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ON EFFICIENT REDISTRIBUTION THROUGH COMMODITY PROGRAMS AND NEGLECTED SOCIAL COST

by

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On Efficient Redistribution through Commodity Programs and Neglected Social Costs

Since Wallace's classic paper, agricultural economists have routinely used Harberger "triangles" to measure the relative efficiency of agricultural programs. Many papers applied the triangle approach empirically (e.g.,Hushak). But further refinement of the triangle methodology awaited Gardner's development of the surplus-transformation curve. Alston and Hurd extended Gardner's work by considering multiple instrument policies (e.g., subsidies cum production control) and reemphasizing Gardner's recognition that the deadweight losses from taxation can be large enough to change traditional efficiency assessments of alternative agricultural policies.

This paper accepts Alston and Hurd's ultimate premise that "deadweight costs of taxes elsewhere in the economy are too important to be ignored in analyzing farm programs" (p.155). Because accurate consideration of these costs requires modelling the tax mechanism, a general-equilibrium model seems most appropriate. General-equilibrium models provide a means for analyzing the intersectoral consequences of agricultural and tax policies that is often absent in theoretical agricultural policy analyses (e.g., Hertel). These effects traditionally were ignored on the premise that they were empirically insignificant. However, this presumption seems increasingly suspect as empirical evidence accumulates suggesting the contrary (see, for example, Australian Bureau of Agricultural and Resource Economics).

This paper's primary goal is to develop a simple general-equilibrium model of farm-program incidence in the presence of distortionary tax policies for a small-open economy. The small-economy approach has the distinct advantage of relative simplicity while conclusively demonstrating that farm programs can have important intersectoral effects even absent commodity price adjustments. Such models are common for other sectors but to the author's knowledge none has been developed for agriculture.

After the model is developed, it is first used to analyze the incidence of three separate agricultural-policy instruments ("decoupled" lump- sum transfers, supply control through input retirement (with side payments), and production subsidies) in the presence of distortionary income taxation. After the incidence of farm programs on various sectors of the economy is analyzed, the paper revisits the issue of the relative efficiency of farm programs. Unlike the work of Gardner and Alston and Hurd, relative efficiency is judged using the Kaldor compensation criterion: The Kaldor test has three distinct advantages which are especially important for general-equilibrium models: The test reduces to examining how the balance of trade is affected by farm policy changes (it is simple to apply); it avoids the interpersonal utility comparisons implicit in the triangle approach ($1 in taxpayers' costs receives the same social weight as $1 lost by consumers); and it is easily related to the utility possibility frontier which is the natural generalization of Gardner's surplus transformation curve.

Although many of the general-equilibrium results are ambiguous, the analysis clearly shows that traditional calculations of the cost and benefits of farm programs based on partial-equilibrium models systematically overstate the benefits farmers realize from farm programs. Virtually all of the general-equilibrium consequences of introducing farm programs (e.g., higher factor prices, higher taxes) erode farmer benefits from these programs. Moreover, the general-equilibrium analysis uncovers possible anomalies which more partial models cannot capture. As examples: raising per-unit agricultural subsidies could theoretically raise enough government tax revenues to more than compensate for increased program expenditures; and making decoupled payments may hurt farmers.

A Simple General-Equilibrium Model of Farm Programs

The economy is small and has three consumable goods: an agricultural commodity, a nonagricultural commodity, and leisure. There are three factors of production: an input specific to the production of the agricultural commodity, an input specific to the nonagricultural commodity, and a mobile factor (referred to as labor for mnemonic purposes but it should be taken to represent all factors mobile between sectors) used in both agricultural and nonagricultural production. Technical production relations are governed by the production possibilities set

(1) $$y = \{(y_a, y_n, A, X, L): y_a \in Y_a(A, L_a),\ Y_n \in Y_n(X, L_n),\ L_a + L_n = L\}$$

Here y_i $(i = a,n)$ represents production of the agricultural and nonagricultural commodity respectively. A is the factor of production specific to agricultural production (for mnemonic purposes refer to A as land), X is the factor of production specific to nonagricultural production, and L is labour. Each Y_i $(i = a,n)$ is a closed, convex cone; i.e., production exhibits constant returns to scale. All producers are profit maximizers so that equivalent representations of Y_i $(i = a,n)$ are given by the net-revenue functions:

(2) $$\hat{R}^a(p_a, w, A) = \text{Max } \{p_a y_a - wL_a : y_a \in Y_a(A, L_a)\}$$

$$\hat{R}^n(p_n, w, X) = \text{Max } \{p_n y_n - wL_n : y_n \in Y_n(X, L_n)\}$$

Here p_i $(i = a,n)$ is the strictly positive price of the ith commodity, and w is the strictly positive price of labour. Because the economy is small, p_a

and p_n are exogenous. These net-revenue functions are always convex, continuous, and positively linearly homogeneous in p_i and w. Moreover, they satisfy Shephard's lemma. In what follows each R^i will be presumed to be at least twice continuously differentiable. By constant returns

$$(3) \qquad \hat{R}^a(p_a,w,A) = A\,\hat{R}^a(p_a,w;\,1) \equiv A\,R^a(p_a,w)$$

$$\hat{R}^n(p_n,w,X) = X\,\hat{R}^n(p_n,w;\,1) \equiv X\,R^n(p_n,w)$$

The function $R^i(p_i,w)$ $(i = a,n)$ is the marginal rent (quasi-rent) of the factor specific to the ith industry at prevailing prices. As such it captures the fact that in an otherwise competitive economy the effects of farm programs are ultimately capitalized in returns to the fixed factors leaving zero economic profit from these programs. The true beneficiaries (victims) of farm programs, therefore, are the owners of these fixed factors.

The owners of A, X, and L are the economic agents of interest. Each's preferences are represented by aggregate expenditure functions which are concave, twice continuously differentiable, nondecreasing, and positively linearly homogeneous in prices and strictly increasing in an utility indicator. Denote the expenditure function for the owners of sector-specific input i as

$$(4) \qquad E^i(p_a,p_n,u_i) \qquad i = A,X$$

where u_i is the utility of the of the owners of the ith factor of production. The mobile factor (labour) owner's expenditure function is

$$E^L(p_a,p_n,w,u_L)$$

Owners of labour consume both the agricultural and nonagricultural commodity (as do the owners of A and X). In addition they also consume their own input (labour) in the form of leisure. Standard duality results imply that each expenditure function is dual to a quasi-concave utility function.

Government Intervention and Equilibrium

Absent government intervention in a small-open economy, the full-employment equilibrium is given by the consumer budget constraints and the requirement that all of the labour supplied is employed. Symbolically, the budget constraints are:

$$
\begin{aligned}
(5) \qquad & E^A(p_a,\ p_n,\ u_A) = R^a A \\
& E^X(p_a,\ p_n,\ u_X) = R^n X \\
& E^L(p_a,\ p_n,\ w,\ u_L) = w\hat{L}
\end{aligned}
$$

where $\hat{L}$ is the total endowment of time to the owners of labour.

