

A GENERAL EQUILIBRIUM APPROACH TO AGRICULTURAL ECONOMICS

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I

Despite a number of significant advances in agricultural economics in past years, it remains true that general equilibrium approaches to agricultural economics are much less understood than are partial equilibrium approaches, and the conclusions of most studies in this area are less general, less consistent with one another, and less definitive. Perhaps the best illustration of this may be given by the fact that agricultural economic analyses thus far developed fail to provide theoretical answers to some fundamental questions in agricultural economics; such as how agricultural income or output is determined, how relative prices of agricultural output to nonagricultural output are determined, how factor price ratios are determined, how monetary and/or fiscal policies affect these variables, etc. This is not to say that there have been no attempts made to answer these questions. This is to say that such questions have been usually examined by various empirical or descriptive studies rather than theoretical and analytical works. When one believes that every empirical or descriptive study must rest on a theoretical framework, on a set of hypotheses that the evidence is designed to test or to adumbrate, what results such empirical or descriptive studies without proper theoretical frameworks provide, if any, are less persuasive and less general conclusions.

The need for a general equilibrium approach to agricultural economics may be demonstrated by the fact that the production of agricultural output competes with the production of nonagricultural output in the use of the limited amount of inputs given in a national economy, and that agricultural output is not a substitute but, mostly, a complement to nonagricultural output with its consumption purpose. This reflects an aspect of the interrelationship between the agricultural sector and the nonagricultural sector. Another, and more important, aspect of this interrelationship may be understood as intersectoral trade between the two sectors such that each sector concentrates on those goods that it can pro-

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duce relatively more cheaply than the other sector and exchanges the surplus; that is, whatever it produces above requirements for its own needs, as opposed to the surplus goods which the other sector cannot produce at all. At the same time, to this intersectoral trade of goods and services there correspond financial flows between the two sectors. This, indeed, is what Quesnay saw more than two hundred years ago even before Smith, and his famous *Tableau Economique* is a simple but ingenious scheme which shows how much output farmers, landlords and merchants received from one another and how much money they paid one another in return.

Proud of being a distant descendant from Quesnay, an agricultural economist may observe from this aspect a remarkable similarity between the state of exchange between two sectors within a national economy and the state of exchange between two national economies. One step immediately taken upon from the discovery of this resemblance between intersectoral and international trade might be to inquire as to the possibility of an applying international economic theory to the case of intersectoral trade.

A quick examination of theoretical international economics—both international trade and finance—basically reveals a general equilibrium theory, condensing the crucial features of two general equilibrium systems so as to focus on relations between a few essential economic phenomena. A more careful examination reveals an excellent system by which relative output prices, relative input prices, volume of exchange, and each partner's income, are all simultaneously determined. In this vein, one may see its potential applicability to agricultural economic analysis. But applying international theory to intersectoral analysis is far from a trivial exercise because their underlying assumptions differ, and such an application has not been undertaken in past literature.

Thus this paper becomes the first attempt to undertake such an application. In this paper I shall examine the different systems of determining relative prices and income (output) of the agricultural sector along with the nonagricultural sector. I have no intention of doing so in light of Korea's or any other countries' structural or historical point of view. It may be too big an inquiry to be answered at present. Rather I confine myself to a purely theoretical mode of intersectoral trade on a basis of given economic structure, which may be adopted with different emphases on different aspects, depending upon the nature of the problem.

In this paper my primary concern is to search for a comprehensive model of intersectoral trade and finance. A comprehensive model, capable of integrating all the elements of a static equilibrium system, must explicitly include the production side, and the demand side, the complete monetary side, all of which permit the simultaneous interaction of chang-

ing prices and output between the two sectors. This requirement is, however, so general that nearly every economist may accept it on a purely formal and abstract level, although each would choose to express them differently in detail, partly because of the inherent complexities of the real world and partly because of economist's disability of surrounding all problems at once. Thus different restrictions are sometimes imposed, with essential parts remaining untouched, to focus attentions on those parts; and according to these restrictions, a static general equilibrium model is sometimes identified as Walrasian, neoclassical, or Keynesian one.

