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Abstract

In the applications of the non-Walrasian macroeconomic framework to open economy models balance of trade is usually assumed to be unconstrained. This assumption rules out any feedback effect of a foreign exchange shortage on the rest of the economy. The present paper examines the role of a foreign exchange constraint in the short-run macroeconomic adjustment of developing countries. A non-Walrasian two-sector model is developed to show that macroeconomic response to external and internal shocks depends on the nature of unemployment in the economy as well as the situation in its foreign exchange market. The results also suggest possible explanations for the differential growth performances of the oil-importing developing countries after the oil crisis in the early seventies. Finally, we find that the "exports-first" rationing rule which is usually assumed to exist in the market for exportables is not appropriate in the presence of a foreign exchange constraint. In this paper, we suggest a more general rationing rule and examine its implications. Unlike the "exports-first" assumption, the suggested rationing rule depends on the situation in the rest of the economy and can be considered as endogenous in this sense.

FOREIGN EXCHANGE CONSTRAINT AND MACROECONOMIC ADJUSTMENT IN DEVELOPING COUNTRIES

If relative prices are rigid, markets may fail to clear and macroeconomic equilibrium has to come about through quantity adjustments. Properties of such "non-Walrasian" equilibria to a large extent depend on the signs of excess demands in those markets which fail to clear. When the situation in a market changes from one of rationing sellers to one of rationing buyers, or vice versa, quantity-adjustment mechanisms and "spill-over" effects may change substantially. The reason is that often the two sides of a market have different elasticities and different relationships with other markets. Differences in the properties of various configurations of excess demands and excess supplies in one-sector closed-economy models have been vividly shown by Barro and Grossman (1971), Malinvaud (1977), and Muellbauer and Portes (1978). In recent years, the "non-Walrasian" framework which was developed in the above studies has been applied to one- and two-sector open-economy models by Dixit (1978), Neary (1980), Cuddington (1980, 1981) and others. These studies show that when the model economy is made open to international trade or when it is endowed with more than one sector, the distinctions among different "non-Walrasian" regimes remain significant and, moreover, the impact of policy on the trade balance also depends on the prevailing situation.

Open-economy fixed-price models have so far focused only on the interactions among labor and goods markets, implicitly neglecting the problems an economy might face in its foreign exchange market. It is usually assumed that the foreign exchange market is always in excess

supply; in other words, the amount of foreign exchange that a country can borrow is unlimited. As a result, in these models, the feed-back effect of a possible foreign exchange constraint on the rest of the economy is generally ignored.[1] This issue is particularly important in developing countries where inability to prove credit-worthiness restrains their borrowing possibilities in the international capital markets.[2] Current foreign debt problems of many developing countries and their consequent severe economic difficulties point to the significance of the foreign exchange constraint in some countries and raise questions about policy alternatives under these circumstances.[3]

In the present paper we intend to examine the role of a foreign exchange supply constraint in the short-run macroeconomic performance of an open economy. We will show that the situation in the foreign exchange market affects policy multipliers in different non-Walrasian regimes. The model developed in this paper also differs from the previous works on non-Walrasian fixed-price open-economy models in another fundamental respect. In those models, a recurrent assumption concerning the rationing rule in the market for "exportables" is that exports are the first component of final demand to be rationed in case of an output shortage. This assumption is usually justified on the basis of transportation and transaction costs.[4] However, if the economy faces a foreign exchange constraint, this rationing rule may have destabilizing effects: a reduction in the supply of foreign exchange leads to a decrease in imports which, in turn, may "spill-over" into the market for exportables by constraining their supply or by inducing an increase in their domestic demand. This effect results in further cut in exports

and further reduction in the supply of foreign exchange. In such a situation, one expects the government to intervene and to stabilize the system by preventing exports from being excessively reduced. In this case, the rationing function in the market for exportables depends on the severity of the foreign exchange constraint, as well as on other parameters. The model presented here provides an example of such an endogenous rationing scheme.

The argument in this paper is based on a two-sector fixed-price model which is described in Section I. In Section II, two unemployment regimes--classical and Keynesian--with and without foreign exchange constraint are specified. Full-employment regimes will not be considered in this paper in order to concentrate on the more likely situations and to keep the paper to manageable proportions. The impacts of domestic price policies and of external shocks in various situations are analyzed in Sections III and IV. Section V, finally, is the conclusion.

I. The Model

The model developed in this section depicts a developing economy with two sectors. The first one, sector 1, produces a final good which is used for consumption, investment, and export. The second one, sector 2, produces an intermediate good which satisfies part of input requirements of the first sector. The rest of the intermediate input requirements of sector 1 are imported. We will assume that these sectors act as two representative profit-maximizing firms. The final good, X_1, is produced according to the following production function:

$$(1) \quad X_1 = f(L_1, N).$$

where L_1 is the level of employment and N is the amount of the intermediate input. The production function of the intermediate good sector, g(.), depends only on amount of labor employed in that sector, L_2, with no explicit intermediate input:

$$(2) \quad X_2 = g(L_2).$$

In a sense, the domestic production of the intermediate good, X_2, may be considered as the net output of the sector. The reason why capital stocks have been omitted from the lists of factors in both production functions is that they are assumed to be fixed and immobile in each sector in the short run.

The two production functions are assumed to have the following properties:

$$(3) \quad f_L > 0, \quad f_N > 0, \quad f_{LL} < 0, \quad f_{NN} < 0, \quad f_{LN} > 0,$$

$$f_{LL}f_{NN} - (f_{LN})^2 > 0,$$

$$g_L > 0, \quad g_{LL} < 0.$$

where the subscripts of f and g refer to partial derivatives of these functions with respect to labor and the intermediate input. The gross complementarity assumption between labor and the intermediate input in sector 1--i.e., $f_{LN} > 0$--is not crucial for our purposes. However, while the existence of such a complementarity in the long run may be disputed, it seems to be a reasonable assumption in the short run, which is the time horizon in our model. Note that since f(.) has only two variable inputs, labor and the intermediate input always have to be net

substitutes, unless either f has convexities or it is of Leontief-type where $f_{LN} = B$.

