An Analysis of Some Trade Theoretic Aspects of Investment and The Balance of Payments

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I. Introduction

Several excellent studies, both theoretical and empirical, focusing on the balance of payments disequilibrium are now available in the international finance literature (see, for example, Despres, Kindleberger, and Salant; Halevi). While the role of savings and investment in the balance of payments disequilibrium is well documented in these models, the fact that saving and investment decisions derive from the production structure of the economy is generally ignored. The pure theory of international trade, on the other hand, has focused in the past on the trade implications arising from the production structure of the economy, but has largely ignored issues of domestic investment and the balance of payments disequilibrium.

The recent spurt in activity in the intertemporal modeling of international trade appears to have been dictated by the realization that issues of domestic investment and balance of payments cannot be analyzed in the framework of conventional trade models. Dornbusch, Svensson and Razin analyzed the effects of changes in the terms of trade on the balance of payments in the context of intertemporal trade models focusing largely on the con-

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sumption decisions of agents in the economy. Bruno and Marion studied the effects of oil price increases on the balance of payments of a small open economy within the framework of intertemporal models of production and factor allocation assuming that physical capital is perfectly mobile international. Batra and Naqvi have examined the effects of a change in the propensity to save on the balance of payments and domestic investment within the framework of an intertemporal model of investment and international trade. The empirical basis of these results of intertemporal trade theory is not yet known. The purpose of this paper is to fill this gap.

In section II, we set out the theoretical model of international trade.[1] In section III, we present the econometric model that derives from the theoretical model of section III. In section IV, we present the results of our empirical investigation, and compare these results with the maintained hypothesis, namely the comparative static properties of the theoretical model. The conclusions and suggestions for further theoretical modeling of intertemporal trade are set out in section V.

II. The Theoretical Model

Batra and Naqvi developed a two sector, two period model where the first and second period are identified with the short run and long run respectively, and capital stock is assumed to be constant in both sectors in the short run but becomes variable in the long run. It should be noted that the two periods are not exclusive. However, the individual firms perceive the long run as a period of time distinct from the short run since the long run permits the variability of the capital stock against the short run which does not.

Assume X and Y are the two sectors of production where each sector employs two inputs, capital (K) and labor (L), in terms of neoclassical linearly homogenous production function.[2] In the

1 Our presentation of the intertemporal model of trade closely follows that of Batra and Naqvi.

2 This is tantamount to assuming that both the goods are stock-flow goods, and hence there is no commitment to one of the goods being a capital good. In addition, since both

absence of any technological change, production functions in both sectors are assumed to be identical in both periods and are characterized by:

$$(1)\quad X^t = X(L^t_x, K^t_x)$$

$$(2)\quad Y^t = Y(L^t_y, K^t_y)$$

where the superscript t = 1, 2 stands for the two periods, and the subscripts denote the two sectors.

Let p^t, W^t and Z^t be the relative price of Y, the real wage rate and the domestic rate of discount respectively in period t and I^t_j, the rate of t^{th} period real investment in the j^{th} sector. It is also assumed that all values are expressed in units of X. Producers in both sectors, facing perfect markets, maximize the present value of the cash flows over the two periods. Given that the stock of capital is fixed in the short run in both sectors, the representative firm each sector chooses the level of inputs L^1_i, L^2_i and K^2_i, $(i = x, y)$, such that the value of marginal product of a factor is equated with the corresponding factor price which is, by virtue of perfect competition, the same in both sectors. this implies that

$$(3)\quad X^1_L = w^1 = p^1 Y^1_L$$

$$(4)\quad X^2_L = w^2 = P^2 Y^2_L$$

and

$$(5)\quad X^2_K = D^2 + \delta = P^2 Y^2_K$$

where X^t_j, and Y^t_j are the marginal products factor j in period t in sectors X and Y respectively, δ is the rate of depreciation of

the goods are stock-flow goods, they can be used both for consumption and for investment. This assumption, along with the usual neoclassical assumption of meliability of capital, eliminates any problem that might arise from incompatibility between the units of measurement of the capital stock K and the units of measurement of the goods X and Y.

capital (assumed constant and the same in both sectors and both periods), and $D^2 = 1+Z^2$. It should be noted that in spite of the fact that capital is given and specific to each sector in the short run, the value of marginal product of capital in both sectors is equal to the price of capital in the short run too.

