfare is as if prices and the discount factor has been held constant but wealth had been decreased by the right-hand side of (4). We call $- z^1 dq^1$ and $- z^2 dq^2$ the present and future <u>static</u> (wealth equivalent) <u>terms of trade effects</u> (on welfare), and $t^2 d\delta$ the <u>intertemporal terms of trade effect</u>.[17]

In particular, we see from (4) that, somewhat paradoxically, the effect on welfare is independent of the degree of substitution between oil, capital and labor in production.[18]

Next, to find the effect on the trade balance, we differentiate (3), using (4), to get, after some manipulations,

$$(6) \qquad dt^1 = - z^1 dq^1 - C^1_W(- z^1 dq^1 - \delta z^2 dq^2 + t^2 d\delta) - E_{1\delta} d\delta - I^1_q dq^2 - I^1_\delta d\delta ,$$

where C^1_W is the marginal <u>propensity to consume</u> in period 1 (out of wealth), i.e. the partial derivative with respect to wealth of the Marshallian uncompensated demand function for final goods in period 1,[19] and where $E_{1\delta} = \partial E_1/\partial\delta$ is the intertemporal pure substitution effect on present consumption of a change in the discount factor.

We can then identify and interpret the determinants of the change of the trade balance. The first term on the right-hand side of (6) we can call a direct static terms of trade effect, due to a revaluation of oil import or, alternatively, to the change in domestic product, in the present. The second term is a wealth effect on present consumption,[20] consisting of the sum of the static and intertemporal terms of trade effects multiplied by the marginal propensity to consume in period 1. The third term is an intertemporal consumption substitution effect. The last two terms we may call investment substitution effects. We also note that the first three terms give the change in saving, and the last two the change in investment.

In order to understand the separate effects of changes in oil prices and the discount factor, we consider the following four pure cases:

(1) By a temporary oil price increase, we mean a situation where only the present oil price increases, i.e. $dq^1 > 0$, $dq^2 = 0$ and $d\delta = 0$. Then we can write

$$\text{(7)} \qquad dt^1 = \underset{(+)}{(1 - C^1{}_W)}\underset{(-)}{(- z^1 dq^1)} < 0 ,$$

where the signs of the separate terms are also shown. The term $(1 - C^1{}_W)$ can be interpreted as the marginal propensity to save out of present domestic product. It is positive if final goods are normal at both dates, which we assume. Since investment is unaffected, the trade balance response depends only on the change in saving. Since present domestic product falls by the static terms of trade effect, saving falls. The trade balance clearly deteriorates.

(2) By a future oil price incerase, we mean a situation where only the future oil price increases, i.e. $dq^2 > 0$ and $dq^1 = d\delta = 0$. We then have

(8) $$dt^1 = -\,C^1_W(-\underset{(-)}{\delta z^2 dq^2}) - \underset{(-)}{I^1_q} dq^2 > 0.$$

Here, both saving and investment changes. Since welfare and wealth falls, consumption falls. Since present domestic product is unchanged, saving increases. Equivalently, the wealth effect on the trade balance is positive. What about investment? If we assume that oil and capital are cooperative inputs in the sense of having positive cross partials in the production function, investment falls when oil prices increase. This can be understood the following way: An oil price increase always decreases oil input (the own substitution effect is always negative). If capital and oil are cooperative, this decreases the marginal product of capital, which causes a decrease in investment.[21] Hence, since savings increases and investment falls, the trade balance clearly improves.

(3) From the above follows that a permanent oil price increase, when both present and future oil prices increase, (i.e. dq^1, $dq^2 > 0$ and $d\delta = 0$), leads in general to an ambiguous change in the trade balance. Investment falls unambiguously, but the net effect on savings is ambiguous. However, if the change in savings is small, the trade balance will be dominated by the investment effect, and the trade balance will improve. This somewhat paradoxical result has been emphasized by Sachs [1981]. Precise conditions under which this occurs can be derived as follows:

Assume that the oil price increase is the same in both periods ($dq^1 = dq^2 = dq$) and that oil import initially is equal in the two periods ($z^1 = z^2 = z$). Then (6) can be written

(9) $$dt^1 = (C^2_W - C^1_W)(-\underset{(-)}{\delta z dq}) - \underset{(-)}{I^1_q} dq^2 \quad (> 0, \text{ if } C^2_W < C^1_W),$$

where C^2_W is the marginal propensity to consume in period 2 (out of wealth).[22]

Hence, if the marginal propensities to consume are the same at both dates, savings remains unaffected and the investment effect determines the trade balance change. It follows that the trade balance unambiguously improves if the period 2 marginal propensity to consume does not exceed that of period 1. In Svensson and Razin [1982] it is shown that this condition for the marginal propensities to consume is associated with a rate of time preference that is a non-decreasing function of the welfare level.[23]