II

Traditionally, international pure exchange theory belongs to a Walrasian general equilibrium framework, which is identified by a set of assumptions such as full employment, fixed factor supplies, instant malleability of capital, and no real financial assets, all of which tend to make the real world they describe something less than perfectly general. Although the Walrasian model does not contain as many merits as the Keynesian model in this respect, it has the virtue of simplicity in relating directly to a barter system. It may be because of this simplicity why economists still make use of it to understand the system of relative price determination in a barter economy. That is, one of the characteristics of the Walrasian barter model is that all demands and supplies are functions of all prices and nothing else. These price-dependent Walrasian behavioural functions can be easily obtained by the ordinary optimization techniques. However, by Walras' law, the set of the behavioural functions cannot be solvable for equilibrium absolute prices, but only for equilibrium relative prices.

Let us articulate this point more clearly by taking the case of intersectoral trade into consideration. If a barter economy is being considered, divided into two sectors, agricultural and nonagricultural, each providing two kinds of output, agricultural and nonagricultural, both of which are traded under perfectly competitive conditions with primary factors of production in perfectly inelastic supply in each sector, then the excess demand function formulation of the model is exceedingly simple. In order to disclose the issue in more detail, let us start with an optimization problem of an economic agent, ignoring aggregation problems. The maximization problem applies first to the production side of the agricultural sector. Since it is assumed that factor supplies are perfectly inelastic, the optimization problem is now to

$$\text{maximize } P_1 y_1^i + P_2 y_2^i + a[F(y_1^i, y_2^i, x)]$$

where

P_i = the absolute price of the i th output ($i = 1, 2$)

y_i^s = supply of the i th output ($i = 1, 2$)

a = the Lagrange multiplier

x = an input vector.

Notice that the function F in the bracket is the implicit form of the production possibility function of the agricultural sector. Thus we have

$$y_1^s = y_1^s(P_1, P_2)$$

$$y_2^s = y_2^s(P_1, P_2)$$

where the subscript 1 represents for agricultural output, and the subscript 2 nonagricultural output. In a similar manner, for the nonagricultural sector, we get

$$y_1^* = y_1^*(P_1, P_2)$$

$$y_2^* = y_2^*(P_1, P_2)$$

where the astrisks indicate the nonagricultural sector. In the above, both supply functions of agricultural goods and nonagricultural output are expressed as depending only upon the two absolute prices of the two outputs.

For the demand side, we continue to assume the usual optimization technique. The utility maximization problem applies to a household in the agricultural sector, assumed to be a representative agent, maximizing a utility index

$$u = u(y_1^d, y_2^d)$$

subject to

$$P_1 y_1^d + P_2 y_2^d = P_1 y_1^s + P_2 y_2^s$$

We therefore have

$$y_1^d = y_1^d(P_1, P_2)$$

$$y_2^d = y_2^d(P_1, P_2)$$

In a similar manner, for the nonagricultural sector, the corresponding demand functions are

$$y_1^{d*} = y_1^{d*}(P_1, P_2)$$

$$y_2^{d*} = y_2^{d*}(P_1, P_2)$$

It is then required that total national supply of each output equals total national demand for those goods in equilibrium:

$$(1) \quad E_1(P_1, P_2) + E_1^*(P_1, P_2) = 0 \quad (\text{for agricultural output})$$

$$(2) \quad E_2(P_1, P_2) + E_2^*(P_1, P_2) = 0 \quad (\text{for nonagricultural goods})$$

where E_i = excess demand for the i th output. This system of equations with two unknowns seems to be solvable. But, each sector faces an extra equation, a budget constraint:

$$P_1 E_1 + P_2 E_2 = 0 \quad (\text{agricultural sector's budget constraint})$$

$$P_1 E_1^* + P_2 E_2^* = 0 \quad (\text{nonagricultural sector's budget constraint})$$

The budget equation in the above is sometimes called Walras' law. From this law it follows that the system now consists of two equations, (1) and (2), but only one of them, say equation (1), is independent, and it is to serve to determine the two independent variables, P_1 and P_2 , which is impossible. Fortunately, since E_i is homogeneous of degree zero in P_1 and P_2 , equation (1) immediately reduces to

$$(3) \quad E_1(P_1/P_2) + E_1^*(P_1/P_2) = 0$$

with one variable, P_1/P_2 , and this equation, as a result, ensures that the only thing to be determined in this system is the relative price of agricultural output to nonagricultural output.