In this model, the domestic price of the final good will be the numeraire. It is convenient to choose the currency units such that the foreign price of the final good is also equal to one. Thus, the exchange rate for exports becomes unity. The foreign price of the intermediate good in terms of the final good is p*. This price may be different from the domestic price of this good, p, due to tariffs, subsidies, or differential exchange rates for imports. The real wage rate which is defined as the wage rate in terms of the final good and denoted as w, is assumed to be the same in both sectors. The three relative prices in this model--p*, p, and w--are exogenous in the short run and vary only parametrically in the policy experiments. Note that since both goods in the model are traded, a devaluation will have the same interpretation as a reduction in the real wage rate.

There are essentially five markets in this economy. These are markets for: the final good, the intermediate good, foreign exchange, "wealth," and labor. We will deal with these markets one by one in the rest of this section. Since prices do not equilibrate supply and demand in these markets, imbalances have to be resolved by rationing of one side of the market or the other, depending on the sign of excess demand. We will distinguish effective demand and supply levels by superscripts D and S, respectively.[5] Actual transactions will be denoted by capital letters without superscripts. These may represent rationed quantities, or they may be equal to their corresponding effective demand or supply levels.

(1) The Final Good Market: The output of the final good is used for private consumption, C, public consumption, G, investment, I, and exports, E. Therefore, for the actual transactions in this market, we always have:

$$(4) \quad X_1 = C + G + I + E.$$

If demand for the final good exceeds its supply, the amount allocated to any one of these uses may be different from its effective demand level. On the other hand, if effective aggregate demand falls short of effective supply, suppliers will face a sales constraint. We will assume that government expenditure and investment demand, denoted respectively as G^D and I^D, are exogenously determined and are never rationed. Exports on the other hand are subject to rationing. The country is assumed to be a price taker in the competitive world market. However, it is reasonable to assume that in the short run the economy has a limited export capacity E^C. Therefore, for actual export we will always have $E \leq E^C$.[6] Finally, private consumption demand, C^D, is a function of the real disposable income, Y:

$$(5) \quad C^D = C(Y), \quad \text{where} \quad 0 < c = C_Y < 1.$$

The condition on the first derivative of C(.) indicates that the final good is normal and, therefore, the marginal propensity to consume, c, is less than one. Excess of disposable income over consumption is saved as "wealth" holding which represents future consumption. Private consumption may also be rationed in the final good market, in which case households will be "forced" to save. If C is the actual consumption, private savings are:

(6) $S_P = Y - C$,

The real disposable income of the households is defined as:

(7) $Y + X_1 - p(N - X_2) - T$,

where T is the amount of direct tax collected by the government. For algebraic convenience, T is assumed to be exogenous.

(2) The Intermediate Good Market: Imports and production in sector 2 are the two sources of supply of the intermediate input which is solely demanded by the final good sector:

(8) $M + X_2 = N$.

We assume that N is greater than X_2, so that M always remains positive. We also assume that sector 2 never faces a sales constraint. Therefore, in case of excess supply in the intermediate good market, imports should adjust to balance demand and supply. However, if demand exceeds supply, input demand in sector 1 has to be rationed. The supply of imports is determined in the foreign exchange market which is discussed next.

(3) The Foreign Exchange Market: Demand for foreign exchange is p*M, and its supply consists of export earnings, E, and foreign borrowing, B. Therefore,

(9) $E + B = p*M$.

We assume that supply of foreign loans and reserves is fixed at B^S. If demand in the foreign exchange market exceeds supply, then imports have to be rationed and the foreign exchange constraint is said to be binding.[7] In case of excess supply, the country borrows less than B^S; that is, B

varies according to the needs of the country, as long as it is less than B^S.

If M is eliminated between (8) and (9), then the intermediate good market and the foreign exchange market can be combined into one single market:

$$(10) \quad E + B = p^*(N - X_2).$$

In the rest of this paper the above relationship will represent this combined market which will be referred to as the foreign exchange market.

(4) The Wealth Market: Equilibrium in the wealth market implies that total investment should be equal to the sum of private savings, S_P, government savings, S_G, and foreign savings, B:

$$(11) \quad I = S_P + S_G + B.$$

Using (4), (6), (7), and (10), we can substitute for I, S_P, and B in order to come up with the government budget identity:

$$(12) \quad S_G = T + (p - p^*)(N - X_2) - G$$

which states that government savings are equal to tax and tariff revenues less government expenditure.

(5) The Labor Market: This market consists of a fixed supply of uniform labor, L^S, and two demand components in the two sectors, L_1 and L_2. As mentioned above, in this paper we will only consider the cases where supply of labor exceeds its total demand and, thus, part of the labor force is unemployed. Following the non-Walrasian fixed-price literature, we will distinguish two types of unemployment--Keynesian and classical--depending on the situation in the final good market.

Causes and natures of these two types of unemployment are different and each situation calls for a different type of policy action. Excess supply of the final good implies that the constraint on employment originates in the deficiency of effective final demand and that the real wage is not a major consideration in the expressed demand for labor. This situation is usually called Keynesian unemployment. On the other hand, if effective final demand is sufficient and producers are not constrained in their output market, employment will be determined by the profitability condition where the real wage rate plays an important role. This is a classical unemployment situation. In this paper, each one of these unemployment regimes will be studied under two circumstances in the foreign exchange market--excess supply and excess demand situations. We will argue that economic problems and policy impacts in each unemployment regime depend on the foreign exchange situation of the economy.

