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An Assessment of the Effect on Land Values of Eliminating Direct Payments to Farmers in the United States

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This study examines the consequences of the complete elimination of direct government payments to farmers on the U.S. economy in general and land values in particular. The analytical approach used consists of a computable general equilibrium model composed of 14 producing sectors, 14 consuming sectors, six household categories classified by income and a government. The results suggest that, with a complete elimination of direct government payments to farmers, there will be a reduction in output by all producing sectors of 0.18 percent or about $14.5 billion, a decline in output in the agricultural sectors of 4.39 percent or about $12.0 billion, a fall in total utility by 0.47 percent or $22.0 billion and a net reduction in expenditures for the government of $13.4 billion. Land values will be adversely affected, falling an average of 14 percent.

I. Introduction

The Federal Agricultural Improvement and Reform Act of 1996 which was signed into law in April 1996 fundamentally redesigns income support and supply management programs for wheat, corn, grain sorghum, barley, oats, rice and upland cotton (Young and Westcott (1996)). The act will have a number of impacts including a reduction in net farm income (Dubman et al. (1993)), greater variability in the price of agricultural commodities affected by the programs (Reichelderfer and Kramer (1993)), and more extensive agriculture-related environmental problems (Crossman and Brubaker (1992), and Kramer and Lynch (1995)). An additional effect will be a change in farmland values which, in turn, will erode the equity position of farmers. It is this latter issue that is of concern here. Before delving into the problem and its implications, however, some background information is useful.

II. Background

U.S. farm real estate accounts for nearly 75 percent of the value of all farm assets, and represents the principal source of collateral for annual operating loans (Dovring (1987)). Farm real estate values are an indicator of the general economic health of the agricultural sector. Changes

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in values affect the equity position of farmers and ranchers and, in turn, their credit worthiness. The drop in farm real estate values, which began in 1983 at the national level, eroded equity positions of some operators, making them relatively more vulnerable for payments on mortgages and operating loans, which carried relatively high real interest rates (Stam (1995)).

Recovery in nominal U.S. average real estate values since 1987 has contributed to stronger economic positions of farm and ranch operators. The per-acre value of U.S. farm real estate rose over 6 percent during 1993, marking the seventh consecutive increase since 1987 (Table 1). As of 1994, the value of farmland and buildings averaged $744 per acre, 24 percent above the 1980s low of $599 (in 1987), but 10 percent below the record high of $823 (in 1982). A 2.6-percent inflation rate (as measured by the GDP implicit price deflator) in 1993 dampened the six percent increase in U.S. average farm real estate value. Real values have tended lower since 1981, leveling off between 1988 and 1993. The U.S. average farm real estate value is currently 47 percent below the 1981 peak value (Economic Research Service (1994)).

Table 1 Average Value Per Acre of Farm Real Estate

Year	Nominal Value	Percent Change	Real Value*	Percent Change
1984	801	1.6	769	−2.4
1985	713	−11.0	657	−14.7
1986	640	−10.2	568	−13.4
1987	599	−6.4	518	−8.8
1988	632	5.5	530	2.2
1989	661	4.6	533	0.7
1990	668	1.1	517	−3.1
1991	681	1.9	505	−2.3
1992	684	0.4	487	−3.5
1993	699	2.2	485	−0.4
1994	744	6.4	503	3.7

* As measured by the GDP implicit price deflator.
Source: Economic Research Service (1994)

Except for some intrinsic qualities that land may possess, the demand for land and its concomitant value are largely determined by expected earnings.[1] The value of land, as with any income-earning asset, benefits from any activity which augments its earning potential. For that reason, the value of agricultural land is typically considered to be determined by the capitalized value of its current and expected future stream of earnings (Goodwin (1994)). Generally, farmland values consists of at least four parts: (1) the income earnings of the land, (2) the expectations of those earnings, (3) how those earnings are discounted from the future back to the present, and (4) potential earnings associated with converting the farmland to nonagricultural uses. Dating at least back to Floyd (1965), it has been widely recognized that federal government farm support programs, which augment farm income, increase land values and landowners' wealth. Moreover,

1. That is, the demand for land is a derived demand (Stigler (1966)).

acreage control programs add to this upward pressure on land values by decreasing the effective supply of land, thus raising the scarcity value of land (Shoemaker et al. (1990)).

Dynamics in the land market are reflected by changing expectations about variables which influence the returns to land in future periods. Such variables include information about future interest rates, yields, output prices, and government policies. Increases in expected yields, output prices, and government support for agriculture will increase the expected growth rate in real returns to agricultural land. Alternatively, changes which decrease the returns earned by land holders in the current period or at some point in the future will result in current land values falling (Goodwin and Ortalo-Magne' (1992) and Scott (1983)).

While farmland values reflect the income from the current use of land, the expected value of alternate use is also incorporated into land prices. In the Northeast, for example, farmland values often are high relative to other regions reflecting the potential for future development in nonagricultural uses (Shoemaker (1990)). It is also important to note that uncertainty about future events may affect agricultural earnings as expectations of future events are adjusted as more information is collected (Raup (1989)). Transitory events, like a drought, should not be expected to affect land values because returns should fall back to normal levels after such an event passes. On the other land, permanent improvements in the quality of a parcel of land, such as an irrigation system, raise productivity and add to farmland value (Shoemaker (1990)). Similarly, if uncertainty exists as to whether government subsidies to farmers will endure, the expected future value of the subsidy will be significantly discounted and this will be reflected in the price of the land. In this way, the current legislative debate over whether to decrease or eliminate domestic agricultural commodity programs can depress land values even if no change in the policy is forthcoming.