An assumption implicit in the above was that input supplies are perfectly inelastic in both sectors. This assumption may be applicable to international trade to a degree. However, this is not the case in intersectoral trade because inputs are more or less free to move from one sector to the other within a national economy, and this factor mobility will continue to affect the equilibrium output price ratio. Fortunately, following Samuelson (1948), we suppose that factor price equalization occurs, such that factor price ratios are related one-to-one to output price ratios, regardless of sector. That is, factors will continue to move across the sectors, until factor prices are equalized, such that factor price differentials between sectors cannot persist, and an output price ratio determined at that point will be the equilibrium one. But this does not mean that factor prices are to be equalized between sectors. In reality there may be a persistent margin between sectors for some reasons such as monopsonistic elements or others. The core of factor price equalization is the tendency to equalize factor prices between sectors, and their market forces determine the exact volume of factor flows across sectors, factor prices, and output prices, depending upon market structures.

III

Equation (3) ensures that trade always attains equilibrium due to the Walrasian tatonnement process. But, what if the Walrasian tatonnement process does not work? Asking this question is worth-while, because in reality it does not always work. The provision of an answer to this question might be one of the most interesting achievements in gen-

eral equilibrium theory, leading us to a more realistic theory of the nontatonnement process. To get a feeling for the way in which the nontatonnement process works, consider a set of markets containing a Walrasian auction system. In this system, all exchange is assumed to occur only at Hicks' "right" prices where notional demands equal notional supplies (Hicks 1946). This is the basic tenet that the Walrasian model maintains. However, as Clower asserted, such a transaction mechanism is possible only when prices adjust to disturbances at infinitely rapid rates, and if prices do not adjust at such an instantaneous rate on account of the absence of such an auctioneer, all transactions are not necessarily made at "right" prices. Making a distinction between notional and effective quantities, Clower argued that actual transactions can be made at "false" prices in general, which equalize effective, not notional, demands to supplies. If so, since markets are interrelated, demand or supply in one market is often restricted by a disequilibrium volume of transactions taken place at false prices in other markets. This presumption of the spill-over effect of one market on another is called the dual decision hypothesis. With this dual decision hypothesis, we can demonstrate that there is an interesting situation where the agricultural output market is in equilibrium without clearance of the nonagricultural output market, or conversely, where the latter is in equilibrium without the former being in equilibrium. Between these two situations there exists a situation where both markets are in persistent disequilibrium with stable relative prices. This situation is called quasi-equilibrium.

In Figure 1 we have four notional curves, each corresponding to total demand and total supply of each output such that

$$y_1^d + y_1^{d*} = D_1 \quad (\text{total demand for agricultural output})$$

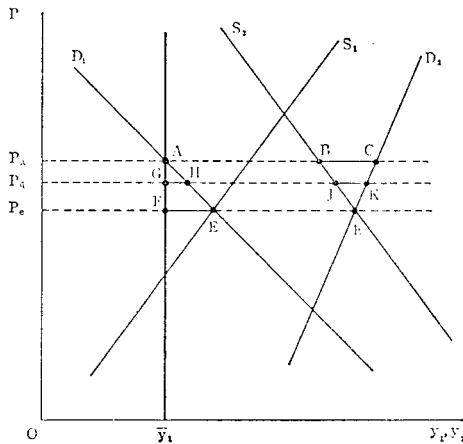
$$y_2^d + y_2^{d*} = D_2 \quad (\text{total demand for nonagricultural output})$$

$$y_1^s + y_1^{s*} = S_1 \quad (\text{total supply of agricultural output})$$

$$y_2^s + y_2^{s*} = S_2 \quad (\text{total supply of nonagricultural output})$$

The vertical axis measures the relative price of the agricultural output to the nonagricultural output. Let us denote it by p (that is, $p = P_1/P_2$). The horizontal axis measures y_1 and y_2 to different scales. The equilibrium relative price p_e is common to y_1 and y_2 . If $p < p_e$, then the agricultural output market has excess demand, while the nonagricultural output market has excess supply. Both market forces will exert to restore p_e . If, on the other hand, $p > p_e$, then the former has excess supply, while the latter has excess demand. Again, the market forces will work to restore p_e . With notional demand and notional supply functions, Walras' law holds. But an entirely different situation is possible, where Walras' law does not maintain.

FIGURE 1.