Assuming full employment in both periods,

$$(6)\quad L^t_x + L^t_y = \bar{L}^t$$

$$(7)\quad \bar{K}^1_x + \bar{K}^1_y = \bar{K}^1$$

and

$$(8)\quad K^2_x + K^2_y = (1-\delta)\bar{K}^1 + I^1$$

where $I^t = I^t_x + I^t_y$, is the rate of gross investment in the economy in period t. Clearly the short run capital stock is fixed, while the capital stock in the long run changes in accordance with the change in short run investment.[3]

The factor maket equilibrium conditions in the two periods are given by equations (3) -(5). Assume next, that neither labor nor physical capital are internationally mobile, which is indeed what is assumed in most trade models. For international mobility of capital, for instance, will reduce the model to one of international investment (see Kemp) rather than of international trade. Moreover, in the absence of any international factor market imperfections, international mobility of physical capital will equate the domestic and international rates of interest, an assumption one would certainly like to avoid at least for developing countries. It is assumed, therefore, that the home country can borrow or lend at the given world interest rate r^t, not necessarily equal to the

[3] It may be noted that changes in the terms of trade do not affect the short run capital stock since the latter is exogenously given. However, a closer look at Table 2 in conjunction with Equation (8) will show the impact of terms of trade changes on the long run capital stock.

domestic rate of interest Z^t. This borrowing or lending is done is accordance with the intertemporal budget constraint, given by:

$$(9)\quad \overline{V}R^1 + I^1 + \frac{I^2}{R^2} + C^1 + \frac{C^2}{R^2} = Q\,,$$

Where $\overline{V}$ is the initial level of foreign debt, which could be positive, zero, or negative, $C = C_x^t + P^t C_y^t$ is real consumption spending in period t, $R^t = 1 + r^t$, $I^2 = \delta K^2$ is the replacement investment in the long run, and Q is real wealth.[4] The real wealth Q equals the present value of total income stream over the two periods or:

$$(10)\quad Q = (X^1 + P^1 Y^1) + (X^2 + P^2 Y^2)/R^2 = Q^1 + Q^2/R^2\,.$$

It should be noted that our assumption of immobility of capital implies that the domestic rates of return and the international rates of interest are in general *not* the same. This assumption, Batra and Naqvi argue, is most likely to describe that situation in developing as well as many developed countries and allows a comparison of this model with the standard two-sector models of trade theory, which have also had a tradition of assuming international immobility of factors. Despite international immobility of the factors of production, free trade in goods can equalize the factor prices internationally if the endowment rays of the trading countries lie within the same cone of diversification. While it is assumed that the small open economy and its trading partner are completely diversified in the production of both goods, we mrely assume that the endowment ray of each country belongs to a cone of diversification, not necessarily the same cone. Hence, the spread between the domestic and the international rates of interest is maintained.

From equations (9) and (10) we get:

[4] The domestic rate of interest Z^t is used for discounting profits of the domestic producer. However, the foreign rate of interest r^t is the rate at which the economy borrows or lends in the international credit market, hence the presence of foreign interest rates r^t in the intertemporal budget constraint of the economy (9). Since the economy considered is a small open economy, its trading and borrowing-lending activities have no appreciable influence either on the relative prices or on the international rates of interest.

$$(11)\quad \overline{V}R^1 + I^1 + \frac{I^2}{R^2} = S^1 + \frac{S^2}{R^2}$$

where S^t is the saving in period t. According to the intertemporal budget constraint given by (11), savings in the two periods finance initial debt, the investment in the two periods and interest payments abroad. Assuming a savings function of the form $S^t = s^tQ^t$, we obtain.

$$(12)\quad \overline{V}R^1 + I^1 + \frac{I^2}{R^2} = s^1 Q^1 + s^2 Q^2 / R^2$$

where s^t is the given propensity to save in period t. Let us assume that all initial debt is repaid at the end of the second period and that in the first period only interest is paid abroad.[5] The balance of payments surplus in the current period, B^1, can now be defined as:

$$(13)\quad B^1 = s^1 Q^1 - I^1 - \overline{V}r^1$$

that is, B^1 equals the excess of savings over investment and interest payments abroad.