III. Agricultural Subsidies and Land Prices

Government support of agriculture has been substantial in the past ten years. Direct Government payments averaged over 28 percent of net farm income from 1984 to 1994 (Table 2). Land, the main resource used in farming, shows the most significant effects from domestic agricultural commodity programs (Shoemaker et al. (1990)).

The effect of direct government payments on agricultural land values has been examined in a number of studies. For example, Duffy et al. (1994) estimate that a cotton farm in the U.S. with an 100 percent base endowment would be expected to sell for a premium of $60-$108 per acre as compared to a farm with no base. Herriges et al. (1992) estimate the implicit price of corn base acreage in the U.S. agricultural commodity program. They calculate that the quasi-rent for an acre is on the order of $11 to $13 (12-14 percent of the land's value) and the discounted returns to farmland is valued at approximately $200 per acre (11-14 percent of total discounted returns). Goodwin and Ortalo-Magne' (1992) evaluate the extent to which wheat subsidies are capitalized into land values in six major wheat producing regions in the U.S., France, and Canada. Their results confirm that agricultural policies that support wheat producers in each of the countries studied *de facto* contribute to the value of wheat producing lands. Featherstone and Baker (1988) examine the effect of commodity price supports on rents and agricultural land values in Tippecanoe Country, Indiana. They show that land values would drop from $1,296

Table 2 Direct Government Payments to Farmers as a Percentage of Net Farm Income

Year	Government Payments	Net Farm Income	Government Payments as a Percentage of Net Farm Income
	--Million Dollars--	--Million Dollars--	
1984	8,400	26,100	32.2
1985	7,705	28,768	26.8
1986	11,814	31,053	38.0
1987	16,747	39,721	42.2
1988	14,480	38,028	38.1
1989	10,887	47,895	22.7
1990	9,298	46,911	19.8
1991	8,215	41,109	20.0
1992	9,168	50,074	18.3
1993	13,402	43,401	30.9
1994	7,900	44,600	17.7

Source: U.S. Department of Agriculture (1995)

per acre under the commodity program provisions of the Food Security Act of 1985 (the 1985 Farm Bill)[2] to $1,121 per acre, a 15 percent reduction, under a market oriented agricultural policy.

A number of other studies have shown that other facets of the domestic agricultural commodity program are also reflected in the value of land. For example, production quotas and grazing permits are capitalized into land values. Segraves (1969) estimates that tobacco allotments raised land values in North Carolina by $3,137 per acre (for land with a tobacco quota) in 1947. This value rose to $14,344 per acre by 1960, reflecting increases in tobacco yields, allotments, and support prices and growing confidence in the sustainability of the program. Vantreese et al. (1989) examine tobacco allotments in Kentucky and estimates that the allotments increased land values by $498 per acre in 1973 but this level fell to $125 per acre by 1985. This decrease represents much lower levels of support for tobacco producers and decreased confidence in the longer term sustainability of the tobacco program. Martin and Jefferies (1966) examine public land grazing permits in Arizona. They find that ranch land values increased an average of $83 per acre during the 1959-63 period due to the grazing permits. Torell and Doll (1991) estimate that the value of ranch land possessing a public land grazing permit in New Mexico was an average of $48 per acre higher than land not possessing such a permit.

Unlike direct subsidies, the extent to which policies such as quota licenses and grazing permits provide support to agricultural producers is limited primarily to those individual producers who receive the original endowments.[3] Hence, these policies affect land values differently than direct government payments. For example, Toussaint (1992) notes that by 1991 in North Carolina, one of every five pounds of quota tobacco was produced on quota land

2. Public Law 99-198.
3. Obviously, because land is substitutable in its various uses, there will be some, most likely very small, effect on the price of non-quota land as a result of the quota and some small impact on the price of land without grazing permits due to the permits.

purchased after 1982. The purchasers of the quota land paid a price which reflected the expected future benefits of the program, a factor not included in the acquisition price prior to the adoption of the quota program. In another study, Offutt and Shoemaker (1988) show that eliminating acreage control programs as an instrument to support farm-sector returns reduces land's share in the value of production. Landowners would bear the brunt of the effects of total removal of government support because the major portion of program benefits accrue to them and not to the providers of labor and capital. They also estimate that acreage control programs have held land's value to just seven percent above what it would have been in the absence of acreage restrictions. Shoemaker (1989) also uses the difference in average bids between sign-ups (enrollment periods) to estimate an upper limit on the Conservation Reserve Program's (CRP) effect on the value of enrolled land. He concludes that even though over 15 million acres were enrolled during the first four sign-ups of the CRP, that amount represents less than 4 percent of all cropland in production. As a result, between 1986 and 1987 the value of all cropland would have dropped 0.3 percent if the CRP had not been in place.

IV. Potential Loss in Land Values under Program Reform in the 1990s

The added income that government payments represent are not entirely transferred into land values because of some uncertainty as to the magnitude of government payments from year to year.

In the short run, eliminating support payments and acreage reduction requirements creates two production effects - each working in opposite directions. On the one hand, the removal of price supports lowers the effective price of program commodities since the target price has historically exceeded and is expected to continue to exceed the market price (Uri (1989)). On the other hand, increased availability of land, released from set-aside programs, provides the potential for greater output. The net result depends, in part, on the relative strengths of the two effects.