The wealth market which balances savings and investment in the economy can be considered as residual. This market will be ignored in our analysis by virtue of Walras' law. Since the intermediate good and foreign exchange markets are also combined as one market, only three markets will be left. Combination of excess supply and excess demand situations of these three markets results in eight different regimes, four of which will be examined here. In the next section, we will characterize the two unemployment regimes in our model and in each case we will specify two foreign exchange sub-regimes.

II. Unemployment Regimes and the Foreign Exchange Constraint

(1) Classical Unemployment: The main characteristic of a classical unemployment regime is that in this situation sectoral outputs are determined by profitability conditions. If there is no foreign exchange constraint, the first-order conditions of profit maximization in the final good sector can be written as:[8]

(13) $f_L(L_1, N) = w$, and $f_N(L_1, N) = p$.

These equations determine L_1 and N, which can be used in conjunction with the production function in (1) to find the profit-maximizing level of output. In the intermediate good sector, output is determined in a similar manner. The first-order condition is:

(14) $pg_L(L_2) = w$.

Solving (14) for L_2 and substituting in (2) yields the level of output in sector 2.

Since in a classical unemployment situation, the demand in the final good market exceeds supply, at least one component of final demand has to be rationed. While there are practically infinite number of ways in which this can be done, we will use a simple rationing rule which may be considered as an "optimal" rationing policy. This rule assumes that the government has some control over exports and acts as a rationing agent with the objective of maximizing the domestic use of the final good, i.e., maximizing $X_1 - E$. In the absence of a foreign exchange constraint, this rule means that exports should be the residual component in the final good market so that all domestic demand is satisfied. That is,

$$(15) \quad E = X_1 - C^D - G^D - I^D \leq E^C.$$

This is, in fact, the assumption that is usually employed in the fixed-price open economy models.[9] However, the implications of our rationing rule are quite different when the economy faces a foreign exchange constraint. In this case, the level of exports becomes important and treating it as a residual is no longer a viable policy. The reason is that the export and intermediate input levels are directly linked to each other through the foreign exchange constraint,

$$(16) \quad E + B^S = p^*(N - X_2).$$

If excess demand for foreign exchange is not induced by heavy subsidization of the intermediate input, marginal productivity of imports in the economy should be greater than p^*. In this case, cutting exports by one unit reduces N by $1/p^*$, which leads to a reduction in the output of the final good by more than one unit. This means that if exports are the residual in the final good market, they will go down more than one unit and imports will be cut further. Such a process takes the system more and more away from equilibrium and destabilizes the economy. Note that as the import shortage exacerbates, the marginal productivity of the intermediate input increases and, as a result, the above process accelerates. This process resembles some short-term disastrous developments in some developing countries, such as the foreign exchange crisis in Turkey in 1958.[10] However, since such events are rare and short-lived, we will assume that often governments manage to avoid them and thus operate closer to the above "optimizing" rule.

Let us now examine the implications of maximizing the domestic use of the final good in the presence of a foreign exchange constraint. If we ignore the demand limitation on E for the time being and let $X_1 - E$ be maximized with respect to E, the first-order condition can be written as:

$$(17)\quad \frac{d(X_1 - E)}{dE} = \frac{dX_1}{dN}\frac{dN}{dE} - 1 = \frac{1}{p^*}\frac{dX_1}{dN} - 1 = 0, \text{ hence: } \frac{dX_1}{dN} = p^*.$$

where we have used (16) to determine dN/dE. The second order condition, which is assumed to hold, is discussed in section (1) of the Appendix. Condition (17) has a simple interpretation: exports should be set such that total marginal productivity of the intermediate input in sector 1 is equal to its foreign price. In order to evaluate dX_1/dN, we should respecify the first-order conditions of profit maximization in sector 1--equation (13)--since this sector is now input constrained. We have,

$$(18)\quad f_L(L_1, N) = w, \quad \text{and} \quad f_N(L_1, N) > p.$$

Differentiating (1) and substituting from (17) and (18) yields,

$$(19)\quad \frac{dX_1}{dN} = w\frac{dL_1}{dN} + f_N = p^*.$$

Equation (19) emphasizes the fact that due to the presence of unemployment in the economy, total marginal productivity of the intermediate input is not just its partial effect, f_N, but it also includes an externality effect due to the change in employment in sector 1. Such externality effects are to be expected in non-Walrasian models where factor markets fail to clear. In this case, labor is a factor in excess supply and, therefore, with a shadow price of zero, while its marginal productivity is positive.

Differentiating the equality in (18), one finds that $dL_1/dN = -f_{LN}/f_{LL} > 0$, which shows that the externality term in (19) is positive.[11] Using this result, (19) may be written as:

$$(20)\quad \frac{dX_1}{dN} = -w\frac{f_{LN}}{f_{LL}} + f_N = p^*.$$

Note that condition (20) will not hold if its solution implies a switch to other non-Walrasian regimes or an "optimal" export level exceeding the exogenous export capacity limit. In particular, if

$$(21)\quad p > p^* + w(f_{LN}/f_{LL}),\ \text{then}\ f_N > p^* + w(f_{LN}/f_{LL})$$

due to the inequality in (18). In this case, we always have $d(X_1 - E)/dE > 0$, which implies that when there is a tariff on imports, or sometimes even when import subsidy is small, domestic use of the final good may be expanded if exports are allowed to increase. Thus exports will be allowed to expand to their capacity limit. This situation, i.e., binding export-capacity and foreign-exchange constraints with classical unemployment, is perhaps more common among developing countries.

If (20) has a valid solution when solved together with (18), it gives the "optimal" levels of employment and intermediate input in sector 1, denoted as L^*_1 and N^*, respectively. Given these levels, output of the final good, X^*_1, and the export level, E^*, can be found from (1) and (15). If the export capacity limit is reached before condition (20) can be fulfilled, then the intermediate input level will be determined by the foreign exchange constraint and employment and output of sector 1 will be given by (18) and (1), respectively.