III. The Econometrics Model

The theoretical model presented in the previous section is characterized by the following reduced form equations which embody the key variables of interest in the economy:

5 It is conceivable that an economy may never have to repay its entire foreign debt. If only a part of the debt is repaid in the short and long run taken together $\overline{V}$ can be interpreted to be that part of the debt which has to be repaid. Alternatively, if a part of the debt is "rolled over", then that amount of the foreign debt which must be repaid would replace $\overline{V}$ in the budget constraint (9). An alternative budget constraint that incorporated debt rollover is:

$$VR^1 + Ur^1 + I^1 + \frac{I^2}{R^2} + C^1 + \frac{C_*^2}{R^2} = Q$$

where $\overline{V} = V + U$, V is the part of the foreign debt that is repaid, and U is the part that is rolled over. The interested reader may varify that the inclusion of the debt rollover does not change the qualitative nature of our findings.

$$(14)\quad X^1_L\ (L^1_x) = p^1\, Y^1_L (\bar{L}^1 - L^1_x)$$

$$(4)\quad X^2_L = p^2\, Y^2_L$$

$$(5)\quad X^2_K = p^2\, Y^2_K$$

$$(15)\quad (1+\delta/R^2)(K^2_x + K^2_y) - (1-\delta)\bar{K}^1 + \bar{V}R^1$$

$$= s^1 Q^1 + s^2 Q^2/R^2$$

where (14) has been obtained using (6) and (3), and (15) by combining (6), (8), and (12). In (14), the arguments of the function are presented explicitly to show that with K^1_x and K^1_y fixed, L^1_x can be solved from (14) itself as a function of p^1 and $\bar{L}^1$. With L^1_x determined, L^1_y can be obtained from the labor constraint, and with K^1_x and K^1_y already known, X^1 and Y^1 and hence Q^1 can be determined as functions of p^1 and $\bar{L}^1$. Hence all the short run variables, except I^1 and B^1, can be determined, as functions of p^1 and $\bar{L}^1$ once (14) is solved.

Next, from (4), (5), and (15) we can solve for L^2_x, K^2_x and K^2_y as functions of the exogenous variable vector $\omega = (\bar{L}^1, \bar{L}^2, s^1, s^2, r^1, r^2, p^1, p^2, \bar{V})$. With L^2_x determined, L^2_y can be obtained from the labor constraint in the second period. With all this information, all the long run variables, and the short run investment and balance of payments, can be determined, and expressed as functions of the exogenous variable vector ω.

Since all endogenous variables, including investment and the balance of payments, depend upon the exogenous variable vector ω, the following regression moels follow from the theoretical intertemporal model of international trade.

$$(16)\quad I_t = f(L_t, L_{t+1}, s_t, s_{t+1}, r_t, r_{t+1}, p_t, p_{t+1}, V_t) + e_t$$

$$(17)\quad B_t = g(L_t, L_{t+1}, s_t, s_{t+1}, r_t, r_{t+1}, p_t, p_{t+1}, V_t) + u_t$$

where e_t and u_t are normally distributed random errors with zero mean and finite variance, and I_t and B_t are the endogenous current period investment and balance of payments surplus. L_t, s_t, r_t, p_t and V_t are the first (current) period exogenously given labor supply, average rate of saving, world interest rate, international terms of trade and the country's debt. The variables with subscript $t+1$ are the second period values of the independent variables. For example, in the theoretical model the second period value of L is L^2 while that in the econometric model is L_{t+1}.

It may be noted that in Batra and Naqvi, $\bar{L}^2 = (1+\lambda)\bar{L}^1$, or in our notation $L_{t+1} = (1+\lambda)L_t$, where λ is the exogenously given rate of growth of labor supply. Further, if labor supply in period 1 increases, then so must labor supply in period 2; it is not meaningful to consider a temporary change in labor supply ($d\bar{L}^1 > 0$ and $d\bar{L}^2 = 0$), and changes in labor supply can only be permanent ($d\bar{L}^2 = (1+\lambda)d\bar{L}^1$). Hence we drop L_{t+1} from our list of exogenous variables. Since changes in the average rate of saving, the world rate of interest and the terms of trade may be temporary or permanent, we retain both the first and the second period values of these variables in our list of exogenous (independent) variables.