(4) Finally, we consider an isolated increase in the discount factor ($d\delta > 0$, $dq^1 = dq^2 = 0$), i.e. a fall in the rate of interest. We get

$$(10) \qquad dt^1 = -\underset{(+)}{C^1_W} t^2 d\delta - \underset{(+)}{I^1_\delta} d\delta < 0.$$

Let us henceforth assume that the country has a deficit in the present trade balance and hence a corresponding surplus in the future (since $t^1 + \delta t^2 = 0$).[24] Then welfare and wealth increases with the increase in the discount factor. Put differently, the country gains from the fall in interest, since it is a borrower. Consequently, present consumption increases, and since present domestic product is constant, saving falls. Investment increases with the increase in the discount factor. (The present value of the marginal product of capital increases, which increases investment.)[25] It follows that the trade balance unambiguously <u>deteriorates</u>.

The results under (3) and (4) above to some extent support Sachs [1981] argument that, for permanent oil price increases, it is really the investment response that determines the changes in the current account. And since investment, if anything, is likely to fall, an improvement rather than a deterioration is likely to occur. To create the deterioration in the current account vis-à-vis OPEC that is necessary for a world equilibrium, world rates of interest may have to fall. These and similar world equilibrium issues are further explored by Marion and Svensson [1981].

IV. A graphical illustration

The equilibrium of the country can be illustrated in a familiar Fisher diagram as in Figure I.[26] The intertemporal transformation curve ST shows the feasible combinations of present domestic product, net of investment, $(Y^1 - I^1)$, and future domestic product, Y^2, when the investment level I^1 varies. It is concave towards the origin, since future domestic product is a concave function of the investment level. The intertemporal budget line has a slope equal to the inverse of the discount factor. One indifference curve of the utility function is shown. The present value maximizing combination of net present domestic product and future domestic product is given by point A, the net domestic product point, which hence determines the equilibrium level of investment, the horizontal distance between A and T. The utility maximizing combination of consumption c^1 and c^2 in the two periods is given by A', the consumption point. Saving in period 1, $Y^1 - c^1$, is given by the horizontal distance between T and A'. The present trade balance $t^1 = Y^1 - c^1 - I^1$, is given by the horizontal distance between A and A'. The diagram is drawn such that the country has negative saving and a trade balance deficit in period 1.

First, consider the effects of a _temporary_ oil price increase, i.e. $dq^1 > 0$. We have $dY^1 = - z^1dq^1 < 0$, i.e. present domestic product decreases with the static present terms of trade effect. This corresponds to a parallel shift of the intertemporal transformation curve ST to the left to S'T' as in Figure II. The net domestic product point shifts horizontally to F, with unchanged investment level. The spending point shifts southwest to F', along the wealth expansion curve through A'. If the marginal propensity to consume is positive at both dates (consumption is normal at both dates), this curve has a positive slope. Saving shifts from the horizontal distance between A' and T to that between F' and T'. Since T has moved to the left but A' to southwest, it is clear that saving falls. The present trade balance shifts from the horizontal distance between A' and A to that between F' and F. Clearly, the trade balance deteriorates, in accordance with our previous results in Section III.

Second, consider the <u>additional</u> effects of a <u>future</u> oil price increase, i.e. $dq^2 > 0$. We have $dY^2 = Y^2_q(1, q^2, I^1)dq^2 = -z^2(1, q^2, I^1)dq^2 < 0$, for each level of investment, where $z^2(1, q^2, I^1)$ denotes future oil import, which is an increasing function of investment, since oil and investment are assumed to be cooperative. That is, the transformation curve shifts vertically down with the static future terms of trade effect, the shift being larger with increasing investment, from S'T' to S"T". At a constant level of investment, the net domestic product point shifts from F to G. However, the oil price increase has decreased the (marginal) profitability of investment. This appears in the diagram as the transformation curve being less steep at G than at F. Hence, the equilibrium level of investment decreases, and the net domestic product point shifts to H. The consumption point shifts to H'. Saving shifts from (the negative of) the horizontal distance between T' and F' to that between T" and H', and thus increases. The present trade balance is now given by the horizontal distance between H' and H. Clearly, the additional effect of a future oil price increase has unambiguously <u>improved</u> the trade balance, from the horizontal distance between F' and F to that between H' and H. However, the <u>permanent</u> oil price increase, has shifted the trade balance from the horizontal distance between A' and A to that between H' and H. The net change in the trade balance depends on the relative slopes of the straight lines through HA and H'A', respectively, and is in general ambiguous.

The special case of a permanent oil price increase discussed above, when the static terms of trade effects on the trade balance cancel and only the investment effect matters, is when the two straight lines GA and H'A' both have a slope equal to unity. Clearly, the same result occurs whenever the two lines have the same slope. We also see that then the investment substitution effect from G to H unabiguously improves the present trade balance.