(2) Keynesian Unemployment: Insufficient effective final demand is the main characteristic of Keynesian employment regimes. Output of sector 1 in this case becomes a function of the final demand which depends on the real disposable income. Since the real disposable income is itself a function of sectoral outputs, the system is determined simultaneously. Writing the right hand side of (4) in terms of the final demand levels and substituting for Y from (7), we find,

$$(22) \quad X_1 = C[X_1 - p(N - X_2) - T] + E^C + G^D + I^D,$$

which determines the sales constraint of sector 1. Note that in this situation export capacity limit will always be binding. Under the Keynesian unemployment regime, when the exogenous variables of the model change, equation (22) sets in a multiplier process which is similar to that of the simple textbook Keynesian models.

If the foreign exchange constraint is not binding, the intermediate input and employment levels in this sector will be determined by production function (1), given the sales constraint, and by the following cost minimization condition:

$$(23) \quad \frac{f_L(L_1, N)}{f_N(L_1, N)} = \frac{w}{p}, \qquad \text{while } f_L(L_1, N) > w, \text{ and } f_N(L_1, N) > p.$$

On the other hand, if the economy faces a foreign exchange constraint, the intermediate input level is given by:

$$(24) \quad N = X_2 + (E^D + B^S)/p^*$$

and employment, is found from the production function in (1) using the sales constraint determined in (22). In this situation, instead of (23) we should have,

(25) $f_L/f_N < w/p$, and $f_L > w$, and $f_N > p$.

In both foreign exchange situations, employment and output in sector 2 are determined as in the classical unemployment regime by the profitability condition (14) and the production function (2).

In the following sections, we will examine the comparative statics of the non-Walrasian equilibria specified here. Changes in exogenous variables are assumed to be small enough to rule out the possibility of switching regimes.

III. Domestic Price Policies

In this section, we will analyze the impacts of changes in the real wage rate and the domestic price of the intermediate good on the economy in different unemployment-cum-foreign-exchange regimes. Demand management policies will not be considered in this paper, since their impacts in different foreign exchange situations are more or less the same and similar to the results of other studies in this area.

(1) Classical Unemployment: It is clear from equations (13) and (14) that in a classical unemployment regime without foreign exchange constraint, for the determination of outputs and inputs only domestic relative prices matter. In order to learn about the impacts of changes in p and w in this situation, we differentiate equations (13) and (14), and solve the resulting system for the differentials of the intermediate input and the sectoral employments levels:

(26) $dL_1 = k(f_{NN}dw - f_{LN}dp)$

(27) $dN_1 = k(-f_{LN}dw + f_{LL}dp)$

(28) $dL_2 = h(-dw + g_L dp)$

where, $k = [f_{LL}f_{NN} - (f_{LN})^2]^{-1} > 0$, and $h = -[pg_{LL}]^{-1} > 0$. Equations (26)-(28) show that a policy of real wage restraint would lead to greater factor use in both sectors and raise their outputs. A reduction in p has the same effects on sector 1, but it discourages production in sector 2. In order to examine the effects of these policies on the real disposable income, we differentiate (7) and use the facts that $dX_1 = wdL_1 + pdN$ and $pdX_2 = wdL_2$ to find:

(29) $dY = dX_1 + p(dN - dX_2) - (N - X_2)dp = wdL - (N - X_2)dp,$

where L is the total employment and, thus, $dL = dL_1 + dL_2$. The right hand side of (29) shows that variations in disposable income can be decomposed into two effects: an employment effect and a transfer effect. The first effect emphasizes the fact that in a classical unemployment regime increased labor income due to increased employment is a net gain to the national income, since labor can produce more at no cost to the economy. The second effect is a pure transfer effect between households and the government due to changes in import tariff or subsidy rates. A real wage restraint policy enhances employment and, therefore, adds to the real income. On the other hand, the net effect of a reduction in the price of the intermediate good on income is not clear a priori, since it enhances production in one sector while decreasing it in the other one. Note that under this policy, the transfer effect also plays a role and adds to the real disposable income depending on the volume of imports.

In order to examine the effects of price policies on exports and trade balance, we differentiate (15) and (10) and use (29) to get:

$$(30)\quad dE = dX_1 - dC = dX_1 - cdY = (1-c)wdL + p(dN - dX_2) + c(N - X_2)dp,$$

$$(31)\quad dB = p^*(dN - dX_2) - dE = -(1-c)wdL + (p^* - p)(dN - dX_2) - c(N - X_2)dp.$$

The first term on the right-hand side of (31) shows that the employment effect in (29), despite its positive impact on consumption, leads to increased exports and reduced trade deficit. The reason is that households' marginal propensity to consume is less than one and their increased savings replace foreign savings. The second term is a "trade-distortion" effect. To the extent that the domestic price of imports exceeds their foreign price (or, alternatively, the final good is underpriced domestically), more imports mean greater national product in foreign currency terms and lead to an improvement in the trade balance. Exports always go up when imports increase, since output increases without adding to the real disposable income in excess of the employment effect. Finally, the third term on the right-hand side of (31) is the impact of the transfer effect mentioned above on consumption which causes a reduction in exports and an increase in the trade gap.

Wage and price policies have ambiguous effects on exports and the trade balance. A real wage reduction increases employment, but has unclear effects on imports. A lower price of the intermediate good, on the other hand, has an ambiguous effect on employment, a positive effect on imports, and a positive effect on households' disposable income. Note that the relative responsiveness of the two sectors is quite important in the determination of the direction of the price

policy impacts. If the intermediate-good sector is highly responsive to the relative price changes, exports might actually fall in response to a real wage cut due to the increase in income and consumption which it induces. In this case, a reduction in p may also lead to a fall in exports. However, the impacts of price policies on the trade balance will still depend on the direction of the "trade-distortion."