In the long run, reduction or removal of agricultural commodity programs will decrease land values, all other things being equal. As noted above, reducing or eliminating support programs reduces expected future returns and therefore land values. The magnitude of the fall in land prices depends on the extent to which current values reflect the expectation of continued government commodity programs. Moreover, the degree to which farmers can change production patterns by substituting land for other inputs and the extent to which they can switch to producing nonprogram agricultural commodities[4] or perhaps timber will determine the overall impact of commodity policies on input use, output, and land values.

What then would be the impact on land values as well as input use and output if government payments were to end abruptly? The total value of land assets would be expected to decline but the order of magnitude is uncertain. Support levels from target prices and loan rates have generally tended downward in the last several years potentially creating the expectation

4. Nonprogram commodities are those not currently included in the domestic agricultural commodity programs. Note the implicit assumption that, if a production switch is made to a nonprogram commodity, this commodity yields a higher net return than the program commodity previously produced.

that support levels will continue to decline. Farmers also seem to expect an overall decline in program benefits (*Des Moines Register* (January 15, 1995)). Expectations of lower benefits reduce the capitalization effect implying that program elimination will have a smaller impact on land values than might otherwise be the case. Further, with inflation in check, real interest rates positive and relatively stable, and increased export opportunities because of the General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA), some of the effects of decreased program payments would be mitigated. In what follows, the measurement of the expected impacts will be undertaken.

Because there are interrelationships between the agricultural sectors and the rest of the sectors in the U.S. economy, to properly analyze the effect of an elimination of domestic agricultural commodity programs, a comprehensive analysis must be employed. The analysis must be one where the linkages between sectors of the economy are explicitly taken into account and one where the price responsiveness of producers and consumers both to absolute and relative changes in the prices of the various goods and services is considered. In what follows, such an analysis will be provided. The approach used will be a computable general equilibrium model that has been disaggregated into fourteen producing sectors, fourteen consuming sectors (Table 3), six household (income) categories (Table 4) and one governmental sector. This level of disaggregation allows for an assessment of the direct effects as well as the indirect effects of eliminating the commodity programs. By measuring these effects, it will be possible to identify the extent to which the agricultural sectors and other producing and consuming sectors and household groups stand to gain or lose Hence, equity considerations as well as efficiency considerations can be addressed. Thus, the incidence of the elimination of the domestic agricultural commodity programs is endogenous to the analysis with no prior assumptions being made. Before conducting the analysis, however, a brief overview of the model will be provided.

Table 3 Classification of Producing Sectors and Consumer Goods and Services

Industries	Consumer Goods and Services
1. Manufacturing	1. Food
2. Coal Mining	2. Alcohol and Tobacco
3. Other Mining	3. Utilities
4. Service	4. Furnishings and Appliances
5. Chemicals and Plastics	5. Housing
6. Food and Tobacco Products	6. Clothing and Jewelry
7. Petroleum Refining	7. Transportation
8. Financial	8. Financial Services
9. Forestry	9. Other Services
10. Wood Products	10. Motor Vehicles
11. Crude Oil and Natural Gas	11. Gasoline and Other Fuels
12. Agriculture 1 - Program	12. Reading and Recreation
13. Agriculture 2 - Livestock	13. Nondurable Household Items
14. Agriculture 3 - All other Agriculture	14. Savings

Table 4 Household Categories Based on Income

Category	Income Range
I	$ 0 - 9,999
II	$ 10,000 - 19,999
III	$ 20,000 - 29,999
IV	$ 30,000 - 39,999
V	$ 40,000 - 49,999
VI	$ 50,000 and over

V. The General Equilibrium Model

The model used follows in the tradition of the Shoven and Whalley (1972, 1992) tax analysis research and incorporates some of the methodological enhancements of the general equilibrium work of Hudson and Jorgenson (1974a, 1974b). For example, it recognizes the differences in preferences of consumers as a function of their incomes and specifies a distinct demand system for each group of households. Additionally, a neoclassical microeconomic model of producer behavior is employed. The model of consumer behavior is integrated with the model of producer behavior (which contains a price-responsive input-output component) to provide a comprehensive framework for policy simulations.

a. *The Producing Sectors*

The production sector of the model consists of an input-output matrix with flexibility with regard to the substitution of the factor inputs (capital, labor, and labor). Technologies are represented by production functions that exhibit constant elasticities of substitution. Technological progress (both embodied and disembodied (Uri (1984)) is assumed not to occur over the period of investigation. Each sector as defined in Table 3 is assumed to have a constant elasticity of substitution (CES) production function (Arrow et al. (1961)) where the value added by the specific sector is a function of labor and capital.[5]

For four sectors (the three agricultural sectors and the forestry sector), however, a third factor of production - land - is included. This is done because of the special importance of this input to these sectors (Heady and Dillon (1961), and Kumbhakar and Hjalmarsson (1933)). It is through this specification that the impact of the elimination of domestic agricultural commodity programs can be estimated.

The incorporation into the production function of land is accomplished by nesting the CES production function. In particular, an input is defined which is solely a function (in CES form) of land and capital which, in turn, takes the place of capital in the original production function specification.[6, 7]

5. There is a transformation matrix whereby raw inputs in the producing sectors are transformed into consumption goods and services. Thus, the fact that agricultural goods are combined with, say, manufactured goods, chemicals and plastics and transportation to produce plastic materials and resins is reflected via this transformation matrix.