Let us assume that the production of agricultural output is less than the equilibrium level for some reason such as bad weather. It follows that there is an upper limit for the supply of agricultural output, and this *effective* supply is illustrated by the vertical line $y_1 = \bar{y}_1$. The rest of the curves do not respond to this change because by assumption all the behavioural functions are dependent only upon p and nothing else. At point A, where the vertical line meets the demand curve D_1 , the agricultural output market is in equilibrium with the relative price p_A , which is a false price; but, unlike the case of the Walrasian tatonnement process, in this case all transactions take place at this false price. However, at point A there exists excess demand BC for nonagricultural output which will push P_2 up with P_1 remaining constant, so that

$$\frac{\dot{P}_2}{P_2} = \lambda_2 E_2(p) > 0 \quad \text{with } \dot{P}_1 = 0$$

where λ_2 is a positive adjustment coefficient. As a result, p will decline until the economy reaches nonagricultural output market equilibrium at point E. On the other hand, at point E, although the economy attains nonagricultural output market equilibrium with p_e , so that P_2 stops changing, the agricultural output market has excess demand E'F, which will in turn raise P_1 with P_2 constant, so that

$$\frac{\dot{P}_1}{P_1} = \lambda_1 E_1(p) > 0 \quad \text{with } \dot{P}_2 = 0$$

where λ_1 is a positive adjustment coefficient. Consequently, the relative price again tends to rise. Between p_A and p_e , there is a p_Q where both market forces are in balance, and both markets have excess demands

GH and JK, respectively, with

$$\dot{p} = 0, \quad \dot{P}_1 \neq 0, \quad \text{and} \quad \dot{P}_2 \neq 0.$$

In such a situation, we have

$$\frac{\dot{p}}{p} = \frac{\dot{P}_1}{P_1} - \frac{\dot{P}_2}{P_2} = \lambda_1 E_1(p) - \lambda_2 E_2(p) = 0$$

which is

$$(4) \quad \lambda_1 E_1(p) = \lambda_2 E_2(p) > 0.$$

It was Bent Hansen (1970) who first christened this kind of situation quasi-equilibrium. It is an equilibrium because it contains a stable relative price of p which is a solution of equation (4). But it is quasi because both markets are not simultaneously cleared. Thus it is characterized by a persistent rise of both P_1 and P_2 at the same rate with p remaining constant, but both markets have excess demands. Neither market will be cleared because positive excess demand of the agricultural output market coexists with positive excess demand for the nonagricultural output market.

Quasiequilibrium has two implications. First, it is an example of the violation of Walras' law. Compare equations (3) and (4). Equation (3) says that if there is excess demand in one market, the other market must have excess supply. On the other hand, equation (4) shows a contrary example, maintaining that both markets have excess demand at the same time. Second, both markets experience insufficient supplies compared with demands at p_0 , which may in turn have a direct negative impact on the labor market. That is, to meet a decline in production, producers will reduce employment below the equilibrium level. Thus the economy is now in a situation where inflation coexists with unemployment. This example shows, at least on a theoretical level, the possibility of a quasiequilibrium caused by reduced agricultural production.

IV

A prominent feature of the Walrasian general equilibrium model is the determination of relative prices, and this feature is largely attributable to the price-dependent aspect of the Walrasian behavioural functions. The price-dependent aspect of the Walrasian model differs from the extreme Keynesian income-dependent model which says that all the behavioral functions depend upon income. The difference may be clarified when one observes an interesting development of economic thoughts. The Walrasian assumption of market adjustment in response to a disequilibrating disturbance was that in the short run prices adjust

more rapidly than quantities, so rapidly that the price adjustment can be regraded as instantaneous. Keynes also followed this by assuming that one variable adjusted so quickly that the adjustment could be regarded as instantaneous, while the other variable adjusted slowly. Where Keynes differed from the Walrasian assumption was changing the roles assigned to price and quantity (Leijonhufvud 1969). He assumed that quantity was the variable that adjusted rapidly, while price was the variable that adjusted slowly, at least in a downward direction. Under this Keynes' assumption, the optimum behavior of the individual units of the economy may be regarded as restricted by a quantity constraint instead of a price constraint, because prices are now regarded as parameters in this case. It was Clower (1965) who first embodied the Keynes' assumption as an income, not price-constrained optimization problem in the case of a lack of effective demand, which also denies Walras' law. In doing so, he could successfully provide an explanation of why income appears itself as an argument in the Keynesian behavioral functions, particularly in the famous consumption function. Leijonhufvud (1969) further elaborated and clarified the issue initiated by Clower. All of these efforts were made to stress the importance of the income variable on the Keynesian behavioral functions.