To derive the labour-supply function, one must first solve the labour budget constraint for u_L in terms of p_a, p_n, w, and $w\hat{L}$ to get an indirect utility function. Denote the result as u_L^*. Shephard's lemma applied to R^a and R^n implies that the labour-market equilibrium condition is

$$(5') \qquad - R_2^a(p_a,w)A - R_2^n(p_n,w)X = \hat{L} - \ell(p_a,p_n,w)$$

where $\ell(p_a,\ p_n,\ w) \equiv E_3^L(p_a,p_n,w,u_L^*)$ is the utility maximizing leisure choice which is homogeneous of degree zero in all prices. (Throughout the paper the convention is that subscript i of a function denotes the partial derivative with respect to the ith argument. To conserve space function arguments will typically be suppressed). Because of the possibility of Giffen-type behavior, the leisure demand curve can be upward-sloping in w resulting in a backward-bending labour supply curve. In what follows, however, always presume that this phenomenon does not occur so that ℓ_3 is always nonpositive.[1] Equilibrium relation (5') is portrayed pictorially in Figure 1.

The following policy implements are considered: a production subsidy to agricultural production denoted by $s \geq 0$, an input-retirement program where producers of the agricultural commodity are paid the amount $b \geq 0$ for each unit of A ($\hat{A} \geq 0$) retired from production, a direct ("decoupled") lump-sum transfer ($D \geq 0$) to the owners of A, and an earnings (income) tax ($t \geq 0$) levied on the owners of X and L. These interventions operate in the following manner: the government revenue from the earnings tax is used to finance the payments to the owners of A.

The earnings tax is distortionary because it affects the labour/leisure choice. If labour supply is perfectly inelastic the earnings tax is not distortionary. The earnings tax has no direct effect on the derived demands for labour in the production of either the agricultural or nonagricultural good: Farmers are not subject to the tax, and the owners of X perceive it as a profit (quasi-rent) tax.

Introducing this form of government intervention requires reformulating the equilibrium relations as:

$$E^A(p_a, p_n, u_A) = R^a(A - \hat{A}) + b\hat{A} + D \tag{6}$$

$$E^X(p_a, p_n, u_X) = (1 - t)R^n X$$

$$E^L(p_a, p_n, w(1 - t), u_L) = (1 - t)w\hat{L}$$

$$-R^a_2(p_a + s,\ w)(A_n - \hat{A}) - R^n_2(p_n, w)x = \hat{L} - \ell(p_a, p_n, w(1 - t)).$$

The effect of small perturbations in the levels of t, s, and $\hat{A}$ on the equilibrium wage (w) are:

$$\frac{dw}{dt} \equiv w_t = \frac{-\,w\ell_3}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1 - t)} \geq 0 \tag{7}$$

$$\frac{dw}{ds} \equiv w_s = \frac{- R^a_{12}(A - \hat{A})}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1 - t)} \geq 0$$

$$\frac{dw}{d\hat{A}} \equiv w_A = \frac{R^a_2}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1 - t)} \leq 0$$

The signs of these inequalities follow by the convexity and homogeneity properties of the quasi-rent functions and the downward sloping demand for leisure. Figure 1 illustrates. Consider first an increase in the earnings tax from zero to a small but positive amount t. The labour-supply function shifts inward as the effective leisure price to the owners of L falls everywhere from w to w(1 - t). More leisure is consumed at all wage levels meaning less labour is supplied. The equilibrium wage necessarily rises. Put simply, the earnings tax is a disincentive to work. Raising taxes thus must increase w.

Now consider an acreage reduction program. Agricultural derived demand for labour shifts inward as acreage is retired. With less demand for labour the wage falls. Similarly, an agricultural production subsidy increases the derived demand for labour (this follows from the homogeneity conditions). The wage rises. Notice, however, that changes in either b or D leave the wage unaltered (although as we shall see later introducing a government budget constraint will change this result).

Program Incidence Without A Binding Budget Constraint

The traditional partial-equilibrium analysis of the incidence of agricultural programs presumes that agriculture does not compete for resources whose scarcity is reflected by an upward sloping supply schedule. In terms of this model, the key assumption to justify such an analysis is that labour is perfectly elastically supplied. The shortcomings of this presumption are manifest: As one example, agricultural programs are known to suffer from "leakage" or "slippage": program benefits targeted at farmers are dissipated to input suppliers and others. Estimates suggest that it takes as much as $4 in government expenditures to raise agricultural incomes by $1 (Council of Economic Advisers).

To clarify the channels of incidence of agricultural programs we first analyze program incidence in the absence of a government budget constraint. Readers might wish to interpret this preliminary analysis as "short-run" in the sense that it allows the country to run a balance of trade deficit[2] that is costlessly funded by borrowing from abroad. Even given the real-world proclivity of the U.S. government for outlays to exceed revenues, this situation is highly unrealistic and cannot long be maintained. (After all one of the largest U.S. government outlays is its interest payment). Its sole purpose, therefore, is to facilitate analysis of the complex general-equilibrium interactions. The analysis is complete only after incorporating the government budget constraint.

Assuming that t is independent of the subsidy rate (i.e., the government does not face a budget constraint), the effects on the owners of A, X, and L of a small perturbation in s is found by differentiating (6) with respect to s:

(8)
$$E_3^A \frac{du_A}{ds} = R_1^a\ (A - \hat{A}) + R_2^a\ (A - \hat{A})w_s$$

$$E_3^X \frac{du_X}{ds} = (1 - t)R_2^n\ X\ w_s$$

$$E_4^L \frac{du_L}{ds} = (1 - t)(\hat{L} - \ell)w_s$$

The last expression uses Shephard's lemma. Expressions (8) are monetary measures of welfare changes experienced by each sector. The coefficients of the utility change on the left-hand side of each equation is the reciprocal of that sector's marginal utility of income. The terms on the right of (8) measure how income received by each sector is affected by the policy change. Incidence comparisons, thus, can be made in either welfare or income terms.