6. While it would be possible to simply add land as an explicit input in the production function, this would implicitly assume that the elasticity of substitution between all pairs of inputs are the same. By nesting, however, the substitution elasticities are permitted to be different between different inputs.

7. Hertel and Tsigas (1987) have a discussion of how substitutable land is in various uses. The substitution elasticities used here are derived from the Hertel and Tsigas analysis.

b. *The Consuming Sectors*

On the demand side, the model reflects the behavior of consumers (who can also serve as investors), the government, and foreigners. Consumers are grouped according to income (indicated in Table 4) and a demand system is specified for each group. Each income group has an endowment of labor and capital and, given the vector of prices, decides the amount to save and invest and the amount of each good and service to consume (purchase). Investment, consequently, is determined by savings.

The output of the 14 producing sectors accrues to the owners of the factors of production (i.e., land, labor and capital) which they sell. With the receipts from sales, these individuals either consume domestic or foreign goods and services, save, or pay taxes to the government. The savings are used for investment and the taxes are ultimately returned to these individuals.

The demand for final goods and services comes from three primary sources: (1) final goods and services which are directly consumed by individuals, (2) investment (which is equal to savings), and (3) foreign demand.

A review of Table 3 will show that the composition of the consumer goods and services sectors does not match that of the producing sectors because the final goods and services produced by the producing sectors must go through various channels (i.e., transportation and distribution) before they can be consumed. To address this problem, a transformation matrix is introduced that defines the contribution of each producing sector to the composition of each of the final (consumer) goods and services.

For each category of households (Table 4), utility is assumed to be a weighted constant elasticity of substitution (CES) function of the 14 consumer goods and services. The weights on these goods and services (which are household category specific) are computed as the share of total purchases going to a specific consumer goods or service. The nature of the CES utility function implies that the elasticity of substitution is the same between any pair of goods and/or services. Because reliable estimates of the respective substitution elasticities across pairs of goods and/or services is difficult to obtain, they are assumed to equal one for all of the combinations. Finally, consumers obtain utility from the consumption of all goods and services including leisure (consumer good and service sector number 12). Hence, it is necessary to determine a weight for this factor in the utility function. For the purpose of the current analysis, this value is assumed to be 0.5 times labor income. The net effect of adding leisure is to incorporate explicitly the fact that consumers not only derive utility from the act of consuming goods and services (which comes through owning the factors of production) but that they also derive utility from leisure. Thus, an increase in leisure can lead to an enhancement of individual well-being in the model.

A household's budget constraint is defined such that expenditures on goods and services must be less than or equal to its income, which is defined to equal its portion of the returns to labor plus the returns to capital plus the returns to land. That is, expenditure by a household must be less than or equal to the total factor payments it receives. Maximizing utility subject to this expenditure constraint gives the demand for the various goods and services by household categories (Mixon and Uri (1985)). Observe that since savings are considered as one of the items in an individual's utility function, the choice between consumption and savings is made explicit.

The second component of the demand for goods and services is investment. Like the final demand by individuals, total investment is disaggregated (though a transformation matrix) by the sector of the economy that produces it. For the purpose of constructing the general equilibrium model and calibrating it, investment is taken directly from the national income and product accounts (as compiled by the Bureau of Economic Analysis of the U.S. Department of Commerce) and, since savings are assumed to exactly equal investment, personal savings are scaled to equal the gross investment observed (measured) for each of the 14 producing sectors.

The final component of demand for goods and services is the demand by foreign consumers. The foreign sector produces imports and consumes exports. Trade balance is assumed (that is, the nominal value of exports is assumed to equal the nominal value of imports in equilibrium) but the exchange rate is not explicitly incorporated into the model specification. Exports are scaled to match imports.[8] As a result, foreigners can be regarded as consumers who purchase United States exports with income from the sale of imports to the United States.[9]

In the model exports (i.e., foreign demand) are delineated by producing sector. That is, a transformation matrix analogous to that used for the consumption of final goods and services is employed. A similar delineation is utilized for imports (i.e., foreign supply). The exports and imports are then scaled so that the total foreign account is balanced. By employing elasticity estimates (both demand and supply) found in the literature, export and import demand relationships are constructed for each producing sector.

c. *The Government Sector*

The government levies taxes on both production and consumption. That is, there are taxes on factors of production, on output, on income and on consumption. Revenues are used to distribute income back to consumers and to purchase goods and services, as well as capital and labor.

First, there is a question of how to treat the government in a general equilibrium model. For the purpose at hand, it is treated as a separate sector with a constant elasticity of substitution utility function. The elasticity of substitution is assumed to be one. This means that the CES production function collapses to a Cobb-Douglas-type production function. The government collects tax revenue in various forms. The explicitly considered taxes include personal income tax, labor taxes (e.g., a social security tax), capital taxes (e.g., a corporate income tax), property taxes, and sales and excise taxes. All these are treated as *ad valorem* taxes and a marginal rate is used for each household category, consumer good and service sector, producing sector and factor input. In the current specification of the model, a budget deficit equal to the base year (see below) amount is assumed. An alternative budget deficit, however, can be presumed.

8. If desired, trade imbalance can be incorporated into the model. In this instance, the order of magnitude of the imbalance must be assumed *a priori*.