Before a Keynesian general equilibrium model proceeds, it should be emphasized that no position is taken here as to the relative merits of a Walrasian model against a Keynesian model, or vice versa, or on the issue of whether or not the Keynesian model adequately reflects the economics of Keynes. While these issues in the literature are both important and interesting, they will not be considered here. The aim of this paper is the more modest one of providing a comparison of the structures of the two traditional approaches, taking at face value whatever explicit or implicit theoretical arguments are employed, to search for a comprehensive model.

A simple Keynesian two-sector model may begin with the agricultural sector's income accounting:

$$(5) \quad y_1 = C_1 + I_1 + X_1 - F_1$$

and the nonagricultural sector's income accounting:

$$(6) \quad y_2 = C_2 + I_2 + X_2 - F_2$$

where y_i = the i th sector's income (output)

C_i = the i th sector's consumption expenditures

I_i = the i th sector's investment expenditures

X_i = the i th sector's exports to the other sector

F_i = the i th sector's imports from the other sector.

Here we assume for simplicity that there is no government conducting

monetary and fiscal policies. We further assume that all investment expenditures are autonomous in both sectors.

Next, let us define each behavioral function, recalling the importance of income as an argument in the functions:

$$C_i = C_i^a + c_i y_i \quad 0 < c_i < 1$$

$$F_i = F_i^a + f_i y_i \quad 0 < f_i < 1$$

where the superscript *a* stands for the autonomous part. It should be obvious in this two-sector model without a foreign sector that one sector's exports are the other sector's imports. That is,

$$X_1 = F_2$$

$$X_2 = F_1$$

Taking these export and import relationships into account, equation (5) and (6) can be written after some rearrangement as:

$$(7) \quad y_1 = \frac{1}{(1 - c_1 + f_1)} [C_1^a + I_1 + F_2^a - F_1^a + f_2 y_2]$$

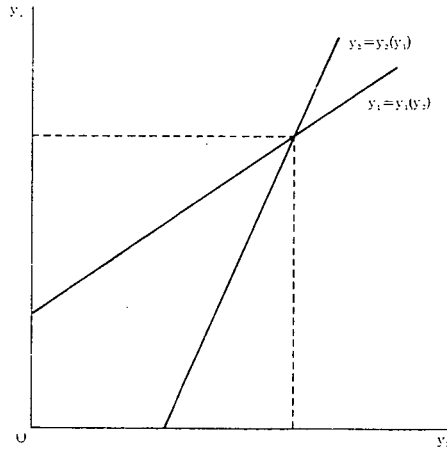
$$(8) \quad y_2 = \frac{1}{(1 - c_2 + f_2)} [C_2^a + I_2 + F_1^a - F_2^a + f_1 y_1]$$

The income of each sector can thus be seen to depend in part on the income-induced and autonomous imports of the other sector. The system now has two equations with two unknowns, y_1 and y_2 . The determination of income in both sectors can be seen by solving this simultaneous equations system. In an alternative way, the solution is illustrated in Figure 2, where the vertical axis measures y_1 and the horizontal axis y_2 . At the intersection point of the two lines, the equilibrium values of y_1 and y_2 are jointly determined. A glance at equations (7) and (8) reveals that given fixed values for the marginal propensities to consume and to import, the agricultural sector's income could be increased via the multiplier effect by a rise in autonomous consumption, investment, or exports as well as by an increase in the non-agricultural sector's income that would be transmitted back to the agricultural sector via $f_2 y_2$.

V

The above Keynesian model is too simple to catch many aspects of the real world. However, we can see at least the core of the system of income determination in a two-sector economy. Let us elaborate the above model a little more by adding elements. In the above we assumed that there is no authority who can implement either fiscal or monetary policies. Let us now include government activities. At the sector level, however, there is a limitation of economic policy, when compared

FIGURE 2.



with the national level. As noted, each sector cannot have access to one of the two basic forms of economic policy—namely monetary authority; the power to create and destroy money must be vested solely in the central government. This implies that in terms of conventional measures, sectors must rely wholly upon sectoral fiscal instruments. However, even though no monetary policy is carried out at the sector level, we can still see the effect of national monetary policy on each sector's economic activities, and sometimes see a national monetary policy which aims to impact on a particular sector.

In order to investigate the potential of fiscal policy at the sector level and monetary policy at the national level, it is useful to set forth a simple income and portfolio model of each sector. The model embodies several important simplifications. First, it is assumed that total government expenditures are allocated between the two sectors exogeneously. Second, it is further assumed that all private investment activities are carried out only in the nonagricultural sector. Third, and more important, all financial assets, irrespective of sector of issue, are assumed to be perfect substitutes for one another and to move without cost between sectors. This assumption implies that interest rate differentials between sectors cannot persist.