As we have seen in Section II, when the foreign exchange constraint is binding in a classical unemployment regime, the economy can face two different situations. In one situation, the total "marginal productivity" of imports is set equal to their foreign price and exports are held below their capacity limit. In the second situation, the total "marginal productivity" of imports is greater than their foreign price and export capacity is fully utilized.

In the first situation, levels of employment and intermediate input in sector 1 are determined by (18) and (20). An interesting implication of these equations is that L^*_1 and N^* are independent of B^S and p. An increase in foreign exchange borrowing limit leads to an equal reduction in exports and to an equal increase in the domestic use of the final good, leaving imports and domestic production levels unchanged. An increase in p has a similar net effect on sector 1 through a different mechanism: domestic production of the intermediate good goes up and, since the demand for this good does not change, less foreign exchange is needed. Therefore, exports can be reduced. Note that these are the options of a country which has sufficient export capacity and access to foreign exchange so that it can subsidize its imports to a large extent and vary its export level in order to maintain a constant flow of intermediate inputs for its industries.

A reduction in the real wage rate, in this case, tends to increase employment, as the differentiation of (18) would indicate. However, as we have shown in section (2) of the Appendix since marginal productivity of labor falls, the externality term in (20) diminishes and tends to reduce the optimal levels of intermediate input and employment in sector 1. Moreover, since changes in f_{LN}/f_{LL} depend on the unknown third order partial derivatives of f(.), this factor also adds to the ambiguity of the effect of a real wage change (see the Appendix, equation A.5).

In the more common case where the foreign exchange constraint is binding and full export capacity is utilized, supply of intermediate input is determined by:

$$(32) \quad N = X_2 + (E^C + B^S)/p^*.$$

Equation (18) then determines the employment level in sector 1 and, as before, output can be found through the production function (1). In this situation, a reduction in p has a large negative effect on production, for the simple reason that in the face of constrained imports, it reduces domestic production of the intermediate good and tightens the input constraint of sector 1. This is in sharp contrast with the results of a fall in the price of the intermediate good when the economy does not face a foreign exchange constraint. Changes in the real wage rate, on the other hand, have effects similar to those they had in the absence of the foreign exchange constraint. However, in this case, the impact of a wage cut is greater since it increases employment in both sectors and relaxes the intermediate input constraint at the same time.

Since, in this situation, exports are exogenously given, the impacts of price policies on the domestic use of the final good are the same as their impacts on X_1.

(2) Keynesian Unemployment: When sector 1 faces a sales constraint, the output multiplier process and the net substitutibility between labor and the intermediate input in sector 1 take effect.[12] Differentiation of (22) summarizes the multiplier effect and shows that the output of the final good is inversely related to the level of imports:

$$(33) \quad dX_1 = -[\frac{pc}{1-c}]d(N - X_2).$$

If the foreign exchange constraint is binding, imports will be predetermined and, thus, output of the final good will not change unless exogenous components of the aggregate demand or the foreign exchange situation change. Under this regime, a reduction in p has no direct effect on sector 1, since the intermediate input of this sector is rationed. However, this policy reduces the output of sector 2 and, therefore, the supply of the intermediate input. Sector 1, then, has to hire more labor in order to produce the same amount of output. It is interesting to note that total employment has to rise. The reason is that the intermediate input has high marginal productivity in sector 1 and the reduction in its availability should be compensated by hiring labor in this sector by more than the amount of labor laid off in sector 2. This result follows from the first inequality in (25) and,

$$(34) \quad dL = dL_1 + dL_2 = (-f_L/f_N + w/p)dN$$

where we have used (14), (24), and the differential forms of (1) and (2). In contrast to the above policy, a reduction in the real wage

rate raises output and employment in sector 2 and provides more input for sector 1. Equation (34) then suggests that employment in sector 1 as well as total employment should fall. Note that under a Keynesian unemployment regime with foreign exchange constraint, domestic price policies have no effect the real disposable income. The reason is that since the reduction in output of sector 2 is always exactly equal to the reduction in the intermediate input of sector 1.

The multiplier effect summarized by (33) becomes more important when the economy does not face a foreign exchange constraint and the level of imports can be changed by price policies. A reduction in p, in this case, will have a negative impact on the economy since it encourages substitution of the intermediate input for labor in sector 1 and, at the same time, discourages production in sector 2. Equation (33) shows that these effects should raise the level of imports and, therefore, reduce the output of the final good. Note that the intermediate-input demand N tends to fall when p goes down, but, as we have shown in the Appendix, this effect cannot reverse the process and cause the output to end up at a level higher than where it initially was. The effect of this policy on total employment is not clear since substitution and effective demand effects on L_1 work in opposite directions. Finally, a reduction in the real wage rate has quite different effects in this situation: employment is encouraged in both sectors, demand for the intermediate input falls, and imports decrease. As a result, the trade deficit diminishes, disposable income increases, and production of the final good rises by a multiplier.

IV. Import Prices, Exports, and Foreign Borrowing

In this section the impacts of external shocks in different situations are examined. We will assume that domestic relative prices are not affected by these shocks in the short run. In particular, we assume that when there is a change in the foreign price of the intermediate good, its domestic price will not be affected. In other words, the government adjusts the tariff or subsidy rate such that the domestic relative prices remain the same. Any domestic price change thereafter is regarded as policy response--the effects of which were examined in Section III. In this respect, it is noteworthy that after the oil price shock of the early seventies, many developing countries subsidized their oil imports and only after some time allowed the domestic price of oil to rise gradually.