Finally, consider the additional effect of an increase in the discount factor, i.e. $d\delta > 0$. This decreases the slope of the intertemporal budget line. The level of investment increases, the net domestic product point shifts from H to J, and the consumption point shifts to J', the shift consisting of the wealth effect from H' to J" (resulting from an intertemporal term of trade improvement) and the substitution effect from J" to J'. Saving falls and the trade balance unambiguously deteriorates.

Since welfare increases monotonically along the income expansion curve through H' and A', it is clear that the diagram also illustrates the welfare effects of the changes in oil prices and the discount factor.

V. Rigid wages and variable employment

In this paper, we have so far assumed full employment of labor. Let us now introduce rigid wages and variable employment.[27] Let us first simply assume that there is a given final goods wage, w^t, in each period. We shall later deal with the reasonable case when there is rigid wages and variable employment only at the first date but flexible wages and full employment at the second date. Then the profit maximizing employment level is given by the condition that the demand price for labor, the partial $Y^t{}_\ell$, is equal to the given wage. For each date we consequently get the employment functions $L^t(q^t, k^t, w^t)$ defined by $Y^t{}_\ell(1, q^t, k^t, L^t(q^t, k^t, w^t)) = w^t$. The change in present employment from an oil price increase will then be given by

(11) $\quad d\ell^1 = L^1_q \, dq^1 < 0$,

which is negative if oil and labor are cooperative in the sense of having a positive cross partial of the production function. That is, present employment decreases with an increase in the present oil price.

The effect on future employment is more complicated, since the employment level and the investment level are simultaneously determined. First, we realize that if there is constant returns to scale, in the sense that future domestic product is linearly homogenous in (k^2, ℓ^2), an arbitrarily given real future wage is in equilibrium incompatible with the given discount factor. The latter implies a given future rate of return to capital which with constant returns to scale fixes the future wage rate (for a given future oil price). Let us avoid this problem by assuming that the future domestic product function is strictly concave in (k^2, ℓ^2), which excludes the constant returns to scale case.

Next, the changes in present and future employment from an oil price increase will be given by

$$
(12) \qquad
\begin{aligned}
dI^1 &= \underset{(-)(+)}{I^1_q dq^2} + \underset{(+)(-)}{I^1_\ell d\ell^2} < 0 \quad \text{and} \\
d\ell^2 &= \underset{(-)(+)}{L^2_q dq^2} + \underset{(+)(-)}{L^2_k dI^1} < 0 ,
\end{aligned}
$$

Under the assumption that capital and labor, capital and oil, and labor and oil, are all cooperative, it can be shown that both investment and future employment decreases. The direct negative effect on investment $I^1_q dq^2 < 0$ is reinforced by an indirect effect $I^1_\ell d\ell^2 < 0$ via the fall in investment. Similarly, the direct effect on employment $L^2_q dq^2 < 0$ is reinforced by the fall in investment, $L^2_k dI^1 < 0$.[28]

Similarly, for an increase in the discount fact, it can be shown that both future employment and investment increases, the investment increase being bigger than with full employment.[29]

The endogenous changes in employment levels that we have now derived will have separate effects on the trade balance that simply adds to the effects we have previously derived for the full employment case. To isolate these separate effects, let us make a digression where we regard the employment changes as exogenous. We hence differentiate (1) and (3) for given changes in the employment levels but with constant oil prices and discount factors. Differentiating (1) gives

(13) $$E_u du = Y^1{}_{\ell} d\ell^1 + \delta Y^2{}_{\ell} d\ell^2 = w^1 d\ell + \delta w^2 d\ell^2 .$$

Hence, the effect on welfare of changes in the level of employment is simply proportional to the changes in the present value of domestic product, the change in wealth.[30] We call the two terms on the right-hand side the present and future (wealth equivalent) employment effects (on welfare), respectively. Differentiating (3) gives

(14) $$dt^1 = (1 - C^1{}_W)w^1 d\ell^1 - C^1{}_W \delta w^2 d\ell^2 - I^1{}_{\ell} d\ell^2 .$$

It follows directly that a temporary decrease in employment, i.e. $d\ell^1 < 0$ and $d\ell^2 = 0$, has a negative consumption wealth effect on the trade balance, which deteriorates. A future decrease in employment has a positive consumption wealth effect on the trade balance. It has an additional positive effect on the trade balance through a decrease in investment, if investment and labor are complements. It follows that a permanent decrease in employment has an ambiguous effect on the trade balance.

At this stage we realize that the effects on welfare and the trade balance of exogenous decreases in employment are completely analogous to the effects of oil price increases. It follows that the effects of exogenous decreases in employment can be graphically illustrated in Figure II, in exactly the same way as we demonstrated the effects of oil price increases.