9. To bring closure to the model, an explicit assumption concerning trade balance is required. In this case, it is assumed that exports are matched to imports. Some other assumption could be employed such as imports exceed exports by a specified amount. That amount, however, is arbitrary. To forego the inherent controversy surrounding this sort issue, a simpler assumption is made. Approaches to handling trade in CGE models is explored fully in Whalley (1985) and Tarr and de Melo (1990).

d. *A Mathematical Statement of the Model*

Given these foregoing considerations, it is useful to state precisely the conditions that the model being used here must satisfy for a general equilibrium to exist. First, there cannot be positive excess quantities demanded. That is,

$$\sum_{j=1}^{m} a_{ij} M_j - E_i\ (\mathbf{p},\mathbf{Y}) \geq 0 \quad \text{for} \quad p_i \geq 0 \tag{1}$$

and where i (i = 1, 2, ⋯, n) denotes the consumer goods and services, M_j (j = 1, 2, ⋯ m) denotes the activity levels, a_{ij} denotes the ij th element in the activity analysis matrix, **Y** denotes a vector of incomes for the k consumers, **p** denotes a vector of prices for the n consumer goods and services and E_i denotes the excess demand for good or service i.

The second requirement for general equilibrium is that the profits associated with a given activity are not positive. That is,

$$-\sum_{i=1}^{n} a_{ij}\ p_i \geq 0 \text{ for } M_j \geq 0. \tag{2}$$

Finally, all prices and activity levels must be non-negative. That is,

$$p_i \geq 0,\ i = 1, 2, \cdots, n \tag{3a}$$

and

$$M_j \geq 0,\ j = 1, 2, \cdots, m. \tag{3b}$$

The model is solved for a general equilibrium using the iterative algorithm nominally referred to as the Sequence of Linear Complementary Problems (SLCP) developed by Mathiesen (1985a, 1985b). This algorithm is based on the fixed point theorem proved by Scarf (1967). A complete listing of the equilibrium conditions together with relevant definitions is found in the Appendix.

VI. Data for the 1988 Base Year

The general equilibrium model is calibrated for 1988. For each of the 14 producing sectors, data on capital receipts and taxes are computed from reports of the Bureau of Economic Analysis of the U.S. Department of Commerce, the U.S. Department of Agriculture, the U.S. Department of Energy, and from Hertel and Tsigas (1987). The various elasticities of substitution employed in the analysis were obtained from Boyd (1988).

Capital income (earnings) and labor income were obtained from the Bureau of Economic Analysis of the U.S. Department of Commerce. Land income was estimated using factor shares obtained from the Economic Research Service of the U.S. Department of Agriculture and applied to the capital income component noted above.

Data on expenditures on each of the 14 goods and services by each of the 6 household categories were obtained from *the Consumer Expenditure Survey: Interview Survey, 1984* (Bureau of Labor Statistics (1986)). By combining this information with the number of households in each household (income) category (these data come from the Bureau of Economic Analysis), the aggregate expenditures on each category of consumer goods and services by each household category were computed. Agriculture sector specific data were obtained from the Economic Research Service (1994).

The various tax rates used in the analysis were obtained from a variety of sources including the Internal Revenue Service, the Economic Research Service of the Department of Agriculture, Hertel and Tsigas (1987), and Ballard, et al. (1985). These rates, as noted previously, are marginal rates. The value of exports and imports in 1988 were taken from the *Survey of Current Business* (various issues) with the exception of the energy data which were obtained from the Energy Information Administration of the U.S. Department of Energy and the agriculture data which were obtained from the Economic Research Service of the U.S. Department of Agriculture.

VII. A Methodological Caveat

Before proceeding to discuss the results obtained from the general equilibrium model, a short digression is in order. In particular, a discussion concerning the advantages and shortcomings of using the particular modelling approach that has been opted for here is in order.

The primary advantage of the general equilibrium modelling approach is that, with all economic entities maximizing their behavior (subject to the relevant constraints), all markets are required to clear. No transactions are conducted at prices other than equilibrium prices and for every factor of production and every good and service consumed, the quantity supplied must exactly match the quantity demanded. All interactions among markets are taken into account and, consequently, all interrelationships between sectors (both consuming and producing sectors including the agricultural sectors) are explicitly considered.

Another advantage of this modelling approach is that it performs the analysis at a disaggregated level and hence can identify sector specific impacts of the policy question being addressed. Frequently, small aggregate effects obfuscate the larger impacts at the sectoral level. Thus, for example, at the aggregate level a change might have little effect on income, but at the household level, the distributional impacts on income might be fairly substantial.

The general equilibrium model also includes a treatment of all taxes. These taxes can introduce a considerable differential between prices paid by consumers and prices received by producers. This can result in distortions in market signals that lead to market failure (e.g., inefficient use of factors of production) (Friedman (1984)).

The model is solved numerically and, after any change in the exogenous (e.g., policy) variable(s), a new, independent (i.e., independent of the previous solution) equilibrium is computed. As a result, the conclusions do not depend on first-order or second-order approximations or the assumption of an infinitesimally small change in one or more of the variables.

The general equilibrium modelling approach is not devoid of deficiencies. The values of the various parameters used in the model are not estimated directly by econometric means. Rather, as noted, they are taken from the literature and represent a consensus among researchers with regard to appropriate values. This does not mean that a complete set of econometric results cannot be generated at some future date. The complexities of such an undertaking, however, are enormous (Jorgenson (1984) and MacKinnon (1984)) and so it is not attempted here.