To understand (8) note that a small increase in s has two immediate effects on the agricultural sector: it raises the subsidy earnings on current production (the first term in the first expression in (8)) and it stimulates agricultural production. The latter increases the demand for labour putting upward pressure on w. As w rises, some of the earnings gain that farmers realize from the subsidy increase is eroded (the second term) leaving an apparently ambiguous effect. But this erosion is only partial. Expression (7) and the homogeneity conditions imply that the first expression in (8) reduces to

$$\frac{R^a_{22}(A - \hat{A})}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1-t)} \frac{R^a(A - \hat{A})}{(p_a + s)} + \frac{R^n_{22}X - \ell_3(1 - t)}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1 - t)} R^a(A - \hat{A})$$

which is positive but less than $R^a_1(A - \hat{A})$. Farmers gain. It is important to note, however, that the traditional measure of the farmers' marginal gain would be $R^A_1(A - \hat{A})$. This measure systematically overstates the true incidence (absent a budget constraint) by $R^A_2(A-\hat{A})w_s$.

As w increases the earnings of L-owners increase: labour income and thus welfare rises. Put another way, some of the subsidy benefits "leak" to the owners of L.

The rise in w associated with changing s forces the X-owners to pay more for their current production plans. They suffer a loss at the margin equalling the product of the labour that they employ times (1 - t).

Changing acreage retired ($\hat{A}$) has the following marginal effects:

$$E_3^A \frac{du_A}{d\hat{A}} = (b - R^a) + R_2^a(A - \hat{A})w_A \tag{9}$$

$$E_3^X \frac{du_X}{d\hat{A}} = (1 - t)R_2^n X w_A$$

$$E_4^L \frac{du_L}{d\hat{A}} = (1 - t)(L - \ell)w_A$$

From (7), an increase in $\hat{A}$ thus adversely affects L-owners but enhances the position of the X-owners. Retiring acreage decreases the derived demand for L and lowers w. The owners of L, therefore, experience an income loss. The owners of X, on the other hand, enjoy decreased competition for the scarce labour input and thus higher returns.

What happens to the owners of A depends critically upon the magnitude of program parameters. If the diversion payment (b) is less than per-acre rent, farmers suffer an immediate marginal loss on each acre equalling the difference between b and R^a. (For example, in the case of an unpaid diversion they just lose R^a.) Because the farmer receives the entire diversion payment as rent but only receives a portion of the subsidy payment as a rent, it is often thought to be cheaper to divert acres than to subsidize production. A further reason exists, however, why acreage retirement may be very effective in raising farm incomes. A falling w helps farmers recoup land-rent losses in the form of cheaper factor payments. The second term in the first expression in (9), therefore, captures farmers' "intensification" response to acreage-retirement programs.

Production-control critics have long argued that curbing production via acreage reduction is difficult because farmers respond by farming remaining acres more intensively. More variable factors of production are committed to the remaining acres. However, absent changes in w, per-acre utilization of the variable factor (labor) is constant. Only as w falls do farmers have the marginal incentive to "intensify." The reader should notice, in particular, that an intensification effect is present here even in the absence (by the small country assumption) of the agricultural-price increase that would normally be associated with acreage retirement. Acreage retirement makes w fall encouraging more intensive farming even in the absence of a change in (p_a/p_n).[3] Without the general-equilibrium labour linkage no "intensification" effect would occur. Because the intensification effect raises land rent as more acreage is retired, the ultimate effect of this policy depends on b. As b gets very large, the owners of A always gain. However, as b goes to zero the owners of A can lose provided that the intensification effect is less than marginal rent.

Expressions (7), (8), and (9) illustrate why general-equilibrium effects are important to agricultural-policy analysis. For example, (9) shows very clearly that acreage retirement has important implications outside of the purely farming sector. Such policies spread beyond agriculture in the form of lower factor returns. Because changes in b or D do not directly affect w, perturbations in either only affect the agricultural sector -- changing agricultural income at the margin by 1 and $\hat{A}$ respectively. Owners of X and L are unaffected while the owners of A clearly gain. This apparent "zero slippage" property has led many to advocate the "decoupled" approach to agricultural policy.

Distortionary Taxation and Neglected Social Costs

Agricultural-program changes carry a cost in terms of increased (or decreased) government expenditure. Ignoring these effects ignores an important channel through which agricultural policy may impinge upon other sectors. Before Alston and Hurd's contribution, the traditional approach to assessing program incidence just subtracted program expenditures from the sum of producer and consumer surplus to arrive at the net program benefit (Gardner). This practice presumes that taxation to finance agricultural programs is nondistortionary. Existing empirical evidence suggests the contrary (Fullerton). To compensate, Alston and Hurd suggest weighting taxpayers more heavily than producers or consumers in surplus calculations. This solution is approximate. Here the source of all deadweight tax and subsidy losses are identified directly. In what follows, we first compute general-equilibrium tax multipliers, i.e., marginal changes in t required to compensate for changes in policy instruments. These multipliers are then used to compute the general-equilibrium incidence of various program alternatives.

General-Equilibrium Tax Multipliers

The government's net expenditure on farm programs is

$$sR_1^a(A - \hat{A}) + b\hat{A} + D - t(R^nX + w(\hat{L} - \ell)). \tag{10}$$

Given a predetermined level of net expenditures (i.e. a government deficit or surplus), setting expression (10) equal to that number implicitly determines the level of the marginal earnings tax (t) consistent with general equilibrium and that deficit or surplus. To visualize this process graphically notice that a marginal increment in t decreases farm program expenditures by the amount $sR_{12}^a(A - \hat{A})w_t$. In words, increasing t causes labor to be withdrawn from the market in favor of greater leisure consumption by L owners. The associated rise in w leads to diminished agricultural production and hence lower subsidy payments. This is illustrated in Figure 2 by the downward sloping (in t) government farm-program expenditure curve.

A marginal increment in t, on the other hand, changes government revenues by $R^nX + w(\hat{L} - \ell) + tw^2\ell_3 + t(R_2^nX + (\hat{L} - \ell) - w\ell_3(1 - t))w_t$. The term $(R^nX + w(\hat{L} - \ell))$ is the direct marginal tax-revenue generated by increasing t. The term, $tw^2\ell_3$, reflects the disincentive to work associated with raising t and the implied effect on tax revenues. This expression is negative. The term, $t(R_2^nX + (\hat{L} - \ell))w_t$ captures the tax's distortionary impact on labor markets through its tendency to increase wages. As w rises with t (see (7)) nonagricultural production becomes less profitable. The earnings of the X-owners falls. Hence, so does the tax revenue from X-owners. But as w increases the earnings of the labor (and hence the tax revenue) still employed rises. That latter tax-revenue increase (use the equilibrium conditions for the labor market) necessarily dominates the tax revenue losses from the X-owners, i.e., $t(R_2^nX + (\hat{L} - \ell))w_t = -tR_2^a(A - \hat{A})w_t > 0$. Finally, as w rises less leisure is demanded and more labor is supplied (the final term). Again tax revenues increase by this effect.