We also realize that as long as we regard the employment levels ℓ^1 and ℓ^2 as exogenous, we may as well interprete them as parameters representing productivity levels, say. Hence, we have implicitly derived the effects on welfare and the trade balance of exogenous changes in productivity, and indeed shown the analogy between oil price increases and productivity decreases. This analogy has recently been emphasized in Bruno [1981]. Formally, the analogy between oil price increases, employment decreases, and decreases in productivity, arises simply because they all appear as parameter changes affecting the domestic product functions in the same way and hence cause similar negative supply shocks.

After this digression, we return to regarding the employment changes as endogenous, given by (11) and (12) because of rigid wages. Since an oil price increase leads to a decrease in employment at the same date, and we have seen that the effect of a decrease in employment is the same as the effect of an oil price increase, we can directly conclude that the existence of rigid wages and the resulting changes in employment will simply reinforce all the separate effects of oil price increases that we derived in Section III. Thus, combining (6) and 14), for instance the effect of a temporary oil price increase on the trade balance will be

$$(15) \qquad dt^1 = (1 - C^1_W)\,(-\underset{(-)}{z^1 dq^1} + \underset{(-)}{w^1 d\ell^1}) < 0,$$

with $d\ell^1 < 0$ given by (11). The trade balance will deteriorate more than it does in the full employment case, since present domestic product falls more because the employment effect adds to the static terms of trade effect.

Similarly, the effect of an increase in the discount factor will be

$$(16) \qquad dt^1 = -C^1_W(\underset{(+)}{t^2} d\delta + \underset{(+)}{\delta w^2} d\ell^2) - \underset{(+)}{I^1_\delta} d\delta - \underset{(+)}{I^1_\ell} \underset{(+)}{d\ell^2} < 0 ,$$

where $d\ell^2 > 0$ by the previous argument. The trade balance deteriorates more than in the full employment case, due to the positive employment effect $\delta w^2 d\ell^2$ on welfare (which decreases savings) and the additional increase in investments $I^1_\ell d\ell^2 > 0$.

Let us finally remark on the reasonable case when there is real wage rigidity in the present (the short run) but flexible wages and full employment in the future (the long run). This case is also consistent with constant returns to scale in capital and labor in the future, for which case future real wages will be determine by future oil prices and the discount factor. We realize that the asymmetry caused by a decrease in employment only in the present will tend to deteriorate the trade balance. In particular, the previous result in the full employment case, that a permanent oil price increase may under some circumstances improve the trade balance, is then further qualified.

In the full employment case, we also noted that welfare effects are independent of the degree of substitution in production between oil, capital, and labor. We realize that with rigid wages this is no longer so, since the magnitude of the employment effects depends on the degree of substitutability between oil and capital and labor. Hence, with rigid wages and variable employment, the degree of substituion in production does indeed directly influence welfare.

VI. Extensions, conclusions, and limitations of the analysis

Let us first mention some extensions of the above analysis. So far, we have assumed that oil is used exclusively as an intermediate input in production. If some oil is also consumed directly by consumers,[31] the static terms of trade effects on welfare are larger in magnitude, since oil import is larger. This by itself should reinforce the effects on the trade balance derived in the case when oil is not consumed, in the same way as do changes in employment when there are rigid wages, as we noted in section V. However, it can be shown[32] that additional substitution effects on consumption enter, making the overall effects on the trade balance ambiguous, except for a pure increase in the discount factor. The ambiguity arises because oil price increases induce substitution in consumption of final goods for oil, when oil and final goods are substitutes. This substitution effect is opposite to the consumption wealth effect.

It is natural to measure the trade balance in terms of final goods, when oil is used as an input in production only. However, when both oil and final goods are consumed, it is less obvious in what units the trade balance shall be measured. One solution is to deflate the trade balance by an exact consumer price index, hence construct a 'real' trade balance. This can be done by assuming that preferences are weakly homothetically separable over time, as in Svensson and Razin [1982]. Then it can be shown[33] that the real trade balance is affected by what can be called real terms of trade effects and changes in the real discount factor, the latter being the present value of the future consumer price index deflated by the present consumer price index. In particular, a temporary oil price increase then also changes the real discount factor through changes in the present consumer price index, which can be shown to give rise to ambiguity in the trade balance response.