Another assumption that does not emulate reality completely is that consumer and producer behavior is modelled with full and complete adjustment between perturbations. This means that the distributed lags associated with the adjustments of the various factors are not overtly modelled although the magnitude of the full adjustment by each producing and consuming sector is captured. Additionally, there is the implicit assumption that all economic agents know the vector of final equilibrium prices, thus allowing for full adjustment on their part.

Finally, there is no regional detail. This is especially important for the issue under consideration because the effect of completely eliminating direct government payments to farmers will vary geographically depending upon the relative importance of government program payments to the local economy. Unfortunately, the requisite data are not available to permit the introduction of spatial detail in the model.

VIII. General Equilibrium Results

Before discussing the results of the general equilibrium model, a couple of items need to be mentioned. First, there are several different proposals currently being considered involving a reduction in or curtailment of domestic agricultural commodity programs (Council of Economic Advisors (1995) and *Des Moines Register* (January 15, 1995)). One receiving a great deal of attention and discussion involves reducing or completely eliminating direct government payments to farmers in the form of deficiency and diversion payments,[10] conservation reserve rental payments, disaster payments, and reserve storage and other programs (Chicago Tribune (March 27, 1995) and Hillgren (1995)).[11,12] To estimate the maximum potential impact, the proposal to eliminate entirely direct government payments will be used in order to measure the upper bound effects of such a proposal. Other less dramatic proposals, will have proportionately smaller effects.

Second, the magnitude of the effect of completely eliminating direct government payments to farmers will have on the substitution of the various factors of production and the coincident effect on their prices is an important consideration. Consequently, the sensitivity of the assumed values for the elasticities of substitution between the various factor inputs needs to be explored. Such a sensitivity analysis will be performed whereby the values are assumed to vary around the point estimates.

a. *Reference Case*

The Reference Case results (both quantities and normalized prices) are presented in Table

10. Deficiency payments are made for wheat, rice, corn, grain sorghum, barley, oats, and all cotton.
11. Payments are made to agricultural producers for participating in farm programs established and defined in federal legislation. To participate in these programs, producers are usually required to set aside part of their land and not produce the program crop on that land. Producers may have to meet requirements related to conservation of the set aside land.
12. Included in the other program category are the dairy termination, tobacco, sugar, and wool and mohair programs.

5, Table 6 and Table 7 for the producing sector, the consuming sector, and households (income categories), respectively. Note that the nominal values of the quantities are in hundreds of billions of 1988 dollars. The sector numbers and category numbers correspond to those used in Table 3 and Table 4. By themselves, the values found in Table 5 through Table 7 provide little useful information beyond showing how the model is calibrated. Rather, the significance of the general equilibrium model and of the equilibrium values is in how these values change in response to a policy initiative that perturbs the general equilibrium.

b. *A Complete Elimination of Direct Government Payments Case*

Table 5, Table 6 and Table 7 present the general equilibrium values for prices and quantities for the producing sectors, consuming sectors and households, respectively, as a result of completely eliminating direct government payments to farmers. Also indicated in these tables are the percentage changes in the equilibrium quantities in the producing sectors, consuming sectors and households due to implementing the proposal.

The complete elimination of direct government payments to farmers will have several effects. Consider the producing sectors first. In response to the elimination of direct payments, total output in the producing sectors will fall by 0.18 percent or by about $14.5 billion.[13] This fall, however, is not uniformly spread across producing sectors. For example, the output of the chemicals and plastics sector will fall by 0.28 percent ($944 million).[14] This is a result of the reduction in agricultural program crop production which is a large user of pesticides provided by the chemical industry. For the crude oil and natural gas sector, output falls by 0.05 percent ($60 million) due to the lower demand for anhydrous ammonia fertilizer whose main feedstock is natural gas. Output in the food and tobacco sector will fall by 0.55 percent ($2.2 billion). This reflects the higher food and tobacco prices induced by the elimination of the government subsidy in the production of program crops (Gardner (1975)). Output in the manufacturing sector rises by 0.18 percent ($4.0 billion) as resources are released from the agriculture program crops sector.

The three agriculture sectors as well as the forestry sector will be affected. Output in the program crops sector will fall by 14.07 percent (or by $10.2 billion) as the elimination of direct government payments make it unprofitable for many farmers to continue to produce what were previously program crops, output in the livestock sector will decline by 0.80 percent (or by $1.1 billion) and output in the all other agriculture commodities sector will be reduced by 0.81 percent (or by $567 million). Output reduction in these latter two sectors is a reflection of the input-output effects of the interrelationship with the agricultural program crops sector. Thus, for example, with the higher price of corn (a program crop) in response to the elimination of direct government payments, the cost of feed for cows (part of the agricultural livestock sector) will rise. With higher input costs and all other things given, output in the livestock sector will fall. Output in the forestry sector will rise by 1.97 percent (or by $296 million) for a number of reasons including the fact that the now cheaper land (see below) is diverted to the production

13. Note that these and other effects are in terms of the annual impacts. That is, they indicate what will occur each year.

14. In order to limit the number of tables, some of the equilibrium prices and quantities will not be explicitly presented although selected values will be discussed. The omitted tables are available from the authors upon request.

of timber. Additionally, the substantial increase in the price of the output of the program crops sector relative to the price of most other output will result in an increase in the output wood products (which is driven in part by an increase in the demand for housing) increasing the demand for timber. Thus, the complete elimination of direct government payments to farmers stands to impose some costs, in terms of reduced output, on the three land-using agriculture sectors of about 4.39 percent (or $12.0 billion) in the aggregate but increase output in the forestry sector.