Thus, the slope of the government tax-revenue curve in t is ambiguous. The possibility that revenues could rise with a tax cut is a manifestation of the "Laffer curve". Its origin is the disincentive to work that increasing t brings, $(tw^2\ell_3)$. Absent a distortionary income tax, no such possibility could occur. In what follows, presume that the Laffer effect is not large enough to dominate the other terms. The government tax-revenue curve, thus, is upward sloping in t as depicted in Figure 2. If the government balances its budget, the equilibrium tax rate is given by t^0 at the intersection of these two curves in Figure 2. If the government is allowed to run a deficit, of say, B, the tax rate consistent with general equilibrium and the deficit is $\hat{t}$.

Determining the true general-equilibrium incidence of agricultural programs when the budget constraint is binding next requires determining how agricultural program changes impinge upon t. (For simplicity, assume henceforth that the budget is balanced. Qualitative results are robust to this assumption.) Some calculus and algebra show that the general-equilibrium adjustment in t (the tax multiplier) for a change in D is:

$$\frac{\partial t}{\partial D} = \frac{1}{R^n X + w(L - \ell) + tw^2\ell_3 - Mw_t} \equiv \frac{1}{T} \tag{11}$$

where $M \equiv [sR^a_{12}(A - \hat{A}) + t(R^a_2(A - \hat{A}) + w\ell_3(1 - t))] \leq 0$. By the presumption that the government tax-revenue curve is upward sloping (i.e., the Laffer effect is negligible), $T > 0$. The economics are clear: Increasing decoupled payments, D, shifts the government farm-program expenditure curve in Figure 2 to the right. At the prevailing marginal tax rate a deficit equalling the change in D emerges. Removing the deficit requires a tax rise.

The term labelled M in (11) plays a key role in what follows. Therefore, it is worth considering separately. In words, M measures how net government expenditures respond to a marginal change in w. A small increase in w decreases net government expenditures for two reasons: It simultaneously discourages agricultural production thus lowering subsidies $(sR^a_{12}(A - \hat{A}))$ and it increases the tax base, $t[R^a_2(A - \hat{A}) + w\ell_3(1 - t)]$. Thus $M \leq 0$. Any policy change $(s, \hat{A}, t)$ affecting equilibrium wages has two distinct effects: a direct impact effect, and an indirect policy effect channelled through the labor market and measured by $tw^2\ell_3 - Mw_i$ $(i = s, \hat{A}, t)$. Notice, in particular, that when labour is in fixed supply $T = R^n X + w(\hat{L} - \ell)$, i.e., the indirect effect is absent. It is this indirect effect that is the source of the deadweight loss from taxes.

Changing the payment rate on retired acres (b) changes t by

$$(12) \qquad \frac{\partial t}{\partial b} = \frac{\hat{A}}{T}$$

As long as $\hat{A}$ is unchanged, raising the diversion payment acts like a "decoupled" payment in that it simply increases the deficit by the amount total payments increase. It has no direct effect on labour markets.

Increasing s changes farm-program outlays by

$$(13) \qquad R^a_1(A - \hat{A}) + sR^a_{11}(A - \hat{A}) + sR^a_{12}(A - \hat{A})w_s.$$

The impact effect of raising s is to increase subsidy payments on existing production while calling forth more supply, $R^A_1(A-\hat{A}) + sR^A_{11}(A-\hat{A})$.

As agricultural production expands, however, labour must be bid away from nonagricultural production. Consequently, w rises. The rise in w chokes off some of the initial agricultural supply expansion ($sR^a_{12}\,(A-\hat{A})w_s$) thus tending to diminish subsidy payments. The homogeneity conditions imply that a sufficient condition for program expenditures to increase is that the *subsidy component of the agricultural producer price*, $(s/(p_a + s))$, be larger than the general equilibrium flexibility of w to changes in the subsidy, $\frac{w_s s}{w}$. This is always true. Expression (7), and the homogeneity condition imply

$$\frac{s}{p_a + s} - \frac{w_s s}{w} = \frac{s}{p_a + s}\left[\frac{R^n_{22}X - \ell_3(1 - t)}{R^a_{22}(A - \hat{A}) + R^n_{22}X - \ell_3(1 - t)}\right] \geq 0.$$

Pictorially, therefore increasing s is depicted as shifting the government expenditure curve in Figure 2 to the right.

Interestingly raising s also increases tax revenues at the margin by the amount $- t[R^a_2(A - \hat{A}) + w\ell_3(1 - t)]w_s$. To see why notice that increased agricultural production bids up w. Tax revenues are lost from the nonagricultural sector as R^nX falls with the increase in w. But these tax losses are more than matched, however, by increased tax revenues from labour and the consequent labor-supply increase. Because tax revenues actually increase with s, the tax-revenue curve in Figure 2 shifts to the right. If it shifts far enough to the right it can actually lead to a lower general-equilibrium tax rate. In general, therefore, the s-general-equilibrium tax multiplier (see (14)) may be either positive or negative.

$$\frac{\partial t}{\partial s} = \frac{R^a_1(A - \hat{A}) + sR^a_{11}(A - \hat{A}) + Mw_s}{T} \tag{14}$$

Although (14) is ambiguous, several things are apparent. First, the more interventionist is the subsidy policy, i.e., the higher is the subsidy component of the agricultural producer price the greater is the likelihood that taxes must rise to balance a subsidy increase. Second, the larger is existing agricultural production (the more important agriculture is in the overall economy) the greater is the chance that t must rise. And finally, the larger are t (the more confiscatory the income tax) and agriculture's share of the labor force, the greater is the chance that t might fall in response to increasing s. For situations like those that characterized U.S. agriculture at the time of the 1985 Farm Bill when the subsidy component exceeded 40% for some commodities and production of program commodities was very large, a tax increase seemingly would be needed to balance the subsidy increase. The fact that raising subsidies may actually generate enough tax-revenues to let tax rates fall is yet another manifestation of the Laffer-type phenomenon already mentioned. In a highly distorted economy apparently cross-cutting policies can often operate in the same and not opposite directions.

Ultimately, it is because expression (14) can be negative (and other such anomalies) that the Alston-Hurd critique of efficiency calculations is so important. Because a highly distorted economy (e.g., with an extremely high marginal tax rate and a large agricultural labor share) can lead to situations where traditional intuition about the effects of a subsidy policy on tax receipts can go completely astray, general pronouncements about the direction that agricultural policy reform should take from partial-equilibrium models must be made with extreme care.