The analysis can be extended to an arbitrary number of goods along the lines of Svensson and Razin [1982]. The generalized terms of trade effects are then exactly analogous to those in the present analysis. Relative price changes introduce consumption and investment substitution effects that may give rise to an ambiguous trade balance response.[34]

Let us also make some general comments on the above analysis. It involves, as do several other recent works, a microeconomic approach, in the sense of using behavioural functions explicitly derived from optimizing behaviour, to problems that have mostly been attacked with the usual macroeconomic tools. The present analysis hopes to help to demonstrate the fruitfulness and power of such an approach. The method of using 'dual' functions, expenditure and domestic product functions, although formally equivalent to using 'primal' utility and production functions, makes, at least for the present problem, for easily derived explicit welfare effects, and greatly facilitates identification, interpretation, and signing of the various wealth and substitution effects. As shown in Svensson [1981], it also simplifies generalizations to many goods and factors, and allows for convenient but rigorous 'real' analysis in terms of various price indices.

More fundamentally, the above analysis attempts to contributed to demonstrate, also with several other recent works, the fruitfulness and, may be, even the necessity, to look at the determinants of the trade balance and the current account in an explicitly intertemporal setting.

Although many of our results may not be new, our method of deriving them has made it possible to express them in rather general, yet easily interpreted, forms. Our results on the welfare effects on oil price and interest rate changes have highlighted the irrelevance for the (first order) welfare effects of the degree of substitutability in production and consumption when there are flexible wages and full employment, and the crucialness of such substitution to the (first order) welfare effects when there are rigid wages and varying employment. Our rather rich results on the effects on the trade balance have made clear how incomplete and possibly misleading a static view of the trade balance is. The results emphasize the different and even opposite impacts of temporary, future, and permanent oil price changes. The analysis of interest rate changes has clarified the role of the intertemporal terms of trade effect on wealth, welfare, and saving in addition to the intertemporal substitution effects on saving and investment.

There are numerous and obvious limitations of the analysis, some of which call for additional research. Only the most simple small open economy case has been analyzed, the case when the country faces given prices on oil and final goods and a given world rate of interest. The case with a two country world, consisting of a final-goods producing Industria and an oil-producing OPEC, where the world rate of interest is endogenous, is studied in Marion and Svensson [1981]. The case with a three country world consisting of a home country, a foreign country, and OPEC, in which both the rate of interest and the relative price between home and foreign produced final goods are endogenous, is taken up in Marion and Svensson [1982a]. That case makes possible a discussion of how structural difference between industrial countries explain differences in their responses to oil price increases.

In the present paper, there is no government and no policy, there is perfect international mobility of capital, and monetary factors are completely abstracted from. One of many policies that is of obvious relevance is the restriction of international capital movements.

The present analysis abstracts from the allocation between traded and non-traded goods. The determinants of the current account when there are non-traded goods are treated in an intertemporal setting by Razin [1980], and, when there is import of oil, by Marion [1981] and Bruno [1982].

The response to oil price increase depends crucially on whether there is home production of oil or not. A net exporter of oil will benefit from positive static term of trade effects. The investment response to a future oil price increase could very well be overall positive, since the profitability of investment in the oil production industry will increase. The present analysis uses the simplifying, but not unrealistic, assumptions that capital, labor and oil are all cooperative. Implications of other assumptions can easily be examined.

The effects on employment of oil price changes have been examined in a very rudimentary way, and there is obvious scope for analysis of various wage indexation schemes and other labor market specifications. Neither have direct welfare effects of employment changes been dealt with.

The restriction to only two periods may appear severe, but has nevertheless made possible rather rich results. It is clear that as long as the only intertemporal distinctions we need are binary, for instance between the 'present' and the 'future', or the 'short run' and the 'long run', two periods are indeed all that is required and with suitable interpretations we can get an almost surprising richness of results. For other problems, finer intertemporal distinctions may be needed, for instance between the 'past', 'present', and 'future' when we want to distinguish between present expected and present unexpected price changes. Or suppose we want to examine the consequences of the possibility that the observed fall in the world rate of interest during the 1970s is not permanent but temporary. Then we need to distinguish between the 'present', the 'near future', and the 'distant future'. In such cases we simply need three or more periods.[35]

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Footnotes

* This paper is a revised and shortened version of Svensson [1981]. I have benefitted from detailed comments by Nancy P. Marion, Dartmouth College, an anonymous referee, and the editors of this Journal. A first draft of Svensson [1981] was presented to the Workshop on Open Economy Macroeconomics, held August 24-28, 1981 at the Institute for International Economic Studies. I am grateful to the participants for many helpful suggests. I especially want to thank Michael Bruno, Lars Calmfors, Henrik Horn, Harry Flam, John Helliwell, Hans Lind, Torsten Persson, and Assaf Razin for specific comments. Remaining errors are my own responsibility. Financial support from the Research Foundations of Svenska Handelsbanken and the Torsten and Ragnar Söderbergs Foundations is gratefully acknowledged.

1. Sachs [1981] provides an excellent discussion of these events, both theoretical and empirical, together with data on many countries' current accounts and on world interest rates.