Accompanying the changes in agricultural output are changes in the prices of the agricultural commodities. Thus, for example, the price of the output of program crops will rise by 22.54 percent, the price of the output of the livestock sector will increase by 0.22 percent, the price of the output of all other agricultural commodities will fall by 2.39 percent and the price of the output of forestry products will fall by 3.44 percent.

While these price changes might seem anomalous at first, they are not when considered in the context of a general equilibrium. With the elimination of subsidies to farmers, the price of program crop sector output will rise. Associated with this price rise is a reduction in the quantity of agricultural program commodities produced. The effects of this reduction in program crop output and higher output price are mixed and will include changes in the relative prices for the factor inputs including land, fertilizer, and agricultural chemicals. The net effects are those indicated.

With regard to the consuming sectors, the complete elimination of direct government payments to farmers in the aggregate results in a decrease in the consumption of goods and services by about 0.11 percent ($4.2 billion). The most adversely impacted sector is the food sector which experiences a 0.57 percent ($3.2 billion) fall in consumption while the second most heavily impacted (in relative terms) is the alcohol and tobacco sector which encounters a 0.45 percent ($492 million) decline. Most other sectors experience a decline in consumption attributable to the indirect effects of the complete elimination of direct government payments to farmers. These indirect effects include a lower real income (brought about by an decrease in the transfers from the government to the agricultural program crops sector and the attendant multiplier effect) and changing relative prices.

Utility falls for all six of the household categories. The aggregate reduction in utility is 0.47 percent ($22.0 billion) for all household categories. The reduction does fall fairly evenly across households, however. Category VI households (i.e., those with incomes in excess of $50,000) experience a reduction in utility of 0.39 percent ($6.5 billion) while category a 0.41 percent ($2.6 billion) reduction in utility. The remaining household categories incur percentage reductions in utility of about the same order of magnitude. Additionally, when all of the effects of the policy initiative are considered (that is, both the direct and the indirect effects), the complete elimination of direct government payments to farmers, in general, is not regressive across household categories. That is, it does not fall most heavily on the lowest household (income) category and progressively less heavily on households with larger incomes. Rather, the effect is approximately constant (in relative terms) across income categories.

The government is the main beneficiary of the complete elimination of direct government payments to farmers. The reduction in expenditures amount to 1.74 percent of about $13.4 billion of the total government budget. Thus, the initiative will have the desired effect of contributing to a reduction in the federal budget deficit.

c. *Whither Land Values?*

What will happen to the price of land as well as the price of the other factors of production in response to the complete elimination of direct government payments to farmers? Recall that all prices are normalized to one initially. With the adoption of the policy initiative, the price of land falls to 0.8592, the price of labor rises to 1.0008, and the price of capital falls to 0.9971 as the price and use of the factors of production adjust to the new equilibrium conditions. Thus, the value of land declines by 14 percent as the demand for land falls reflecting such things as the now lower income earnings of the land and the lower expectations of those earnings.[15] Note that this value is consistent with the estimates of others studies (cited previously) concerning the impact of direct government payments to farmers for the production of program crops has on the value of land.

IX. Sensitivity Analysis

No analysis is complete without an examination of the sensitivity of the results to key assumptions. In the foregoing discussion, many assumptions were made with regard to model structure and parameter estimates. A full examination and discussion of these assumptions would be virtually impossible. Consequently, only the results from the sensitivity analysis of one crucial assumption will be discussed. Namely, what are the effects on the vector of equilibrium prices and quantities of the assumption concerning the elasticity of substitution between the factors of production - land, labor, and capital? The original point estimates of these elasticities are lowered by 50 percent and raised by 50 percent. In general, the effect of raising the elasticity of substitution is to magnify the influence of the complete elimination of direct government payments to farmers initiative while lowering it, mitigates its impact. The quantitative effects, however, on the results are minimal. For example, with changed elasticities of substitution neither output nor consumption nor total utility is affected by more than $100 million. The price of land falls by 15.4 percent with the higher elasticities of substitution and falls by 12.7 percent with the lower elasticities. In no case is there any change in the qualitative results discussed previously.

These sensitivity results suggest that the values of the input substitution elasticities, while important in the determination of the vectors of general equilibrium prices and quantities and significant in determining the implications of a policy initiative whereby there is a complete elimination of direct government payments to farmers, are not so pivotal to the model that an error in their values lead to misleading and nonsensical results.

15. There is the possibility that the impact of the complete elimination of direct government payments to farmers has already been partially factored into the current (base year) price of land as forward looking land purchasers have seen the inevitable elimination of direct government payments to farmers and factored this in to what they are willing to pay for agricultural land. The quantitative magnitude of this, however, is impossible to ascertain and, consequently, the best that can be concluded is that estimated decline in the value of land of 14 percent is probably somewhat understated in the context of the longer horizon transcending the base year.

X. Conclusion

The foregoing analysis has examined the effects of the complete elimination of direct government payments to farmers on the U.S. economy in general and land values in particular. The analytical approach used in the study consisted of a computable general equilibrium model composed of 14 producing sectors, 14 consuming sectors, six household categories classified by income and a government. The results suggest that, with a complete elimination of direct government payments to farmers, there will be a reduction in output by all producing sectors of 0.18 percent or about $14.5 billion, a decline in output in the agricultural sectors of 4.39 percent or about $12.0 billion, a fall in the consumption of goods and services by about 0.11 percent or $4.15 billion, a fall in total utility by 0.47 percent or $22.0 billion and a net reduction in expenditures for the government of $13.4 billion. Land values will be adversely affected, falling an average of 14 percent.