We do not yet have a theory of the determination of second period exogenous variables s_{t+1}, r_{t+1}, and p_{t+1}. Insofar as the economy being analyzed in a small open economy, the supposition is that it is one of the many small economics trading, borrowing and lending in the world commodity and capital markets, and it cannot exert any appreciable influence on the world rate of interest or the world terms of trade. Let the agents in the economy form an expectation in period t about the terms of trade in period $t+1$. Let the expectation be p_{t+1}, the true value p^*_{t+1}, and the error they make ε^1_t. And similarly for r and s. Then we postulate the following expectation formation rules:

$$(18)\quad p_{t+1} = p^*_{t+1} + \varepsilon^1_t$$

$$(19)\quad s_{t+1} = s^*_{t+1} + \varepsilon^2_t$$

and,

$$(20)\quad r_{t+1} = r^*_{t+1} + \varepsilon^3_t$$

where ε^i_t, $i = 1, 2, 3$, is the unautocorrelated normally distributed random error of expectation with zero mean and finite variance, and is temporally independent of the variable in whose expectation formation it arises. That is, we assume that on the average the expectation about the next period terms of trade, world interest rate and the average rate of saving turn out to be correct.

In view of (16) — (20), assuming f(·) and g(·) of (16) and (17) are linear, and the previous discussion, the following linear hypotheses are obtained from the theoretical model of section 1:

$$(21)\quad I_t = \alpha_0 + \alpha_1 L_t + \alpha_2 s_t + \alpha_3 s^*_{t+1} + \alpha_4 \gamma_t + \alpha_5 \gamma^*_{t+1} + \alpha_6 p_t + \alpha_7 p^*_{t+1} + \alpha_8 V_t + e_t',$$

$$(22)\quad B_t = \beta_0 + \beta_1 L_t + \beta_2 s_t + \beta_2 s_t + \beta_3 s^*_{t+1} + \beta_4 r_t + \beta_5 r^*_{t+1} + \beta_6 p_t + \beta_7 p^*_{t+1} + \beta_8 V_t + u_t'$$

where, it may be noted that $e_t' = e_t + \alpha_7 \varepsilon_t^1 + \alpha_3 \varepsilon_t^2 + \alpha_5 \varepsilon_t^3$, and $u_t' = u_t + \beta_7 \varepsilon_t^1 + \beta_3 \varepsilon_t^2 + \beta_5 \varepsilon_t^3$ are normally distributed random variables with zero mean and finite variance.

Before we proceed to the estimation of (21) and (22), a methodological remak is in order. Our maintained hypothesis is the structural, theoretical trade model. We translate this hypothesis into a set of testable hpotheses, namely the comparative static properties of the theoretical model arising from its reduced form, which depicts the general equilibrium relationships among the endogenous and exogenous variables. Since the properties of the reduced form model are being tested empirically, a confirmation does not mean that the structural model reflects the true picture: indeed, an infinite number of structural models could have the sme comparative static properties. However if the data contradict any one of the comparative static properties, then it follows that the structural theoretical trade model definitely does not reflect the true picture.

It may also be noted that no explanatory variable has been introduced or dropped in (21) and (22) on an ad-hoc basis, but just the variables dictated by the reduced form of the theoretical model have been included. This adds to the strength of our empirical investigation.

IV. Empirical Results

For the purpose of estimation we considered annual data on the Korean economy for the twenty year period 1963-1983. The Korean economy is a small open economy with considerable foreign debt problems, and its export, import and borrowing activities do not have any perceptible effect on the world terms of trade or the world rate of interest.

The ordinary least squares estimation of the investment equation (27) did not indicate any significant autocorrelation (the Durbin-Wastson test statistic had a value of 2.186). This was confirmed by the maximum likelihood estimation with a grid search for the first order autocorrelation coefficient, ρ. The estimate of ρ was -0.270 with a t-statistic value of -1.222. Next, a Box-Cox regression run of the investment equation favored a log-linear specification for the functional form of the investment equation with the foreign debt V entering linearly because it was not found to be positive every year. Hence the functional specification of the investment equation finally adopted was:

$$(23)\quad \ln I_t = \alpha_0 + \alpha_1 \ln L_t + \alpha_2 \ln s_t + \alpha_3 \ln s^*_{t+1} + \alpha_4 \ln r_t + \alpha_5 \ln r^*_{t+1} + \alpha_6 \ln p_t + \alpha_7 \ln p^*_t + \alpha_8 V_t + e''_t .$$

The results of the ordinary least squares estimation of the investment equation (23) are reprted in (Table 1).