2. An intertemporal view of foreign trade and different stages in the balance of payments was very fashionable in the Trade and Development literature of the 1960s, as for instance in Bardhan [1966] and Bruno [1967], see also Bazdarich [1978]. An excellent early reference, which contains a synthesis between static international trade theory and Fisherian capital theory, is Miller [1968]. More recently, Razin [1980], first version distributed 1978, discusses the current account in a rigorous intertemporal model with non-traded goods and investment. Sachs [1982a] and Lipton and Sachs [1980] offer a theoretical framework for discussing the current account in a two-country growth model, with perfect international capital mobility and far-sighted optimizing agents. The models are too complicated to solve analylitcally,

though, and must be studied by simulation techniques. Obstfeld [1980, 1982] discusses the current account in an Uzawa [1968]-type continuous time model with intertemporal optimization behavior. This Uzawa-type analysis involves several, for the results crucial, simplifying assumptions, as shown by Svensson and Razin [1982].

Recently, McKinnon [1978, 1981] and Sachs [1981] have argued the fruitfulness of looking at the current account as the difference between saving and investment, rather than as a time-independent difference between exports and imports. Sachs [1981] also develops a two-period model of the current account and provides an excellent discussion of its response to temporary and permanent oil price increases with results similar to those of Svensson and Razin [1981] and the present paper. See also Bruno [1982] and Sachs [1982b].

Dixit [1981] presents a very neat intertemporal general equilibrium model of trade in goods, capital, and oil. He does not consider trade balance issues but concentrates on problems of income distribution and strategic behaviour between countries with different endowments.

Taking monetary factors into account as in Helpman [1981], Persson [1981] uses an explicitly intertemporal framework in discussing the balance or payments in different currency areas and exchange rate regimes. See also Helpman and Razin [1982].

3. Since there is no initial foreign debt and no interest payments on foreign assets in the first period, the current account and the trade balance in the first period are identical. Henceforth, we shall only refer to the trade balance.

4. Let us note that in our analysis an 'oil price increase' means 'a (marginal) increase in the present oil price' relative to what the present oil price otherwise would have been, or 'a (marginal) increase in the future oil price' relative to what

the future oil price increase would otherwise have been. It should <u>not</u> be interpreted to mean an increase over time in the sense that future oil prices are (marginally) above present oil prices. That latter interpretation is however included as a special case, if the before-change situation is one with present and future oil prices being equal, and the change is an increase in the future oil price with the present oil price held constant.

More precisely, for exogenously given oil pirces q^1 and q^2 in the two periods, we get an equilibrium of endogenous variables (welfare, trade balance, output, etc.) in the two periods. We let the vectors ξ^1 and ξ^2 denote these endogenous variables. The exogenous oil price increases $dq^1 > 0$ and $dq^2 > 0$ result in new exogenous oil prices $q^1 + dq^1$ and $q^2 + dq^2$, and in a new equilibrium $(\xi^1 + d\xi^1, \xi^2 + d\xi^2)$. These oil price increases (dq^1, dq^2) and equilibrium changes $(d\xi^1, d\xi^2)$ are increases and changes relative to the before-change oil prices (q^1, q^2) and equilibrium (ξ^1, ξ^2).

A completely different meaning of an oil price increase would be that it refers to a situation where $q^2 > q^1$, that is, the future oil price is higher than the present one. It is certainly of interest to examine what the equilibrium (ξ^1, ξ^2) looks like in that case. Strictly, it requires global rather than our local differential-calculus analysis. However, for the local case, this meaning of an oil price increase is indeed a special case of our analysis. This can be seen in the following way: Let the initial oil prices be such that $q^1 = q^2 = \bar{q}$, resulting in an equilibrium $(\bar{\xi}^1, \bar{\xi}^2)$. (It does in general of course not follow that $\bar{\xi}^1 = \bar{\xi}^2$). Then consider an increase $dq^2 > 0$ in the future oil price, resulting in a new equilibrium $(\bar{\xi}^1 + d\xi^1, \bar{\xi}^2 + d\xi^2)$. Here the change $(d\xi^1, d\xi^2)$ in the equilibrium reveals how an equilibrium with the future oil price (marginally) above the present oil price differs from an equilibrium where oil prices are the same at the two periods.

5. Any established terminology for this kind of complementarity (technical complementarity?) is unknown to me. The term 'cooperative' has been suggested by Elhanan Helpman, according to whom it is used in Hebrew technology. Note that the usual definition of complementarity/substitutability is in terms of the cross partials of the conditional (i.e. constant output) input demand function. A thorough discussion and empirical evidence on such (Hicksian) complementarity and substitutability between captial, labor, energy and materials inputs is in Berndt and Wood [1979]. They discuss separable production functions of the form, for instance, $x = f(g(k, z), \ell)$ where $f(\ )$ and $g(\ )$ are constant returns to scale, all of which hence fulfill our assumption of cooperation between factors: $f^t_{k\ell}, f^t_{kz}, f^t_{\ell z} > 0$. (Partials will be denoted by subindices throughout the paper.)