Retiring acreage from production requires the following marginal adjustment in t

$$(15) \qquad \frac{\partial t}{\partial \hat{A}} = \frac{(b - sR_1^a) + Mw_a}{T} .$$

Expression (15) is also ambiguous. The immediate impact of increasing $\hat{A}$ is measured by the first term in the numerator of (15). As acreage is retired, the government spends b dollars more per acre retired. But as acreage is withdrawn production and subsidy payments decline. Whether the impact effect is positive or negative depends upon the relative magnitude of b and the per-acre "deficiency payment" (sR_1^a). So yield on retired acres (R_1^a) as well as the relative size of the diversion payment (b) and subsidy is important here. For an unpaid diversion, i.e., b = 0, the government clearly saves. This is the traditional intuition that has led OMB and other government agencies to advocate supply control through involuntary acreage retirement programs (ARPs) as a budget-saving device. But more is involved. The secondary effects, induced through the labour market of withdrawing acreage from retirement and measured by Mw_a, are positive. As acreage is retired, labor demand falls putting downward pressure on w. Labor earns less and hence tax revenues from the owners of L decrease. Tax earnings from the owners of X increase but they are more than matched by the decreased tax revenues from L. Because retiring acreage also cuts into tax revenues, the likelihood that a higher marginal tax rate is necessary to restore budgetary balance increases.

We now consider the impact on the incomes of the owners of A, X, and L of a "decoupled" approach, increased subsidy payments, and a change in the acreage retired from production.

General-Equilibrium Incidence of a Decoupled Approach

The general-equilibrium incidence on the owners of A, X, and L, respectively, of an increase in the decoupled payment (D) to farmers is measured by:

$$(16) \qquad E_3^A \frac{du_A}{dD} = 1 + R_2^a(A - \hat{A})w_t \frac{\partial t}{\partial D}$$

$$E_3^X \frac{du_X}{dD} = \left[(1 - t)\, R_2^n\, X\, w_t \;-\; R^n X\right]\frac{\partial t}{\partial D}$$

$$E_4^L \frac{du_L}{dD} = \left[(1 - t)(\hat{L} - \ell)w_t \;-\; w(\hat{L} - \ell)\right]\frac{\partial t}{\partial D} .$$

First consider what happens to farmers. Increasing D_o results in an impact marginal gain of one dollar. But D increases must be matched by tax-revenue increases and increasing the tax rate drives up w (see (7)). Some of the farmers' impact gains from the decoupled payment are eroded by higher wages. Here farmers lose at a rate equalling current hirings of labour times the increase in w. Overall the effect on farmers of an increase in D is ambiguous. It seems possible, although perhaps not plausible, that farmers may lose from being granted a lump-sum increase. If farmers are to lose they must use labour intensively and leisure demand must be very sensitive to tax rate changes. The smaller is agriculture's use of labor and the smaller is agriculture relative to the rest of the economy the smaller is the chance that agriculture will lose.

The possibility (however unlikely) that farmers might lose from a decoupled payment sharply contrasts with traditional wisdom about the "decoupled" approach to farm policy. In a partial-equilibrium analysis, the only effect on "producers" of an increase in a decoupled payment would be the direct effect. The secondary effect would be totally ignored. The important difference is the existence of a distortionary income tax. If the income tax were not distortionary (a sufficient condition is that labor is in fixed supply) then w_t is zero which with (16) implies an unambiguous gain for the owners of A that equals the partial-equilibrium gain from increasing D. Moreover, it is important to note that ignoring the presence of the distortionary tax leads not only to an overestimate of the societal gain from a "decoupled" approach, as Alston and Hurd have already pointed out, but also to an *overestimate of farmer gains from a decoupled approach.*

X-owners lose unambiguously from a "decoupled" approach. Because increasing D implies increasing taxes they lose R^nX dollars for each unit that t is raised. But higher taxes also inflate wages, they also suffer an tax-induced income loss in the form of a higher wage bill. Whereas, traditional calculations overestimate farmer gains, these results show they underestimate X-owners' losses. The traditional measure of the X-owner loss would only capture the direct marginal tax increase ($-R^nX$) and would ignore the labour-market losses.

The overall effect of an increase in D on labour is ambiguous. Because taxes are raised they experience marginal losses of $w(\hat{L} - \ell)$ for each unit t is raised. However, as t rises some losses are recouped in the form of higher wages. Which effect dominates again depends upon how responsive labor supply is to changes in w. In general the less elastic is labour supply the more likely it is that L-owners lose.

Agricultural-Subsidy Incidence

The general-equilibrium incidence of a change in s is measured by

$$E_3^A \frac{du_A}{ds} = R_1^a(A - \hat{A}) + R_2^a(A - \hat{A})(w_s + w_t \frac{\partial t}{\partial s}) \tag{17}$$

$$E_3^X \frac{du_X}{ds} = - R_2^n X \frac{\partial t}{\partial s} + (1 - t)R_2^n X(w_s + w_t \frac{\partial t}{\partial s})$$

$$E_4^L \frac{du_L}{ds} = (1 - t)(\hat{L} - \ell)(w_s + w_t \frac{\partial t}{\partial s}) - w(\hat{L} - \ell)\frac{\partial t}{\partial s} .$$

Increasing s now has an ambiguous effect on the owners of A. They still gain from increasing the subsidy on existing production. This gain still dominates the loss that emerges as w rises in response to increasing s. But the change in s now requires a change in t. While increasing s may theoretically generate enough tax revenues to allow t to fall, this seems highly unlikely as a practical matter. (If true it would provide a novel approach to solving the current U.S. fiscal deficit crisis.) One expects that t must rise, further inflating wages and agricultural production costs. This loss erodes the subsidy gain even further with the result that owners of A might actually lose from increasing s. Again traditional measures over-estimate A-owners' gain.

By (7) and (14) the magnitude of this additional effect depends upon: how distortionary the income tax is (how elastic labor supply is to changes in w); how elastic agricultural supply is to changes in the producer price; how large the subsidy component of the agricultural producer price is; and how important the agricultural sector is in the labour market.

The more distortionary the income tax, the more w-elastic is agricultural supply, and the larger the subsidy component of the agricultural producer price the more likely it is that agricultural gains from increasing s are seriously eroded by these secondary effects. The smaller is agriculture's reliance on the labor market, the smaller is the chance that the tax and wage effects will overwhelm the direct effect. While the likelihood seems that farmers will gain from the increased subsidy this gain is clearly over-estimated by the traditional partial-equilibrium analysis.

Provided that raising s requires raising taxes, the owners of X lose from an increase in s. Both the agricultural-supply expansion effect and the tax-induced decline in leisure associated with the increase in s raise wages. Faced with higher costs the owners of X earn less at the same time that they are faced with a higher tax burden.

The effect on L-owners is ambiguous. (Compare with the situation where a change in s leads to no change in t.) They gain from the increase in wage that the subsidy policy and the associated tax rise engender. But they also face a higher marginal tax rate. Which effect dominates depends upon the level of t and how flexible wages are. A sufficient condition for the owners of L to always gain is that $(1 - t)w_t \geq w$. But using (7)) shows that this condition can never be satisfied.