As a consequence of this analysis, the implications of the complete elimination of direct government payments to farmers are clear. Namely, most producing sectors experience a reduction in output although a few benefit in terms of increased output in response to resources being released from agriculture. The various consuming sectors experience a cumulative fall in the consumption of goods and services as net income in the aggregate falls and as the prices of some goods rise. These changes, however, are relatively modest.

Beyond the quantifiable effects on production, consumption, and utility, land values and the values of the other factors of production, there will be some difficult-to-quantify improvements in the environment. The nature and extent of these, however, are not discussed here because the computable general equilibrium model used in the analysis does not have an environmental component because elements of environmental quality are extremely difficult to quantify let alone interrelate with the various producing and consuming sectors of the U.S. economy.

Appendix

Empirical Model

I. Overall Equilibrium by Sector

$$Y_j + GE_j + UM_j = \sum_L RAS_{jL} + GD_j + CD_j + UX_j + INV_j \quad (1)$$

$$\sum_c SL_c = \sum_j DL_j + GDL \quad (2)$$

$$\sum_c SK_c = \sum_j DK_j + GDK \quad (3)$$

$$\sum_c SD_c = \sum_j DD_j + GDD \quad (4)$$

where

$$GDL = \sum_j TL_j \quad (5)$$

$$GDK = \sum_j TK_j \quad (6)$$

$$GDD = \sum_j TD_j \quad (7)$$

II. Consumer Goods and Services

$$CD_j = \sum_i Z_{ji} [GCE_j - TC_j] \quad (8)$$

$$\sum_c RCS_{ic} = GCE_i \quad (9)$$

$$\sum i \ RCS_{ic} = SL_c + SK_c + SD_c + TRN_c - PIT_c \quad (10)$$

$$GC_c = \sum_i RCS_{ic} - SAV_c + (1-TAU_c)(ZTA_c - 1) \ SL_c \quad (11)$$

$$GC_c = SL_c + SK_c + SD_c + TRN_c - PIT_c + (1 - TAU_c)(ZTA_c - 1) \ SL_c \quad (12)$$

$$TE = \sum_c(SL_c \ ZTA_c \ TAU_c + SK_c \ TAU_c + SD_c \ TAU_c - (\phi_c + TRN)) \quad (13)$$

where $\phi_c = SL_c \ TAU_c + SK_c \ TAU_c + SD_c \ TAU_c - PIT_c$

III. Foreign Sector Balance

$$\sum_j (UM_j (EM_j / (1 + EM_j)) + UM_j / (1+ EM_j)) = \sum_j (UX_j + FE_j) \tag{14}$$

IV. Consistency

$$\sum_c (SL_c + SK_c + SD_c + TRN_c - PIT_c - TC_c) = \sum_c CG_c \tag{15}$$

(Net household income equals household expenditures)

$$\sum_j (GSK_j + GE_j + TL_j + TK_j + TD_j + TXO_j)+ GTL \tag{16}$$

$$= \sum_c TRN + \sum_j (GDK_j + GD_j) + GD_c)$$

(Government income plus endowments equals government outlays)

$$\sum_j (UM_j - UX_j) = 0 \tag{17}$$

(Net exports equal zero)

$$\sum_j (CD_j + GD_j + UX_j - GE_j - UM_j) \tag{18}$$

$$= \sum_c (DL_j + DK_j + TL_j + TK_j + TXO_j)$$

(The value of demand equals value added plus taxes)

Y_j – Total production in sector j (j = 1, 2, …, 14)

CD_j – Consumer demand for product j

GE_j – Government endowment of product j

UM_j – Imports of product j

$\sum_L RAS_{jL}$ – RAS balanced input - output intermediate demands

GD_j – Government demand for product j

INV_j – Investment in sector j

UX_j – Exports of product j

SL_c – Supply of labor by household c (c = 1, 2, …, 6)

SK_c – Supply of capital by household c

SD_c – Supply of land by household c

DL_j – Demand for labor in the industry j

DK_j – Demand for capital in the industry j

DD_j – Demand for land in industry j

GDL – Government demand for labor

GDD – Government demand for land

TL_j – Tax on labor in industry j

TK_j – Tax on capital in industry j

TD_j – Tax on land in industry j

GCE_i – Consumer demand for consumer product i (i = 1, 2, …, 14)

Z_{ji} – A 14 by 14 transformation matrix

RCS_{ic} – RAS balanced matrix of each household's demand for each consumer good
TC_j – Excise tax on consumer good j

TRN_c – Transfer payment to household c

PIT_c – Personal income tax payment for household c

TAU_c – Marginal income tax rate for household c

SAV_c – Savings in household c

GC_c – Gross consumption of household c

ZTA – Consumption plus leisure coefficient

TE – Total government endowments

EM_j – Demand elasticity of export demand

FE_j – Endowment/Demand sector of adjusted elasticity of export demand

GSK_j – Government endowment of capital in industry j

GDK_j – Government demand for capital in industry j

GTL – Government wage taxes on its own employees

TXO_j – Government output tax on industry j

TC_c – Consumption taxes on household c

CG_c – Total government consumption by household c

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