6. 'Deteriorates' here means relative to what the (present) trade balance would have been if there had been no oil price increases. Cf. note 4.

7. The results (1) to (3) are derived in Svensson and Razin [1982] for the case with many traded goods, but with fixed output vectors and no investment. Except for the detailed conditions mentioned under (3), they are also derived by Sachs [1981].

8. This point is made by Sachs [1981].

9. The analogy between productivity decreases and raw material price increases is emphasized in Bruno [1981].

10. As is well-known, we can either interprete this equilibrium as a Hicksian perfect foresight 'full equilibrium over time', or a Hicksian 'temporary equilibrium in period 1', where period 2 variables represent commonly held subjectively certain point expectations.

11. The expenditure function is defined as $E(1, \delta, u) = \min \{c^1 + \delta c^2 : U(c^1, c^2) \geq u\}$. See Dixit and Norman [1980], or Varian [1978], for properties and uses of the expenditure function.

12. Throughout the paper we shall use final goods as numeraires.

13. The DP function is defined as $Y^t(1, q^t, k^t, \ell^t) = \max \{x^t - q^t z^t : x^t = f^t(k^t, \ell^t, z^t)\}$. It is also called the value-added, the restricted profit, the variable profit, the GNP, or the revenue function. A comprehensive reference is Bruno [1978] or Diewert [1974]. See Varian [1978] for a micro-textbook using this and similar dual functions, and Bruno [1973], Chipman [1972], Dixit and Norman [1980], Khang [1971], and Woodland [1981], for their use in international trade theory.

Note that Domestic Product equals National Product in period 1, since there is no initial debt. In period 2, National Product equals $Y^2 + rt^1$, the sum of Domestic Product and net interest income from abroad rt^1, where $r = (1/\delta) - 1$ is the rate of interest and t^1, the period 1 trade balance, is net lending in period 1 to the rest of the world.

14. The equilibrium investment level is the solution to the problem $\max \{\delta Y^2(1, q^2, k^1 + i^1, \ell^2) - i^1\}$, where i^1 is investment. Hence the investment function fulfills the first order condition $\delta Y^2_k = 1$. We assume an interior solution.

15. This concept of wealth includes also the present value of future labor earnings (human wealth).

16. E_1 is the partial with respect to the first argument, the price of final goods, and E_δ is the partial with respect to the second argument, the present value of future final goods, etc.

17. The importance of the intertemporal terms of trade effect is emphasized by Razin [1980] and Persson [1981].

The expression $E_u du$ in (4) is in general the 'change in real income' often used in international trade theory.

18. More precisely, the substitution effects are irrelevant to the <u>first-order</u> effects on welfare. Differentiating (1) to the second order reveals that substitution enter as second-order effects. Hence, the substitution effects are dominated by the terms of trade effects for small changes in oil prices and the discount factor.

19. We have used that C^1_W equals E_{1u}/E_u.

20. A more precise terminology would be a 'welfare' effect on consumption.

21. By differentiating the marginal condition $\delta Y^2_k = 1$ we get $I^1_q = -Y^2_{kq}/Y^2_{kk}$. But $Y^2_{kq} = f^2_{kz}/f^2_{zz} < 0$ since $f^2_{zz} < 0$ and we assume $f^2_{kz} > 0$, (that oil and capital are cooperative). Furthermore, $Y^2_{kk} < 0$ by concavity of the production function. Hence, $I^1_q < 0$.

22. We use that $C^1_W + \delta C^2_W = 1$, by the intertemporal budget constraint.

23. A homothetic utility function has a constant rate of time preference.

24. This is consistent with the realistic world equilibrium where OPEC has little consumption in the first period in comparison to its oil income.

25. We have $I^1_\delta = -Y^2_k/Y^2_{kk} > 0$, since $Y^2_{kk} < 0$.

26. Similar Fisher diagrams, although without the intertemporal transformation curve, are used in Svensson and Razin [1982] and Sachs [1981].

27. By variable employment we mean that employment is endogenously determined and may be less than full, hence giving rise to unemployment. We do <u>not</u> refer to a situation with variable utility maximizing labor supply.

28. We have $dI^1/dq^2 = (I^1_q + I^1_\ell L^2_q)/(1-I^1_\ell L^2_k) < I^1_q < 0$, since the term $I^1_\ell L^2_k$ can be shown to be positive and less than one (see Svensson [1981, n.29].