The ordinary least squares estimation of the balance of payments equation (21) indicated the presence of autocorrelation, since the Durbin-Watson test static had a value of 2.539. The maximum likelihood estimation of (22) with a grid search for ρ confirmed this. The estimate of p was -0.320 with a t-statistic of -1.472. Next, a Box-Cox regressioin run with a maximum likelihood grid search for first order autocorrelation supported a log-linear specification of the functional form of the balance of

Table 1

EMPIRICAL RESULTS

Dependent Variables	Constant	Explanatory Variables										
		$\ln L_t$	$\ln s_t$	$\ln s^*_{t+1}$	$\ln r_t$	$\ln r^*_{t+1}$	$\ln p_t$	$\ln p^*_{t+1}$	V_t	D-W	R^2	Method
$\ln I_t$	-62.784	6.874	0.252	-0.492	1.298	.330	0.266	2.038	0.127x 10^{-3}	2.003	0.997	OLS
		(8.854)	(1.026)	(2.393)	(3.287)	(3.235)	(0.535)	(4.204)	(2.448)			
B_t	21615.0	-3098.4	-2022.7	741.50	3801.1	-1310.4	3704.4	-3605.7	-0.427x 10^{-1}	2.741	0.872	ML (Grid
		(2.710)	(5.317)	(2.200)	(6.624)	(1.861)	(4.940)	(4.830)	(0.494)			Search)

payments equation, with B_t and V_t entering the equation linearly because these variables were not positive in every year. Hence we adopted the following functional specification of the balance of payments equation.

$$(24)\quad B_t = \beta_0 + \beta_1 \ln L_t + \beta_2 \ln s_t + \beta_3 \ln s^*_{t+1} + \beta_4 \ln r_t + \beta_5 \ln r^*_{t+1}$$

$$+ \beta_6 \ln p_t + \beta_7 \ln p^*_{t+1} + \beta_8 V_t + u''_t.$$

The results of the maximum likelhood estimation of the balance of payments equation (24), with an autocorrelation correction employing a grid search, are presented in Table 1.

In Table 2 the comparative static properties of the theoretical model (see Batra and Naqvi) are presented. Table 3 contains a summary of the qualitative results of the estimation of the investment and the balance of payments equation (23) and (24). For a comparison of the theoretical and empirical results, we shall refer to Tables 2 and 3.

Table 2

THEORETICAL RESULTS*

Dependent Variables	Independent Variables							
	$\bar{L}^1$	s^1	s^2	r^1	r^2	p^1	p^2	$\bar{V}$
I'	(+)	(+)	(+)	(-)	(?)	(?)	(?)	(-)
B'	(?)	(?)	(?)	(+)	(?)	(?)	(?)	(+)

Table 3

EMPIRICAL RESULTS*

Dependent Variables	Explanatory Variables							
	L_t	s_t	s^*_{t+1}	r_t	r^*_{t+1}	P_t	P^*_{t+1}	V_t
I_t	(+)	(?)	(-)	(+)	(+)	(?)	(+)	(-)
B_t	(-)	(-)	(+)	(+)	(?)	(+)	(-)	(?)

* A (+) sign indicates a direct relationship, a (-) sign an inverse relationship, and a (?) sign indicates that the relationship is indeterminate (theoretical results), or statistically insignificant (empirical results).

A. The Investment Function

It is apparent from the results in Table 1 that the current average rate of saving and the current terms of trade are statistically insignificant in explaining the current rate of investment in the economy. The next period's average rate of saving and the terms of trade, however, are statistically significant in explaining the current rate of investment. And so are the current labor supply, world interest rate and foreign debt, and the next period world rate of interest. The importance of the rate of saving in explaining investment is well documented in the literature. In addition, our results highlight the importance of labor supply and the foreign debt as statistically significant explainers of the rate of investment in the economy.