Then, an agricultural sector's output and portfolio model may be given by

$$(9) \quad y_1 = C_1(y_1) + G_1 + X_1 - F_1(y_1)$$

$$(10) \quad M_1^d = M_1^d(y_1, i) \quad M_{11}^d > 0, \quad M_{12}^d < 0,$$

and a nonagricultural sector's model by

$$(11) \quad y_2 = C_2(y_2) + I_2(i) + G_2 + X_2 - F_2(y_2)$$

$$(12) \quad M_2^d = M_2^d(y_2, i), \quad M_{21}^d > 0, \quad M_{22}^d < 0.$$

In the money market equilibrium total supply of money is equal to total demand for money:

$$(13) \quad M^s = M_T^d(y, i) \quad M_{T1}^d > 0, \quad M_{T2}^d < 0.$$

in addition, we have the following definitions:

$$(14) \quad y = y_1 + y_2$$

$$(15) \quad X_1 = F_2(y_2)$$

$$(16) \quad X_2 = F_1(y_1).$$

Use of the following notations is made in the above:

M^s = total supply of money

M_T^d = total demand for money

M_i^d = the i th sector's demand for money

i = the rate of interest

y = total output

By Walras' law, we eliminate the financial asset market. Then the system constitutes eight equations of eight unknowns ($y_1, y_2, y, i, M_1^d, M_2^d, X_1, X_2$) with three exogeneous (policy) variables (M, G_1, G_2). Thus the system is solvable with respect to each unknown, and in this way agricultural output is determined.

Now, in order to see the effect on agricultural output of, among other things, changes in G_1 or other policy variables, let us differentiate totally (9) through (16), and have them in rearranging terms. Then the system is given by

$$\begin{bmatrix} 1 - C_{11} + F_{11}, & -F_{21} & 0 & 0 & 0 \\ M_{11}^d & 0 & M_{12}^d & -1 & 0 \\ -F_{11} & 1 - C_{21} + F_{21} & -I_{21} & 0 & 0 \\ 0 & M_{21}^d & M_{22}^d & 0 & -1 \\ M_{T1}^d & M_{T1}^d & M_{T2}^d & 0 & 0 \end{bmatrix} \begin{bmatrix} dy_1 \\ dy_2 \\ di \\ dM_1^d \\ dM_2^d \end{bmatrix} = \begin{bmatrix} dG_1 \\ 0 \\ dG_2 \\ 0 \\ dM \end{bmatrix}$$

The second subscript represents the first derivative. Denoting the determinant of the Jacobian matrix by D and the cofactor of the element in the i th row and the j th column by D_{ij} , the solution of the above system is:

$$dy_1 = \frac{1}{D} [D_{11}dG_1 + D_{31}dG_2 + D_{51}dM]$$

$$dM_1^d = \frac{1}{D} [D_{14}dG_1 + D_{34}dG_2 + D_{54}dM]$$

After some effort, one may obtain:

$$D > 0, \quad D_{11} > 0, \quad D_{s1} < 0, \quad D_{14} > 0, \quad D_{s4} > 0.$$