Incidence of Acreage Retirement

The general-equilibrium incidence of retiring acreage (holding b fixed) is

(18)
$$E_3^A \frac{du_A}{d\hat{A}} = (b - R^a) + R_2^a(A - \hat{A}) \left(w_A + w_t \frac{\partial t}{\partial \hat{A}}\right)$$

$$E_3^X \frac{du_X}{d\hat{A}} = - R^n X \frac{\partial t}{\partial \hat{A}} + (1 - t)R_2^a X\left(w_A + w_t \frac{\partial t}{\partial \hat{A}}\right)$$

$$E_4^L \frac{du_L}{d\hat{A}} = (1 - t)(\hat{L} - \ell)\left(w_A + w_t \frac{\partial t}{\partial \hat{A}}\right) - w(\hat{L} - \ell)\frac{\partial t}{\partial \hat{A}} .$$

As acreage is retired, land owners trade rent on each acre retired for a payment of b. Retiring acreage also shifts the agricultural labor demand curve inward putting downward pressure on w. Land owners also save on their current wage bill. As before, the tax effect remains ambiguous depending critically upon whether acreage retirement leads to budget savings.

The owners of X gain from acreage retirement to the extent that wages are depressed by the acreage retirement. However, whether they gain or lose on balance also depends critically upon the effect retiring acreage has on the level of government revenues. The owners of L lose from acreage retirement to the extent that w is bid down, but whether they gain ultimately depends upon how the government's budget is affected by retiring acreage.

Social Efficiency and Farm Policy

Assessing the overall incidence of a farm policy is key to evaluations of "efficient" farm policies. To solve the problem associated with, say, trading consumer gains against producer losses, Gardner and later Alston and Hurd use the surplus-transformation curve. Gardner's definition of "more efficient" is ..."capable of generating a larger sum of surpluses"...for a given producer surplus - consumer surplus ratio (p. 228). As the number of agents grows, this idea becomes conceptually difficult to apply. For example, once Gardner introduces taxpayers he presumes their costs can be subtracted from consumer surplus in applying this efficiency criterion. Taxpayers and consumers, therefore, necessarily receive the same weight in the social calculus. While this may be appropriate in some, or even many, instances, it is a presumption that can definitively change results. Differential weighting of tax costs and consumer surplus is one of the primary points of departure for Alston and Hurd. They show that once the deadweight costs of taxation are incorporated into the analysis, efficiency judgements can change.

In searching for an alternative means of judging relative efficiency of farm programs, one would like to avoid the interpersonal utility comparisons that are implicit in the surplus-transformation curve approach when there are more than two groups in society. This naturally suggests judging relative efficiency of farm programs using the compensation tests that have emerged in the welfare economics literature (Graff). Each change in farm policy can be viewed as a "project" and compensation tests may be applied to determine whether the project should be executed. Viewing farm policy in this fashion allows the application of well-understood principles from the shadow-pricing literature (Little and Mirrlees; Hatta).

Each compensation test has well-known shortcomings (Hatta). Therefore, in choosing a test for social efficiency caution suggests a conservative approach. From a general-equilibrium perspective the most conservative (the easiest to pass) and most basic of these tests is the Kaldor compensation test, i.e. the gainers from proposed policy changes be able to compensate profitably the losers. If the Kaldor test cannot be passed, neither the more complicated Scitovsky or Samuelson tests can be passed. Simply put the Kaldor test determines whether there are potential gains from making a policy change.

Because our interest is in farm policy, the Kaldor criterion shall be refined further. A projected farm-policy change passes the Kaldor test, and thus potentially improves social efficiency, if farmers can profitably compensate X-owners and L-owners for the policy change. Specifically, a farm-policy change passes the Kaldor test if making the change permits holding u_X and u_L constant while increasing u_A. It is understood that a farm-policy change includes not only the change in the policy implement but also the change in the income tax rate that is required to preserve the government budget constraint.

The first step in making this notion operational is to sum the budget constraints in (6). (This operation is tantamount to allowing lump-sum transfer between individuals.) The homogeneity properties of the expenditure and quasi-rent functions then give:

$$(19) \qquad p_a[E_1^A + E_1^X + E_1^L - R_1^a\,(A-\hat{A})] + p_n[E_2^A + E_2^X + E_2^L - R_1^n\,X] = G + w\,[\,\hat{L} - \ell + R_2^a\,(A-\hat{A}) + R_2^n\,X]$$

where G denotes net government expenditures on farm programs (i.e. expression (10)), and the left-hand side of expression (19) is the country's trade deficit evaluated at international prices. Fixing u_X and u_L at their equilibrium values, equations (19), (10) set to zero (balanced budget), and the last equation in (6) (the labor-market clearing condition) constitute three equations in three unknowns u_A, t, and w.

Notice, in particular, that market-clearing in the labour market and balancing the government's budget implies that the trade deficit must equal zero. Denote the trade deficit by B(s,A,D,b; u,w,t), where u is the

3-dimensional vector of utilities. Differentiating expressions (19), (10) set to zero, and the labour-market clearing condition (holding u_X and u_L constant) gives respectively:

$$(20) \qquad B_{u_A}[\partial u_A/\partial D] = -(B_t + B_w w_t)\partial t/\partial D.$$

$$B_{u_A}[\partial u_A/\partial s] = -[B_s + (B_t + B_w w_t)\partial t/\partial s + B_w w_s],$$

$$B_{u_A}[\partial u_A/\partial \hat{A}] = -[B_A + (B_t + B_w w_t)\partial t/\partial \hat{A} + B_w w_A].$$

Because of the similarity between the effect of perturbing D and that of perturbing b, in what follows we only analyze the former.[5]

B_{u_A} is a positive number if A-owners demand for both commodities is normal. Make that assumption in what follows. Therefore, it follows from (20) that judging the potential efficiency of different farm-program changes reduces to considering what impact these farm-program changes have on the compensated (constant utility) trade deficit.[6] If a program change decreases the compensated trade deficit (decreasing the trade deficit is equivalent to relaxing the country's budget constraint), farmers can keep L-owners and X-owners as well off as before the change and also gain themselves. If a program change increases the compensated trade deficit, farmers cannot simultaneously keep L-owners and X-owners as well off as before and improve their own utility. Keeping L-owners and X-owners utility constant then requires u_A fall. Relative efficiency comparisons, therefore, can be based upon the relative magnitudes of the expressions on the right hand side of (20). All else constant, if policy change A increases the compensated trade deficit more than policy B, then policy change B is more efficient than A.

Using (11), the last expression in (20) becomes

$$(21) \qquad B_{u_A}[\partial u_A/\partial D] = -(B_t + B_w w_t)/\ T.$$

The expression $(B_t + B_w w_t)/ T$ measures the effect on the compensated trade deficit of increasing government outlays by \$1. As such it measures the deadweight costs of the distortionary tax system. This term is crucial to what follows, so it merits some specific attention.