It can be seen from Tables 2 and 3 that the effect of a change in labor supply and debt on the rate of investment obtained theoretically is confirmed empirically. In addition, the effect of changes in the terms of trade (in both periods), the rate of saving in the current period, and the world rate of interest in the second period on the rate of investment, obtained theoretically, are not contradicted by the empirical results. The theoretical results on the effects of changes in the current world rate of intrest and the second period average rate of saving, however, are contradicted by the data on the Korean economy.

While the sample dealt with here is rather small, and the degrees of freedom being only 10, the theoretically obtained signs of dI^1/dr^1 and dI^1/ds^2 are clearly violated by the data on the

Korean economy. Further, the empirically obtained signs of $dI^1/dr^1(>0)$ and $dI^1/ds^2(<0)$ do have an intuitive basis. For an increase in the world rate of interest, given that physical capital is not perfectly mobile, while it does not increase the domestic rate of interest, it does reduce lucrative investment opportunities abroad, and induces a partial movement of capital into the economy in question, thereby increasing the rate of domestic investment. Also the expectation of a higher average rate of saving in the next period could conceivably be the cause of postponing some of the investment to the next period, thereby reducing the current rate of investment. In the next section we shall address ourselves to the remodeling intertemporal trade on these empirical violations of the theoretical results.

B. The Balance of Payments Function

Again, from Table 1 it is apparent that while the long run international rate of interest and the outstanding foreign debt are statistically insignificant in explaining the extent of balance of payments disequilibrium, the supply of labor, the average rates of saving both in the short and in the long run, the terms of trade in both periods, and the current international interest rate are statistically significant explainers of the extent of current balance of payment disequilibrium. The importance of the rates of saving and the international rates of borrowing and lending in explaining the balance of payments is well documented in the literature. In addition, our results highlight the importance of labor supply in explaining the balance of payments of an economy.

From Table 2 and 3 it is clear that on the current balance of payments the effects of changes in current labor supply, average rate of saving and the world rate of interest obtained theoretically are confirmed by the data. Further, the effects on the current balance of payments of changes in the terms of trade in both periods, world interest rate in the second period, the long-run average rate of saving and the foreign debt in the current period are not contradicted by the data. Hence the empirically obtained results on the effects on balance of payments of the various exogenous changes do not contradict any of the theoretically obtrained results.

V. Concluding Remarks

Using a two-sector, two-factor, intertemporal model of production and factor allocation to analyze intertemporal trade in a small open economy, and estimating the theoretically obtained reduced form equations for investment and the balance of payments, we have seen that the supply of labor is a statistically significant explainer of both domestic investment and the balance of payments. In addition, we found that a country's foreign debt is a statistically significant explainer of domestic investment in the economy. While these two results are a positive contribution of the intertemporal pure theory of international trade, two of the theoretical comparative statics results were violated by the data: empirically it was found that $dI^1/dr^1 > 0$, and $dI^1/ds^2 < 0$. Further, these empirical results are fairly appealing intuitively.

As mentioned earlier, this empirical investigation estimates the reduced form model. This study shows that while most of the theoretically obtained results are supported by the empirical evidence, some are not. Therefore, our empiricial investigation suggests that the basic structure of the intertemporal model be retained. However, a much richer model would emerge if domestic distortion and more general savings hypotheses are also included.

The intertemporal trade model rests on four crucial assumptions; (1) The technology in the economy is a constant returns to scale technology, (2) Physical capital is perfectly immobile internationally, (3) There are no factor market distortions, and (4) Saving in any period is a constant proportion of income in that period, and investment, foreign debt and its accumulated interest are financed by the savings in the two periods. This fourth assumption provides the specific form of the intertemporal budget constraint. While the first two assumptions are quite realistic, further investigation with the inclusion of factor market distortions and a more general savings function may be rewarding.

The introduction of inter-industry wage differential, and the use of an alternative savings function, perhaps of the type $S^t = s^t Q$, where Q is total wealth, appear to be natural first steps toward the development of a more general theory of intertemporal trade. Consideration of short run unemployment is another aspect that can add to the strength of the intertemporal trade model that has been discussed.

While intertemporal trade theory is currently in its developmental stage, it is certainly an important development in trade theory in that it permits in a trade theoretic context, and more effort needs to go into this area for it to address realistically issues of domestic investment and the balance of payments of a small open economy.

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