(1) Classical Unemployment: In a classical unemployment situation without a foreign exchange constraint, an increase in the foreign price of imports would only increase the trade deficit, leaving everything else the same. However, if the economy faces a foreign exchange constraint, such external shocks become quite effective, particularly when the export capacity limit is also binding.

If the foreign exchange constraint is binding but exports are voluntarily held below their demand limit, a change in the foreign price of the intermediate good changes the "optimal" input and production levels. It can be shown that if the second-order conditions of the rationing rule holds, an increase in p^* will reduce L^*_1 and N^* (see section (2) of the Appendix). As one expects, the domestic use of the final good falls exactly by the additional amount of foreign exchange

that the country has to pay for its imports; that is, by imports times the increase in p*. This result can be verified by differentiating (16) and substituting from (20):

$$(35)\quad dE = p^*dN + (N - X_2)dp^*,$$

$$d(X_1 - E) = (-w\frac{f_{LN}}{f_{LL}} + f_N - p^*)dN - (N - X_2)dp^* = -(N - X_2)dp^*.$$

As we saw in Section III, equations (18) and (20) imply that L^*_1 and N^* are independent of B^S and, therefore, an increase in the foreign borrowing limit leads to an equal reduction in exports and increase in the domestic use of the final good, leaving everything else the same.

If the export capacity limit is binding, any increase in B^S leads to an increase in N and drives up the output of sector 1. Domestic use of the final good increases by an amount larger than the increase in foreign borrowing due to the high marginal productivity of intermediate input. To show this, we can write:

$$(36)\quad d(X_1 - E^C) = dX_1 = (\frac{dX_1}{dN})(\frac{dN}{dB^S})dB^S = \frac{1}{p^*}(\frac{dX_1}{dN})dB^S > dB^S,$$

where we have used the fact that, in this case, $dX_1/dN > p^*$. In this situation, an increase in p^* has the same effect as that of a reduction in B^S by the amount of imports times the change in p^*. Therefore,

$$(37)\quad d(X_1 - E)C = -\frac{1}{p^*}(\frac{dX_1}{dN})(N - X_2)dp^*$$

Note that equations (35)-(37) show that under a classical unemployment regime, $dX_1/(p^*dN)$ may be used as a measure of foreign exchange "shortage" to determine the extent to which domestic production is vulnerable to external shocks. $dX_1/(p^*dN) = 1$ implies marginal produc-

tivity of imports is equal to their international price and, therefore, there is no real "shortage."

(2) Keynesian Unemployment: If import prices rise when the economy is in Keynesian unemployment situation with no foreign exchange constraint, it only increases the trade deficit. On the other hand, if the foreign exchange constraint is binding, the same shock leads to an increase in employment and production. This effect is similar to that of an increase in p in the absence of a foreign exchange constraint: when terms of trade deteriorates, imports have to be reduced; this squeezes the supply of the intermediate input for sector 1 and induces more employment. As a result, disposable income increases and begins a multiplier process which leads to higher employment and higher output. A reduction in the borrowing limit has also the same effect.

These results are quite interesting since they show that import price rise and foreign exchange supply reduction have positive impacts when the economy apparently suffers from foreign exchange "shortage," i.e., precisely when one expects the opposite. In this situation, excess demand for imports and "shortage" of foreign exchange are deceptive since intensifying the "shortage" would force a substitution towards unemployed domestic resources and induce higher final demand and higher output. Note that the measure of foreign exchange "shortage" discussed above, i.e., $dX_1/(p^*dN)$, is negative in this case.[13]

The results of this section have interesting implications for the interpretation of the growth performance of developing countries after the oil shock in 1973. In the mid-seventies, many oil-importing developing countries suffered from loss of terms of trade in their

foreign markets. Although the increased supply of capital in the world markets alleviated the problem to some extent, rising debts could not be sustained and most of these countries had to reduce the rate of growth of their imports. The differential effects of these shocks in different countries, of course, depended on the magnitude of shock that each country experienced. However, in light of the above analysis, one also expects the effects to depend on the initial conditions of the country as well as on the policies pursued later. If a country is in a Keynesian unemployment situation, it may actually benefit from a loss in its terms of trade. This might have been the case in India where the GNP growth rate increased somewhat in the mid-seventies.[14] On the other hand, in a classical unemployment situation, the growth rate may fall when import prices increase. As we have seen above, the magnitude of the change in the rate of growth of output depends on the severity of foreign exchange shortage. If imports are productive for the economy, particularly if the country is pursuing second-stage import substitution policies and protecting its intermediate good sectors, loss of purchasing power in foreign markets would cause a great loss in terms of output. This situation may apply to many Latin American countries where growth rates diminished after the oil shock. However, export promoting countries such as Korea and Singapore, which had better foreign exchange situations and more developed export markets as well as lower intermediate good prices, suffered much less.[15] These countries may be classified under the classical unemployment regime with weak foreign exchange constraint and with no binding export limit.

V. Conclusion

In this paper we have examined the role of the foreign exchange market in non-Walrasian fixed-price open economy models. The two-sector model developed in this paper shows that the non-Walrasian unemployment regimes may respond to internal and external shocks differently depending on the situation in the foreign exchange market. The results of experiments with changing domestic and foreign prices as well as the foreign borrowing limit are summarized in Table 1. This table shows that while wage policies have more or less similar effects in all situations, import price policies have different impacts depending on the nature of the unemployment regime and on the foreign exchange situation. The effects of an increase in foreign borrowing and of an import price shock are also different in alternative regimes. Such differences suggest that in "suboptimal" situations there is no unique adjustment process and, therefore, macroeconomic policies should be designed with an understanding of the nature of "disequilibrium" in all markets in the economy. We have also seen that such differences may explain differential growth rates of oil-importing developing countries after the oil crisis in the early seventies.