In expression (21), the term B_w represents the partial derivative of the compensated trade balance with respect to the wage level. It is composed of a production and a consumption effect: The production effect is always positive (i.e. increases the trade deficit) because increasing wages discourages production of both commodities. The consumption effect, due to labour owners reallocating their consumption between commodities and leisure, also increases the trade deficit because leisure consumption is a net substitute for expenditure on commodities (see immediately below).

The expression $(B_t + B_w w_t)$, therefore, is the total derivative of the compensated trade deficit with respect to the tax rate. The second term is nonnegative given our assumptions (recall (7) implies that increasing taxes increases wages). The first term, B_t, however, is negative (it decreases the deficit). To understand why, notice that (19) implies

$$B_t = - w\ [p_a E^L_{13} + p_n\ E^L_{23}] = w^2(1 - t)E^L_{33}.$$

B_t, therefore, measures the degree of substitutability between leisure and the other commodities for L-owners. But the homogeneity conditions, which give the second equality, insure that leisure is a substitute for the commodity aggregate $p_a E^L_1 + p_n E^L_2$. Decreasing the opportunity cost of leisure by raising the income tax discourages commodity consumption and decreases the trade deficit. Generally, therefore, the sign of $(B_t + B_w w_t)$ is ambiguous. However, in what follows we typically presume that it is positive, i.e., increasing taxes increases the trade deficit. Some complicated calculations employing

(7) and the above show that when $s = 0$, $(B_t + B_w w_t)$ is positive. Only the presence of the production subsidy allows the counterintuitive result that increasing a tax which creates a disincentive to produce would decrease the trade deficit.

These results and presumptions indicate that increasing decoupled payments is not a project that would pass the Kaldor compensation test because if u_X and u_L are held constant, raising D requires u_A to fall. Notice, however, that the results illustrate an important fact. If leisure demand is perfectly inelastic (and hence the income tax does not distort marginal incentives), then by (7) and the above $(B_t + B_w w_t)$ is zero. Redistributing via decoupled payments passes the Kaldor test so long as the tax system incurs no deadweight loss. Absent deadweight tax losses, decoupled payments always can be perfectly compensated by lump-sum payments to X-owners and L-owners. The magnitude by which a decoupled approach fails the Kaldor test depends solely upon the deadweight costs of the tax system.

Expression (21) offers a baseline against which to compare the results from marginal perturbations in the subsidy and the acreage retirement. Before examining those effects in detail, the reader should note that there are two possible avenues through which they might pass the Kaldor test: The program change might lead to a significant enough budget saving or revenue enhancement to insure that the income tax can be lowered thus lowering the compensated trade deficit; or the program change may directly or indirectly improve the compensated deficit apart from the tax effect.

Our first case involves increasing s. Using (20) and (14) gives

$$(22) \qquad B_{u_A}[\partial u_A/\partial s] = p_a R^a_{11}(A-\hat{A}) - B_w w_s - (B_t + B_w w_t)[sR^a_1(A-\hat{A}) +$$

$$sR^a_{11}(A-\hat{A}) + Mw_s]/\ T.$$

There are three distinct effects in (22): The instantaneous impact of increasing the production subsidy is to expand agricultural output (first term on the right of (22)). As agricultural output expands, the compensated trade deficit shrinks. But the increased subsidy also tends to increase wages. As wages increase (second term on the right of (22)), the compensated trade deficit grows. The final effect is through the tax system. As noted earlier, raising subsidies could decrease net government expenditures permitting a cut in the income tax rate. However, this seems unlikely in the real world. Therefore, the third effect is probably a deadweight loss from the taxation required to finance the increased expenditure on subsidies.

Some manipulation using the symmetry and homogeneity properties of the quasi-rent functions shows that

$$\text{sign}\ [p_a R^a_{11}(A-\hat{A}) - B_w w_s] = \text{sign}\ (1-t)\ R^a_{11}E^L_{33}[(p_a+s)(1-t) - p_a]$$
$$+ s[R^a_{12}(A - \hat{A})^2] - sR^a_{12}(A - \hat{A})[R^a_{22}(A - \hat{A}) + R^n_{22}X]$$

The expression on the right still has an ambiguous sign but it is more informative than (22). It reveals that a crucial determinant of whether the direct and indirect (i.e., non-tax) effects of raising the subsidy improves the compensated trade balance are the relative magnitude of the subsidy component of the producer price and the marginal tax rate. If the marginal tax rate exceeds the subsidy component of the agricultural producer price, this expression is positive indicating that non-tax effects decrease the compensated trade deficit. Then non-tax effects must then be balanced against the deadweight losses that arise from the tax system. If the subsidy component of the agricultural price is very small relative to marginal tax rates (e.g. no current subsidy exists), increasing the subsidy may pass the

Kaldor test. But if the subsidy component of the agricultural price is large (as it was in 1985), the Kaldor test will be failed.

Turning to acreage retirement, expression (20) gives

$$(23) \qquad B_{u_A}[\partial u_A/\partial \hat{A}] = -\hat{A}p_a R_1^a - B_w w_A - (B_t + B_w w_t)[b - s\hat{A}R_1^a + Mw_A]/T.$$

Again there are three effects to be considered: The most direct is that retiring acreage from production reduces supply and therefore increases the compensated trade deficit. But retiring acreage also decreases wages, and as wages fall the compensated trade deficit falls suggesting a possible welfare improvement. Finally, there is the tax effect. Subsidy payments fall as acreage is retired but diversion payments rise to replace these savings. At the same time, tax revenues are pushed downward by the falling wages engendered by the acreage retirement program. If the diversion payment is large relative to the pre-acre subsidy, net government outlays could increase as more acreage is retired. The associated need to raise taxes to match these spending increases expands the compensated trade deficit with an associated deadweight loss arising from the distortionary tax system.

On the other hand, it is often thought that diversion programs are cheaper to run than subsidy programs. With a paid diversion, the entire government payment is realized as rent by the farmer whereas with a subsidy program the farmer only captures a portion of the subsidy as rent. If retiring acreage does lead to budget savings, the reduced need to use distortionary taxes to raise government revenue would decrease the compensated trade deficit suggesting an efficiency improvement. Retiring acreage might then pass the Kaldor test. When compared with a decoupled approach which definitely fails the Kaldor test because of the distortionary tax system, a more socially efficient farm program might entail higher acreage retirements and lower decoupled payments.