29. We have $dI^1/d\delta = I^1_\delta/(1 - I^1_\ell L^2_k) > I^1_\delta > 0$.

30. We note that the simplicity of (13) is because we assume that welfare depends on consumption only, and not directly on employment levels. Without the assumption, the employment effects on welfare would depend on the differences between wage rates and effects enter as second-order effects. Hence, the substitution effects are dominated by the terms of trade effects for small changes in oil prices and the discount factor the supply prices of labor, and employment substitution effects on consumption would

enter in (14). Persson [1982], in discussing welfare effects of stabilization policies in different exchange rate regimes, includes such employment effects on welfare.

31. For instance, if oil input for heating of private homes or gasoline for private transport is regarded as direct consumption rather than as production of housing and transport services.

32. See Svensson [1981, Sect. 7].

33. See Svensson [1981, Sect. 8].

34. See Svensson [1981, Sect. 9].

35. See, for instance, Marion and Svensson [1982b].

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FIGURE I

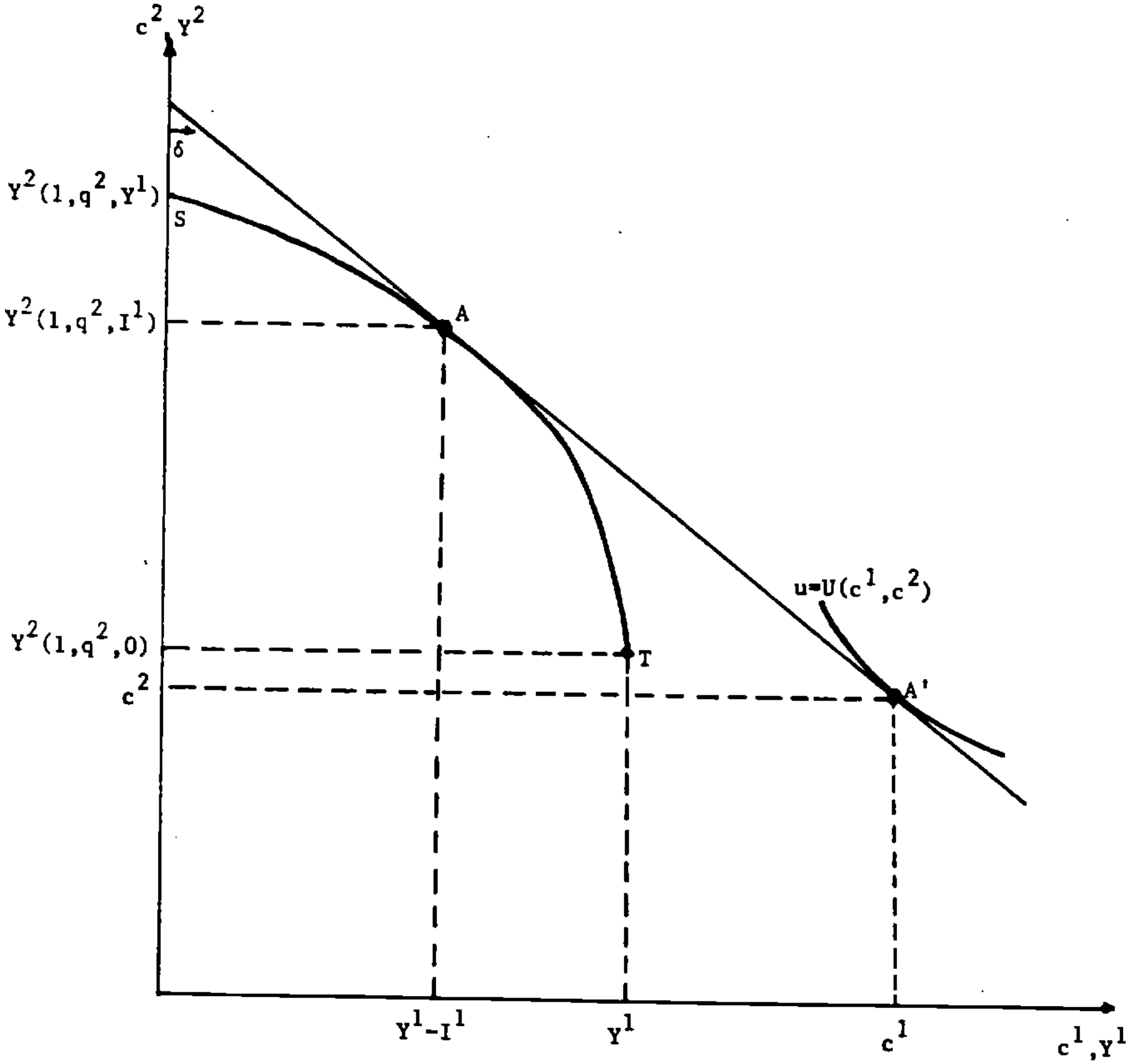

FIGURE II