This paper has also taken a step towards the introduction of a more relevant rationing scheme into the open economy fixed-price models. We have argued that the simple rationing functions which are usually assumed to prevail in the market for exportables can actually be destabilizing when the economy faces a foreign exchange constraint. In this paper, we have explored the implications of a rationing rule which maximizes the domestic use of the final good by setting an "optimal"

export level. This rule gives different priorities to the export component of final demand in different situations. However, in most cases it leads either to the full utilization of the export capacity or to the rationing of exports alone.

Part of the results in this paper are, of course, due to the introduction of an intermediate input into the model. This aspect as well as the foreign exchange constraint make the model more relevant for the study of macroeconomic adjustment mechanisms in developing countries. However, the short-run analysis of this paper is certainly inadequate for an understanding of the full consequences of foreign exchange shortage, input and output rationing and other kinds of disequilibria in these countries.

Appendix

(1) The second-order condition of the domestic-use maximization problem is:

$$(A.1)\quad \frac{d^2X_1}{dE^2} = \frac{1}{p^{*2}}\frac{d^2X_1}{dN^2} < 0.$$

where the differentiation is carried out assuming that w and p* are constant. Substituting for dX_1/dN from (20), carrying out the second differentiation, and rearranging, we find:

$$(A.2)\quad S = -w\left[\frac{f_{LNN}f_{LL} + f_{LLL}f_{LN}/f_{LL} - 2f_{LLN}f_{LN}}{(f_{LL})^2}\right] + f_{NN} - \frac{(f_{LN})^2}{f_{LL}} < 0.$$

Therefore, the second-order condition holds.

(2) The effects of changes in w and p* in a classical unemployment situation with foreign exchange constraint and "optimal" exports can be seen by differentiation of (18) and (20):

$$(A.3)\quad f_{LL}dL_1 + f_{LN}dN = dw,$$

$$(A.4)\quad -wd(f_{LN}/f_{LL}) - (f_{LN}/f_{LL})dw + df_N = dp^*.$$

Carrying out the differentiations in (A.4) and solving for dL_1 and dN, we get:

$$(A.5)\quad SdL_1 = -(f_{LN}/f_{LL})dp^* + (S - R)dw,$$

$$(A.6)\quad SdN = dp^* + Rdw,$$

where $R = w(f_{LLN}f_{LL} - f_{LLL}f_{LN})/(f_{LL})^3$. (A.5) and (A.6) show that partial derivatives of L_1 and N with respect to p* are both negative. The

signs of their partial derivatives with respect to w cannot be determined a priori, since the signs of R and S-R are unknown.

(3) In order to analyze the impacts of domestic policies on our model economy under a Keynesian unemployment regime with no binding foreign exchange constraint, we begin with the differentiation of (1) and (23):

$$(A.7)\quad f_L dL_1 + f_N dN = dX_1,$$

$$(A.8)\quad -b_L dL_1 + b_N dN = f_N dw - f_L dp,$$

where $b_L = wf_{LN} - pf_{LL} > 0$ and $b_N = pf_{LN} - wf_{NN} > 0$. Solving (A.7) and (A.8) for dL_1 and dN yields:

$$(A.9)\quad DdL_1 = b_N dX_1 - (f_N)^2 dw + f_L f_N dp,$$

$$(A.10)\quad DdN = b_L dX_1 - f_L f_N dw + (f_L)^2 dp,$$

where $D = b_L f_N + b_N f_L > 0$. Equations (A.9) and (A.10) show that employment and intermediate input demand increase with X_1 and their prices have the expected signs.

In order to prove that output and the intermediate input demand in sector 1 both fall when p goes down, we substitute for dX_1 from (33) into (A.10) and rearrange to show that, in this situation, imports should increase:

$$(A.11)\quad [D + b_L pc/(1-c)](dN - dX_2) = DdX_2 - f_L f_N dw + (f_L)^2 dp.$$

Obviously, the first and third terms on the right-hand side of (A.11) will be positive when $dp < 0$. Therefore, $dN - dX_2 > 0$, since its coefficient in (A.11) is positive. Finally, $dX_1 < 0$ due to (33).

Notes

[1]Cuddington (1981) and Steigum (1980) consider the effects of import rationing. However, as we will see in this paper, the implications of import rationing are different from those of a "foreign exchange constraint." In particular, the causes of import and export rationing and their rules turn out to be quite different.

[2]The possibility of credit rationing in international capital markets due to asymmetric information and "sovereign risk" has been studied by Sachs and Cohen (1982) and Kletzer (1982). Empirical evidence on the prevalence of borrower rationing in international credit markets for LDCs can be found in Eaton and Gersovitz (1980) and Gersovitz (1982).

[3]In the past, the importance of foreign exchange availability in developing countries has been emphasized by the "two-gap" models. However, these models have relatively rigid structures and, moreover, suffer from the lack of a strong choice-theoretic foundation. Such weaknesses render the "two-gap" models inappropriate for the analysis of domestic policies. For examples of discussions of the "two gap" models see Chenery and Bruno (1962), Chenery and Strout (1966), Bruton (1969), and Findlay (1973).

[4]For example, see Cuddington (1980).

[5]Following Benassy (1975), we define the effective demand or supply of an agent in a given market by the behavior of the agent in that market when he takes into consideration the constraints he faces in all other markets, but ignore any possible constraint he might face in the market he is attending.

[6]The existence of such a constraint on exports in the short run are several. For example, the capacity for production of "exportables" may be limited or infrastructure and marketing facilities may be underdeveloped. In any case, the point of this simplifying assumption is to capture the essence of the difficulties in expanding exports in the short run.

[7]It is important to bear in mind that in the real world, distinction between binding and relax foreign exchange constraint is not as clear-cut as pictured here. However, one can distinguish between "hard" and "soft" constraints in the sense defined by Kornai (1979). If borrowing more than what the country has already borrowed is difficult and costly, the foreign exchange constraint is said to be "hard"; otherwise, it is "soft." Similar definitions apply to other demand and supply constraints in the present model. The strict relationships defined here are simplifications and are meant to render the model manageable.