Thus the potential effects of policies can be summarized as

$$(17) \quad \frac{\partial y_1}{\partial G_1} = \frac{D_{11}}{D} > 0$$

$$(18) \quad \frac{\partial y_1}{\partial M^s} = \frac{D_{s1}}{D} < 0$$

$$(19) \quad \frac{\partial M_1^d}{\partial G_1} = \frac{D_{14}}{D} > 0$$

$$(20) \quad \frac{\partial M_1^d}{\partial M^s} = \frac{D_{s4}}{D} > 0.$$

It is apparent from (17) and (19) that a rise in government expenditures for agricultural sector affects this sector's output and demand for money in the same direction. An interesting result here is a relationship between total supply of money and agricultural sector's output shown in (18). It reveals that a reduction in this sector's output is associated with a rise in money supply. This somewhat novel result may be simply explained by the "Crowding-Out Effect". For ease of exposition, let us assume that the functional form of demand for money is identical in both sectors. When money supply rises, its first impact may be a falling of the interest rate in the aggregate money market with given total output which is not yet affected [see equation (13)]. It follows that at the sector level each sector's demand for money also rises by half of the total rise via the falling of the interest rate with the given sector's income. Recalling the assumption that private investment is carried out only in the nonagricultural sector, one see the other effect of the rise in money supply exerted in a rise in investment in the nonagricultural sector, to which the effect of monetary policy is now transmitted through the fall of the interest rate. The rise in investment will directly raise y_2 in (11). As a result, in order to hold portfolio balance relationship with a rise of y_2 in (12), the nonagricultural sector will demand more money than its share. But at the aggregate level it can do so only by attracting some money from the agricultural sector, which has already shared the other half of the increase in the money supply, and also it will not attract all of the other sector's share because of (20). To do this, the nonagricultural sector will push up the once-declined interest rate. But the interest rate will still be lower than before the money supply changes, and will not eventually restore the old level because the total amount of money in the economy is greater than before. In the process of the attracting money with a lower interest rate, a decline in y_1 would be inevitable to meet the agricultural sector's portfolio balance requirements in (10).

VI

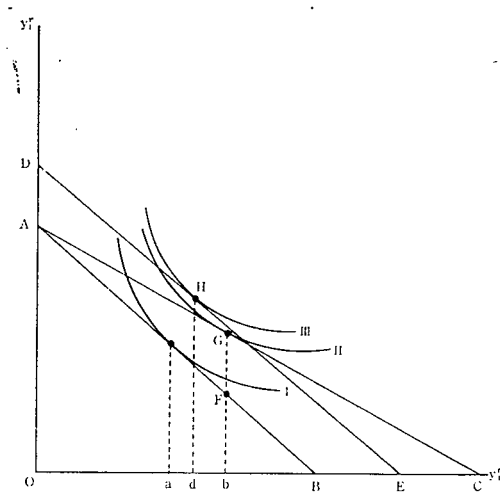
The preceding analysis reveals that a rise in government expenditures on the agricultural sector will raise this sector's output. Agricultural output may be classified into two kinds, agricultural private output and agricultural public goods. Now let us suppose that government expenditures for the agricultural sector, G_1 , are in the form of grants, taking aim at increasing the production of particular agricultural public goods. There are two types of grants; unit grant and lump-sum grant. In view of the widespread use of government grants to agriculture, it is important that we examine the likely effects of each on the allocation of resources.

Consider Figure 3. I, II, III represent the agricultural sector's indifference curves between agricultural public goods, y_1^p , and agricultural private goods, y_1^i . Denote the price of y_1^i by P_1^i and of y_1^p by P_1^p . Then we have $P_1 y_1 = p_1^i y_1^i + p_1^p y_1^p$, which is a budget constraint illustrated by the line AB. In the absence of any grants, the agricultural sector would choose a level of the production of y_1^p equal to Oa with the budget line AB and the indifference curve I. If a unit grant were provided the sector, it will reduce the price of y_1^p and thereby pivot the budget line to AC. Consequently, the production of y_1^p would rise to the level Ob. In this case the total grant amounts to the vertical distance FG. Suppose, however, that instead of this unit grant, the same of FG is given to the sector in a form of a lump-sum grant, with the proviso that these funds were to be used in the provision of y_1^p . Such a grant would shift the budget line from AB to DE. Note that although this grant requires that a sum of FG be spent to provide the output of y_1^p , it does not change the price per unit of the public goods, so that the slope of DE is the same as the slope of the sector's original budget line AB. As a result, the provision of y_1^p would rise to Od, which is less than Ob. The key to this analysis is that the lumpsum grant has only an income effect, while the unit grant has both income and substitution effects. If government's intention is to increase the production of the public goods, it would be more effective to provide a unit grant rather than a lump-sum grant. If, on the other hand, it is to improve the agricultural sector's welfare measured by the level of the indifference curve, the reverse would be the case because the indifference curve III is in a higher position than the indifference curve II.

Conclusion

This paper makes an attempt to broaden the scope of agricultural economic analysis to the extent that the general equilibrium approach is needed in agricultural economics when one is asked as to how relative

FIGURE 3



prices and relative incomes are determined between agricultural and nonagricultural sectors. It also is particularly needed when asked as to what effects the change in the price of agricultural output has on change in the general price level, and vice versa. This kind of question can not be effectively analyzed by partial analysis, or an econometric model without the proper structure form. Although the contents presented in this paper are in the form of the general equilibrium system, they are not complete in the sense that they do not address assets markets other than the money market. A more comprehensive model must be developed.

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