This last result is, of course, quite counterintuitive because *it implies that literally throwing productive resources away may be more socially efficient than lump-sum transfers. And this can be true even without the positive price response that would be associated with supply control in the large-country case.* One notes, however, that expression (23) indicates that this only happens when subsidy payments are large. The reason the result makes sense in this case is twofold but simple. First, it is in this case where the budgetary savings are of acreage retirement likely to be quite high. Put another way, it is the case where the deadweight losses associated with the tax system raising the revenue to support subsidy payments are large. But, perhaps just as important, when subsidy earnings are extremely high the labour market will also be very distorted. And the efficiency losses suffered by throwing away productive land may be balanced by the efficiency gains realized from freeing labour resources for the nonagricultural market. This latter effect is ignored in the partial-equilibrium approach.

Conclusion

This paper examines the general-equilibrium incidence of farm programs in the presence of distortionary taxes. Under these circumstances it has been shown that traditional calculations of subsidy incidence systematically overestimate the gains agricultural producers derive from farm programs. An approach based on Kaldor's compensation test has been suggested and applied to farm programs. The compensation test is shown to depend upon how the compensated trade deficit responds to a policy change.

Footnotes

1. The utility-constant excess demand curves used in the Kaldor tests are always downward sloping by the concavity of the expenditure function.

2. As will become clear, a government budget deficit is equivalent to a balance of trade deficit.

3. Because we have presumed constant returns, per-acre use of labour only depends on (p_a/w). In a model with decreasing returns a similar effect would emerge so long as labour was a normal input. However, per acre use of labour would not be independent of acres farmed.

4. Becker contains a detailed discussion of this issue in the context of interest-group behavior.

5. All of the derivative expressions in (20) are taken at constant u_X and u_L. Most importantly, this implies that all labour responsiveness, and hence wage effects, are along the compensated leisure curve. This curve always slopes down in wages (labour-supply is unambiguously upward sloping).

6. Hatta makes a similar point for general policy changes. Also see Fane for a related approach based on the equivalent variation of the farm policy.

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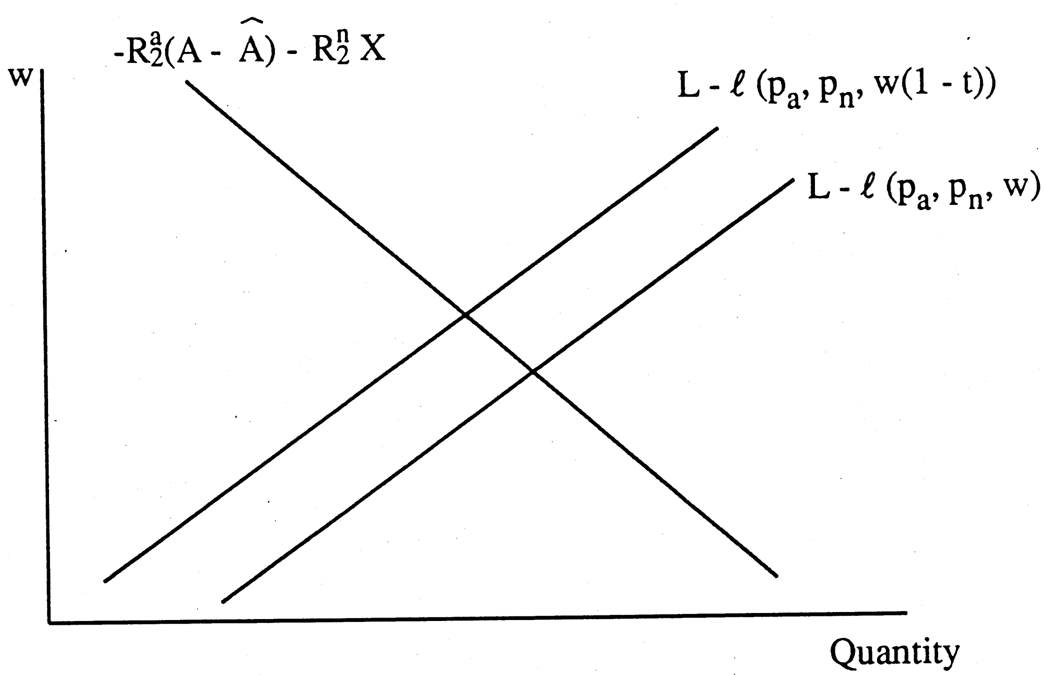

Figure 1: Labour-Market Equilibrium

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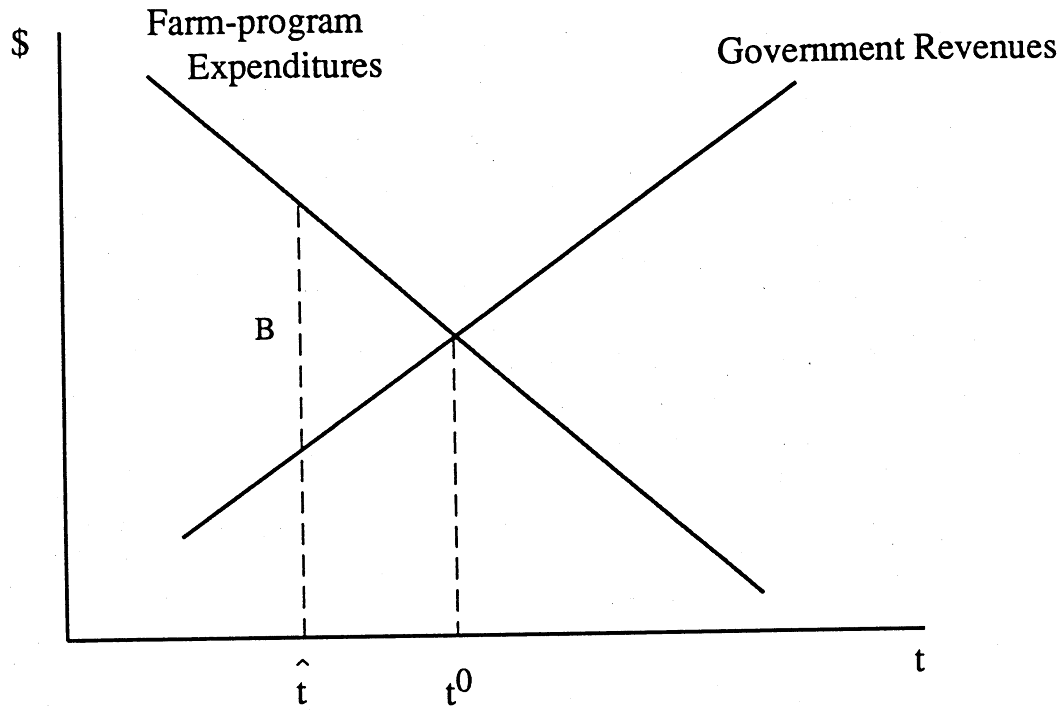

Figure 2: Equilibrium Tax Rates

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