[8]The second order conditions will hold by virtue of the assumptions made in (3).

[9]For example, see Dixit (1978) and Cuddington (1980, 1981).

[10]See Krueger (1978), p. 50, for details.

[11]Note that the complementarity assumption between labor and intermediate input in (3) is responsible for this result. This assumption may not hold in the long run.

[12]As mentioned above, in sector 1, labor and the intermediate input are always net substitutes.

[13]The result that foreign assistance may have negative marginal productivity in an economy in a Keynesian unemployment situation, was not noticed by the "two-gap" models because they did not allow for demand constraints or substitution between domestic and foreign resources. Thus, a foreign exchange constrained Keynesian unemployment situation could not appear in those models.

[14]These examples are merely suggestive and not based on any case study. Therefore, they might not be truly applicable. In particular, in case of India, increased remittances from the Gulf region and good harvests due to favorable weather, rather than the foreign exchange shortage, may have been the major causes of increased growth in the mid-seventies. However, one also observes the fact that, unlike most other countries, India had no inflation during the same years, suggesting a lack of excess demand and possibly a Keynesian unemployment situation.

[15]Growth performances of these and other developing countries after the oil crisis have been studied by several authors. Most of these studies analyze the policy responses after the oil shock and pay little attention to the initial conditions of these countries. See, for example, Balassa (1980).

References

Balassa, B. (1980), "The Newly-Industrializing Developing Countries after the Oil Crisis," Weltwirtschaftliche Archiv, 116: 142-194.

Barro, R. J. and Grossman, H. I. (1971), "A General Disequilibrium Model of Income and Employment," American Economic Review, 61: 82-93.

Benassy, J. P. (1975), "A Neo-Keynesian Disequilibrium in a Monetary Economy," Review of Economic Studies, 42: 503-523.

Bruton, H. B. (1969), "The Two-Gap Approach to Aid and Development: Comment," American Economic Review, 59: 439-446.

Chenery, H. B. and Bruno, M. (1962), "Development Alternatives in an Open Economy," Economic Journal, 72: 79-103.

Chenery, H. B. and Strout, A. (1966), "Foreign Assistance and Economic Development," American Economic Review, 56: 679-732.

Cuddington, J. T. (1980), "Fiscal and Exchange Rate Policies in a Fix-Price Model with Export Rationing," Journal of International Economics, 10,3: 319-340.

Dixit, A. K. (1978), "The Balance of Trade in a Model of Temporary Equilibrium with Rationing," Review of Economic Studies, 45: 393-404.

Eaton, J., and Gersovitz, M. (1980), "LDC Participation in International Financial Markets: Debt and Reserves." Journal of Development Economics, 7: 3-21.

Findlay, R. (1971), "The Foreign Exchange Gap and Growth in Developing Countries," in Bhagwati, J. et. al. Trade, Balance of Payments, and Growth, North Holland, Amsterdam.

Gersovitz, M. (1982), "The Estimation of the Two-Gap Model," Journal of International Economics, 12: 111-124.

Kletzer, K. (1982), "A Model of International Lending with Default Risk," Department of Economics, University of California, Davis, Working Paper No. 210.

Kornai, J. (1979), "Resource-Constrained Versus Demand-Constrained Systems," Econometrica, 47,4: 801-819.

Krueger, A. O. (1978), Foreign Trade Regimes and Economic Development: Liberalization Attempts and Consequences, National Bureau of Economic Research.

Malinvaud, E. (1977), The Theory of Unemployment Reconsidered, Blackwell, Oxford.

Muellbauer, J. and Portes, R. (1978), "Macroeconomic Models with Quantity Rationing," Economic Journal, 88: 788-821.

Neary, J. P. (1980), "Nontraded Goods and the Balance of Trade in a Neo-Keynesian Temporary Equilibrium," Quarterly Journal of Economics, 95,3: 403-429.

Sachs, J. and Cohen, D. (1982), "LDC Borrowing with Default Risk," National Bureau of Economic Research, Working Paper No. 925.

Steigum, E. Jr. (1980), "Keynesian and Classical Unemployment in an Open Economy," Scandinavian Journal of Economics, 82: 147-166.

Table 1

Domestic Policy Variables

	p					w				
	Classical Unemployment			Keynesian Unemployment		Classical Unemployment			Keynesian Unemployment	
Endogenous Variable	N	B_1	B_2	N	B	N	B_1	B_2	N	B
X_1	-	0	+	+	0	-	?	-	-	0
X_2	+	+	+	+	+	-	-	-	-	-
L^2	?	+	+	+	-	-	?	-	-	-
E	?	-	0	0	0	?	?	0	0	0
X_1-E	?	+	+	+	0	-	?	-	-	0
B^1	?	0	0	+	0	?	0	0	-	0

Foreign Exogenous Variables

	p*					B^S				
	Classical Unemployment			Keynesian Unemployment		Classical Unemployment			Keynesian Unemployment	
Endogenous Variable	N	B_1	B_2	N	B	N	B_1	B_2	N	B
X_1	0	-	-	0	+	0	0	+	0	-
X_2	0	0	0	0	0	0	0	0	0	0
L^2	0	-	-	0	+	0	0	+	0	-
E	0	?	0	0	0	0	-	0	0	0
X_1-E	0	-	-	0	+	0	+	+	0	-
B^1	-	0	0	-	0	0	0	0	0	0

B: Foreign exchange constraint binding

B_1: Foreign exchange constraint binding; export limit not binding

B_2: Foreign exchange constraint binding; export limit also binding

N: Foreign exchange constraint not binding